7.0 EVALUATION OF IMPACTS

7.1 Introduction

The implementation and construction of the project will involve activities having the potential to negatively affect the environment. In order to identify and assess all potential impacts, the project activities have been grouped into four broad categories as follows:

- Pre-construction phase
- Construction phase
- Post-construction / post-reclamation phase
- Impacts arising from abandonment of the project

Pre-construction Phase

- Reconnaissance Survey
- Site and Soil investigation
- Related Studies (Feasibility Study and EIA study)

Construction Phase

- Preliminary works and site preparation
- Land acquisition (if required)
- Environmental mitigation works (silt curtain installation, construction of bunds, revetment etc.)
- Reclamation works & construction of coastal protection structures
- Post survey works
- Demobilisation, landscaping (if any) & final clean-up

Post-Reclamation Phase

- Marine traffic for fisheries activities

From the information above, the environmental components which are likely to induce potentially significant impacts are identified for analysis, discussion and assessment. In arriving at decisions on environmental impacts, the relevant guidelines published by the DOE were used as references.

Appendix VI gives a summary of the potential impacts of the proposed project using the impact assessment matrix. Major impacts for various environmental factors are outlined and further elaborated in the following sections.

7.2 Hydraulic and Hydrodynamics

This section is extracted from the approved Hydraulic Study Report done by Aqvaspace Sdn. Bhd. The Hydraulic Study approval letter from Department of Irrigation and Drainage (DID) is attached in **Appendix V**.

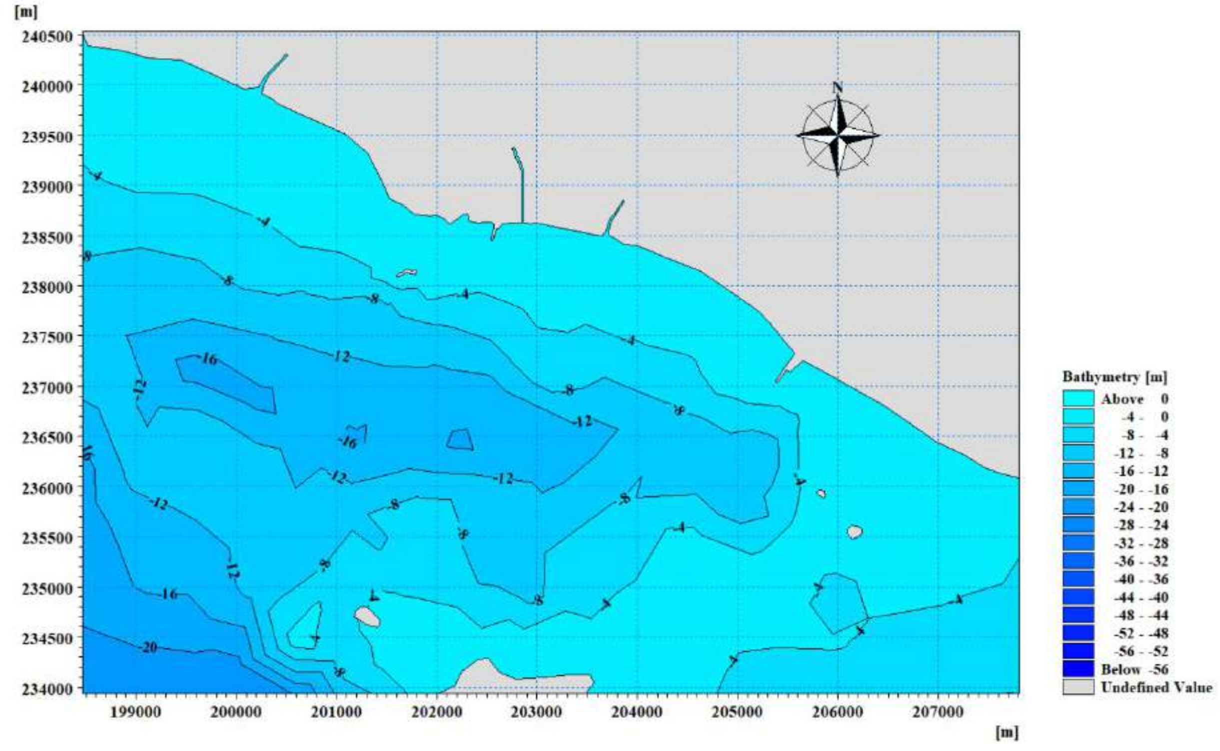
7.2.1 Impact on Hydrodynamic Condition

Two different scenarios were selected under this study to assess the impact of the proposed reclamation works i.e. Scenario A – Baseline condition and Scenario B – with proposed reclamation. **Figure 7.1** shows the outline of the project area and displays the model bathymetry for two different scenarios. It shows the actual structure along the project area. The modelling focuses on the proposed reclamation area which is connected to the mainland.

7.2.1.1 Impact on Current Speed

Current speeds are mainly induced by the tidal forcing and the bathymetry characteristics as well as by the wind action on the water surface. In general, current speeds are lower in the shallow areas and the model prediction shows that the mean difference read approximately -0.405m/s and maximum difference is 0.105m/s in the vicinity of the reclamation site. **Table 7.1** shows the comparison for mean current speed in the project area.

Scenario A - Baseline Condition



Scenario B - With Proposed Reclamation

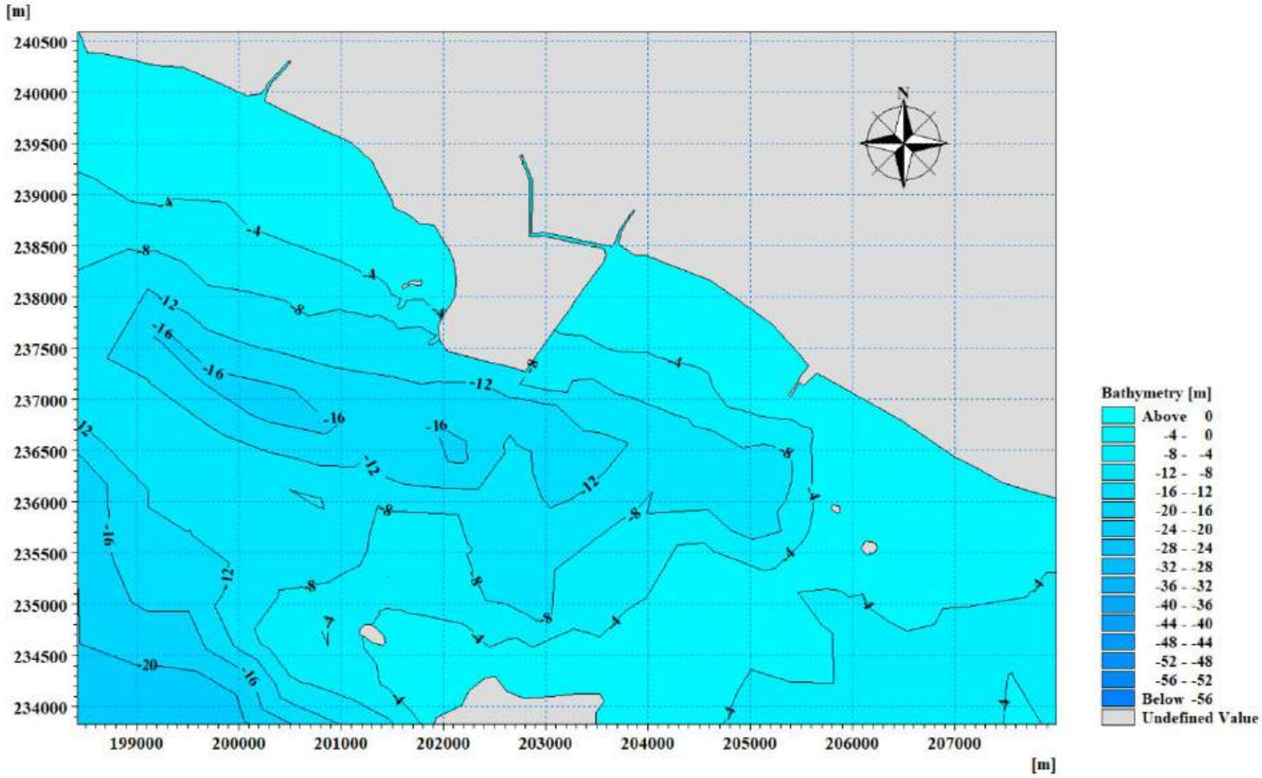


Figure 7.1: Scenario A and B with Bathymetry

Table 7.1: Comparison For Mean Current Speed In The Project Area

Scenario	Monsoon	Mean Current Speed (m/s)
Scenario A (baseline)	Northeast Monsoon	0.04 - 0.2
Scenario B (proposed reclamation)	Northeast Monsoon	0.04 - 0.2
Scenario A vs Scenario B	Northeast Monsoon	-0.045 - 0.105
Scenario A (baseline)	Southwest Monsoon	0.04 - 0.2
Scenario B (proposed reclamation)	Southwest Monsoon	0.04 - 0.2
Scenario A vs Scenario B	Southwest Monsoon	-0.045 - 0.105

7.2.1.2 Impact on Water Level

Water levels are produced by a combination of forces of which the two major components are gravitation forces and climatic effects that induce a variation of the tidal levels due the shear effect of the winds and/or regional barometric pressure fields. An assessment of water levels has been carried out to provide additional information on water levels around the project area that can be used to verify if the proposed reclamation work levels are acceptable.

Based on the modelling done, it is evident that the change in maximum water level is very minimal. **Table 7.2** shows the minimum and maximum water levels for different monsoons.

Table 7.2: Comparison For Minimum and Maximum Water Levels in the Project Area

Scenario	Monsoon	Water Level (m/s)	
		Minimum (m)	Maximum (m)
Scenario A (baseline)	Northeast Monsoon	-1.52 to -0.72	1.39 to 1.40
Scenario B (proposed reclamation)	Northeast Monsoon	-1.50 to -0.72	1.392 to 1.40
Scenario A vs Scenario B	Northeast Monsoon	-1.50 to 0.30	0.00 to 1.20
Scenario A (baseline)	Southwest Monsoon	-1.52 to -0.72	1.392 to 1.40
Scenario B (proposed reclamation)	Southwest Monsoon	-1.50 to -0.72	1.392 to 1.40
Scenario A vs Scenario B	Southwest Monsoon	-1.50 to 0.30	0.00 to 1.20

7.2.1.3 Impact on Wave Condition

Wave modelling was carried out for the existing condition and different scenarios in this section. Two different scenarios were carried out for the reclamation purposes. The results indicate that wave heights ranges between 0.24m to 0.42m depending on the wave directions (see **Table 7.3**).

Table 7.3: <u>Comparison For Significant Wave Heights and Mean Wave Direction in Project Area</u>

Scenario	Monsoon	Significant Wave Height (m)	Mean Wave Direction (degree)
Scenario A (baseline)	Northeast Monsoon	0.24 – 0.30	225 - 240
Scenario B (proposed reclamation)	Northeast Monsoon	0.36 – 0.42	255 – 270
Scenario A (baseline)	Southwest Monsoon	0.30 – 0.36	165 – 180
Scenario B (proposed reclamation)	Southwest Monsoon	0.36 – 0.42	160 - 180

7.2.1.4 Impact on Mud Transport

Impact on bed thickness change is assessed for two different scenarios. The scenarios show the bed thickness change is only between 0.0m/year to +0.04588m/year. It is found that the project site may experience minimal impact of erosion and deposition even after the reclamation has been completed. It is clear from the model results that not much impact on the morphology of the area even with the presence of the proposed reclaimed land.

7.2.2 Sediment Plume Dispersion Pattern

The plume dispersion study was carried out for northeast monsoon. The purpose of the sediment dispersion study is to investigate the movement of suspended sediments during the filling process for reclamation. This is to simulate conditions during the period of the works being carried out. The levels of suspended sediment concentration are assessed to determine potential impact to the surroundings. Sediment plumes originating from the reclamation operation were simulated. Two scenarios were investigated, with silt curtain and without silt curtain during reclamation works. Silt curtain are able to control the dispersion of turbid water by diverting the flow under the curtain, thereby minimizing turbidity in the upper layer of the water column outside the silt curtain.

The spill rate and the total spill will be highly dependent upon work procedures, scheduling and reclaimed material characteristics. Each conveyor barge with a capacity of 1,250 m^3 is assumed to operate for 12 hrs (from 7 am to 6 pm) on a daily basis. Each barge has a pumping rate of 0.1 m^3/s. The spill concentration is 4.0 kg/m^3 for without silt curtain condition and 0.8 kg/m^3 for with silt curtain condition. Results from the spill are presented in mean suspended sediment concentrations showing the extent and concentration over the simulation period for spring and neap tide at four different points or sources.

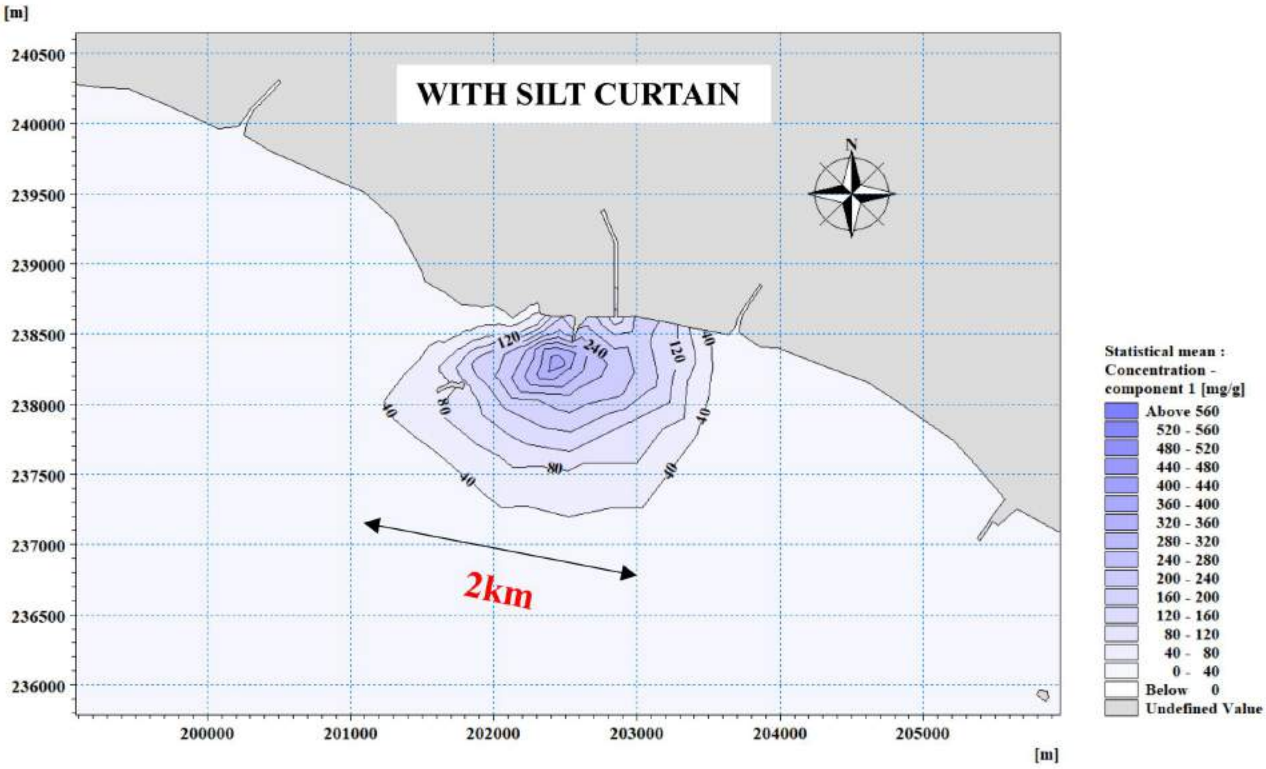
The plume patterns indicate that excess suspended sediment concentrations generated from the reclamation work are only at the project site and nearby area. **Figures 7.2** and **7.3** show the mean sediment dispersion pattern during neap tide and spring tide. The mean plume extents approximately up to 3.5km and 3km during neap tide with and without silt curtain respectively. On the other hand, the maximum plume extent approximately up to 6.8km during spring tide with and without silt curtain.

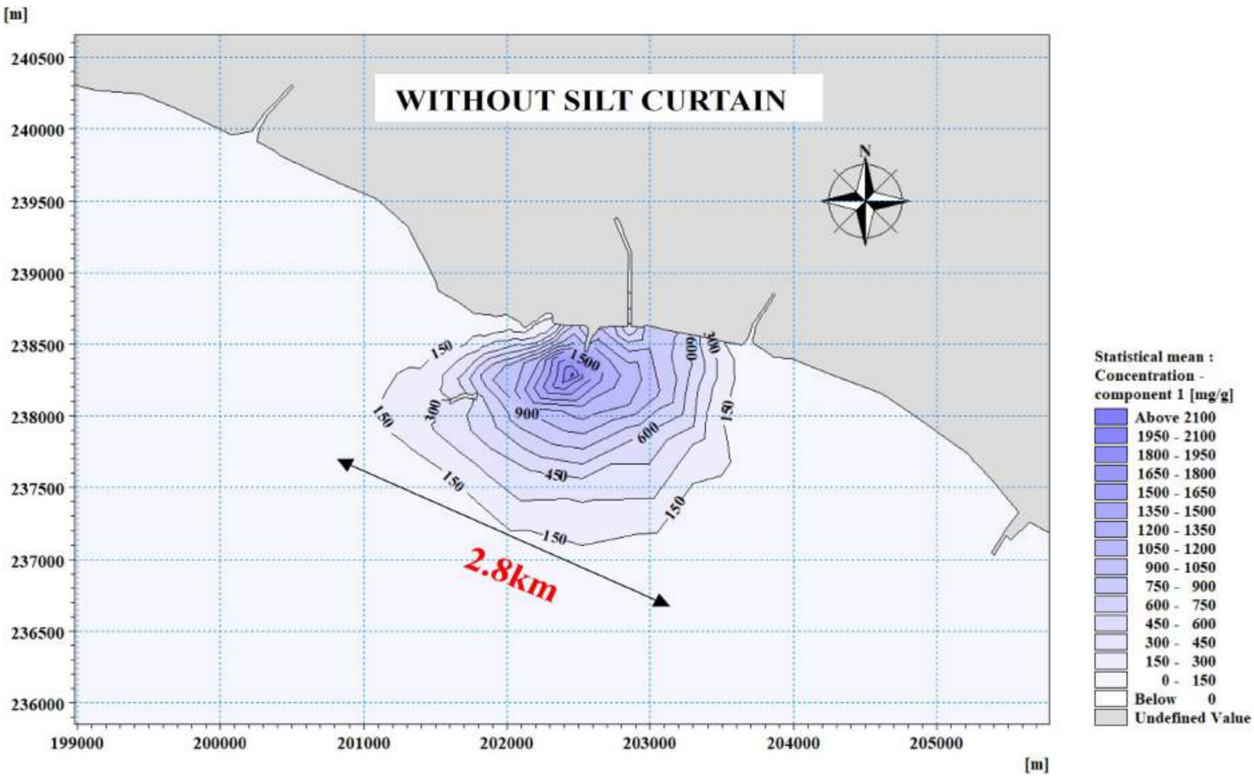
7.2.3 Cumulative Hydraulic Impact Assessment With All Other Proposed Reclamation Projects Nearby

In conjunction to overall impact assessment study, several approved projects that are expected to kickoff near to the proposed reclamation area are considered into the simulation in terms of hydrodynamic evaluation. Four projects are considered to be included into the evaluation process as per shown in **Figure 7.4**.

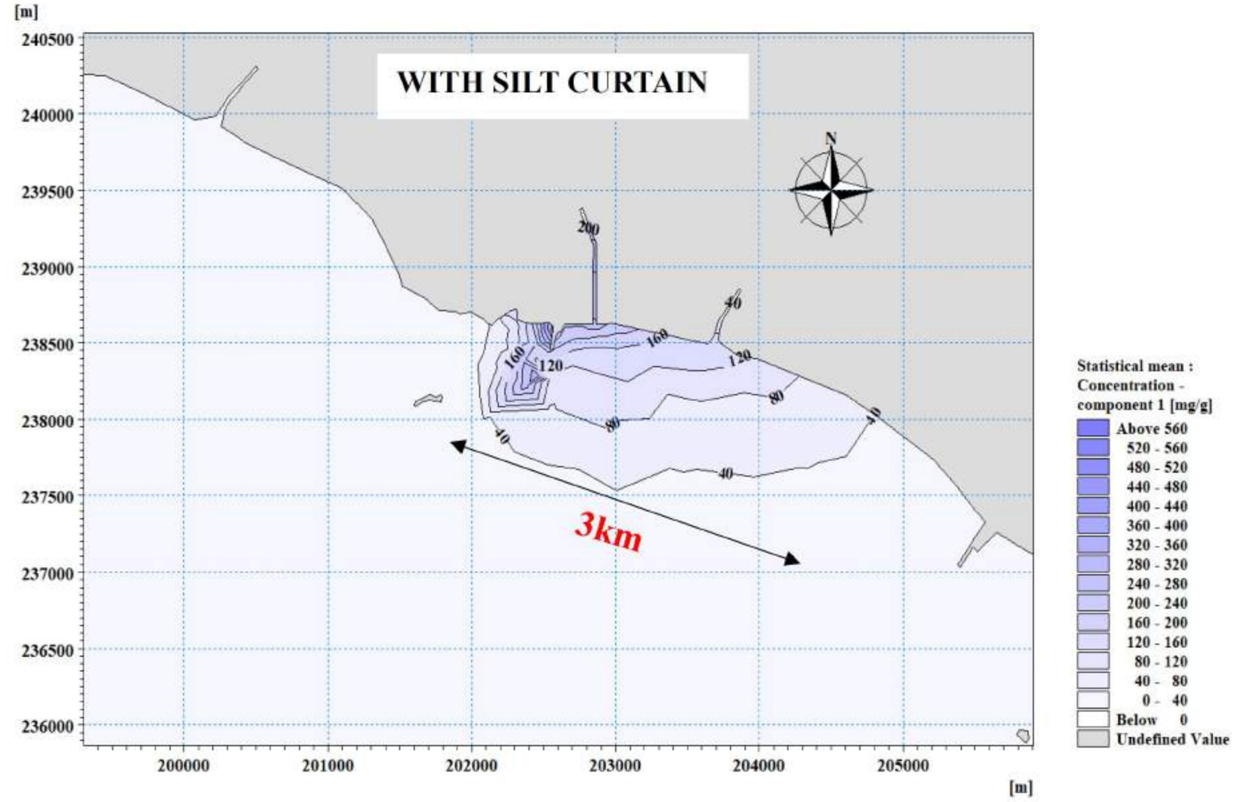
The assessment factors are based on current speed, water level and significant wave heights. The summary of the analysis of the results are as shown in **Figure 7.5**.

(a) **Current speed** pattern shows slight increment of about -0.035 m/s + 0.215m/s for mean current pattern. Approved projects show higher pattern of current speed due to the uneven reclamation plot base on the developers' proposal, where else the Yayasan Melaka project just showing very minimal changes. Both simulated





CIRI SELASIH SDN. BHD. ENVIRONMENTAL & TRAFFIC CONSULTANT	**Figure 7.2:** Mean Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Neap Tide with and without Silt Curtain at All Sources	7-5a



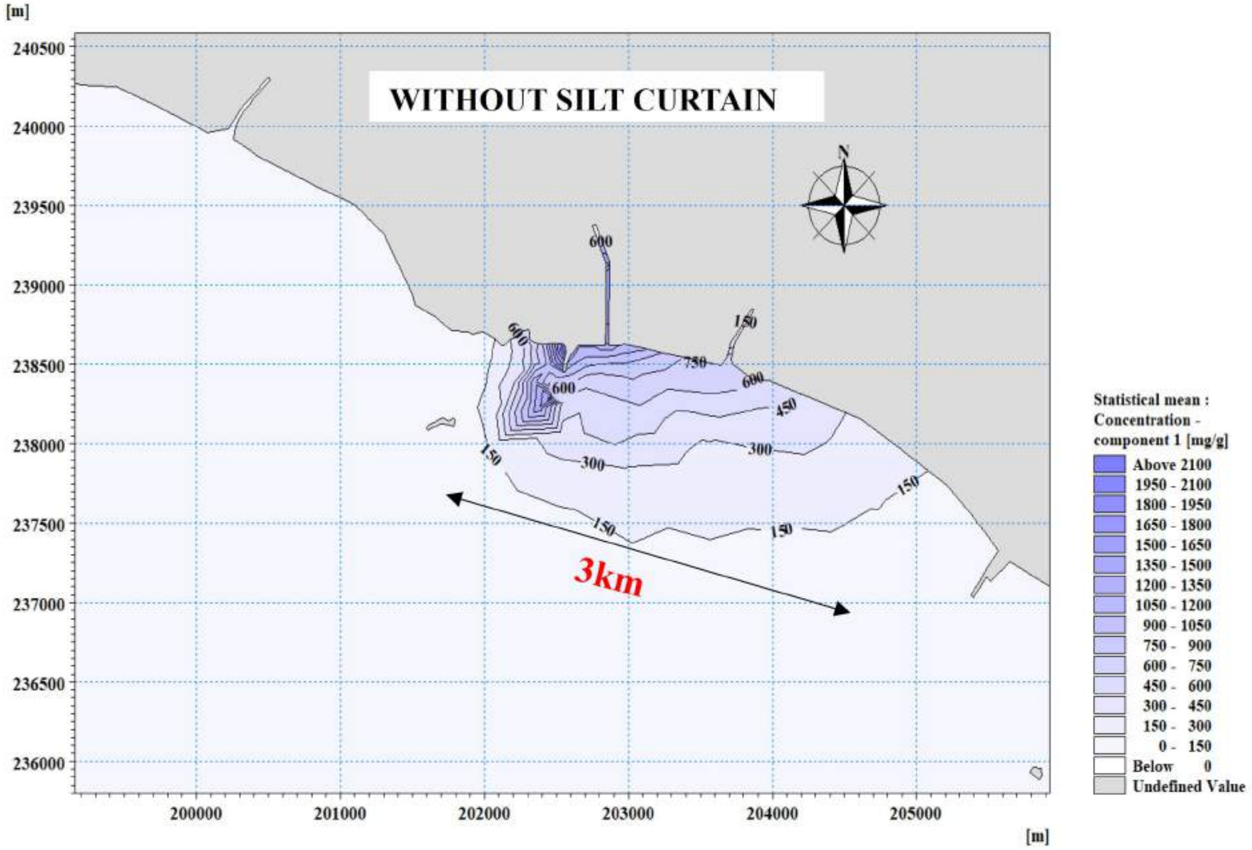


Figure 7.3: Mean Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Spring Tide with and without Silt Curtain at All Sources

Legend

No	Project Area	Developer
1	Proposed Reclamation 100 ac	Kota Laksamana
2	Proposed Reclamation 50 ac	Hatten
3	Proposed Reclamation & Floating Chalet	Melaka Tengah
4	Proposed Reclamation 609 ac	KAJ
5	Proposed Reclamation 400 ac	Yayasan Melaka

Source: Hydraulic Report, 2019

Figure 7.4: Approved Nearby Reclamation Projects

Scenario	Monsoon	Yayasan Melaka	Approved Project	Changes in Current (Mean) of Yayasan Melaka vs Approved Projects
		Current Speed		
		Mean (m/s)	Mean (m/s)	Mean (m/s)
Scenario-A	NE	0.04 – 0.2	0.04 – 0.44	0.24
Scenario-B	NE	0.04 – 0.2	0.04 – 0.44	0.24
Scenario-A Vs Scenario B	NE	-0.045 – 0.105	-0.08 – 0.32	-0.035 - 0.215
Scenario-A	SW	0.04 – 0.2	0.04 – 0.44	0.24
Scenario-B	SW	0.04 – 0.2	0.04 – 0.44	0.24
Scenario-A Vs Scenario B	SW	-0.045 – 0.105	-0.08 – 0.32	-0.035 - 0.215

Scenario	Monsoon	Yayasan Melaka		Approved Project		Changes in Water Level (Minimum) of Yayasan Melaka vs Approved Projects	Changes in Water Level (Maximum) of Laksamana Prima vs Approved Projects
		Water Level					
		Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)	Minimum (m)	Maximum (m)
Scenario-A	NE	-1.52 – -0.72	1.39 – 1.4	-1.52 – -0.72	1.39 – 1.44	0.0	0.0 - 0.04
Scenario-B	NE	-1.5 – -0.72	1.392 – 1.4	-1.56 – -0.72	1.39 – 1.44	0.06	0.002 - 0.04
Scenario-A Vs Scenario B	NE	-1.5 – 0.3	0.0 – 1.2	-1.5 – 0.3	0.0 – 1.2	0.0	0.0
Scenario-A	SW	-1.52 – -0.72	1.392 – 1.4	-1.52 – -0.72	1.39 – 1.44	0.0	0.002 - 0.04
Scenario-B	SW	-1.5 – -0.72	1.392 – 1.4	-1.56 – -0.72	1.39 – 1.44	0.06	0.002 - 0.04
Scenario-A Vs Scenario B	SW	-1.5 – 0.3	0.0 – 1.2	-1.5 – 0.3	0.0 – 1.2	0.0	0.0

Scenario	Monsoon	Yayasan Melaka		Approved Project		Changes in Significant Wave Heights of Yayasan Melaka vs Approved Projects	Changes in Mean Wave Direction of Yayasan Melaka vs Approved Projects
		Wave					
		Heights (m)	Direction (Degree)	Heights (m)	Direction (Degree)	Heights (m)	Direction (Degree)
Scenario-A	NE	0.24 - 0.3	225 -240	0.24 – 0.32	240 – 260	0.02	15 - 20
Scenario-B	NE	0.24 – 0.36	225 - 255	0.24 – 0.32	250 - 275	-0.04	20 - 25
Scenario-A	SW	0.24 – 0.3	165 - 180	0.24 – 0.3	180 – 195	0.0	0
Scenario-B	SW	0.24 – 0.36	160 – 180	0.24 – 0.36	175 - 200	0.0	15 - 20

Source: Hydraulic Report, 2019

Figure 7.5: Comparison of Mean Current Speed, Minimum and Maximum Water Level and Wave at Yayasan Melaka Reclamation Area and Approved Hydraulic Study Area

model for various Northeast monsoon and Southwest monsoon show no changes in current speed.

(b) **Water Level** pattern variation was compared at minimum and maximum level between proposed and approved reclamation layout. However, there are no changes in minimum and maximum water level.

(c) **Significant of wave heights and wave direction** were also considered for both Yayasan Melaka and the approved project areas. Bathymetry differences between both areas show various results at both sites. The Northeast monsoon range of wave heights comparison between the projects for scenario A shows range from 0.0 m to + 0.1 m and for the scenario B after project implementation varies from + 0.02 to + 0.04 m. There are slight changes in wave direction pattern for all projects for Northeast monsoon. Scenario A varies from 15 to 20 degree while for Scenario B, it is 5 degree changes in mean wave direction.

The same comparison for Southwest monsoon does not indicate the same pattern of wave heights and direction as Northeast monsoon. Baseline and post development significant wave height comparison shows 0.0m changes by comparison for the Southwest monsoon. The wave direction pattern shows some refraction pattern after the project implementation at the KAJ (Melaka Gateway) project site. There are no changes in wave direction for baseline condition for Southwest monsoon and 15 to 20 degree for post projects implementation for all projects. As discussed above, the KAJ development shows some variation before and after reclamation.

7.2.4 Hydraulic Impact Assessment on Pulau Menatang

Pulau Menatang is located at about 300m distance to the west of the proposed reclamation area (see **Figure 7.6**). This small island is estimated to be about 0.38 hectares (ha) in size. It submerges into water during high tide phenomenon and exposed during low tide occurrence. Due to the near distance from the proposed project site, Pulau Menatang might face some hydraulic changes due to the proposed project. The hydraulic impact assessment evaluation is based on the hydrodynamic changes such as

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Source: Hydraulic Study

Figure 7.6: Location of Pulau Menatang

tidal impact, current speed, current direction, and wave and morphological changes. Both evaluation are based on the numerical modelling simulation by evaluating Pulau Menatang alone as well as cumulative impact assessment based on the approved nearby reclamation projects.

According to the assessment done by the hydraulic modeller, the hydrodynamic assessment for Pulau Menatang indicates that there will not be any major hydraulic changes to Pulau Menatang with the presence of the proposed project. Cumulative assessment of hydraulic impact on Pulau Menatang also shows no major implication on Pulau Menatang Island.

7.3 Hydrology

This section is extracted from the approved Hydraulic Report.

7.3.1 Impact to Nearby Rivers (Sg. Punggor & Sg. Umbai)

Based on the frequency analysis done in the Hydraulic Study, flow from Punggor-Umbai catchment (see **Figure 7.7**) for different ARI was calculated and furnished in the **Table 7.4**. Based on the above mentioned analysis, the model was simulated for 100 ARI, 50 ARI, 25 ARI, 10 ARI and 5 ARI flow conditions at the upstream. At the downstream, usual tidal fluctuation was considered as there are tidal gates at both the outfall.

Table 7.4: Flow in the Punggor – Umbai River Catchment For Different ARI

Return Period (ARI)	Flow at the Upstream of Punggor River (m^3/s)
100 year	46.2
50 year	43.6
25 year	40.8
10 year	36.8
5 year	33.2
2 year	26.8

7-7a	CIRI SELASIH SDN. BHD. ENVIRONMENTAL & TRAFFIC CONSULTANT	*Source: Hydraulic Report, 2019*	**Figure 7.7:** River Network Surrounding the Study Area

All the scenarios were simulated and maximum water level along the Sg. Punggor and Sg. Umbai has been calculated. The results are furnished in **Chart 7.1** to **Chart 7.5**. It is found from the figures that maximum water level varies from 2.95 mMSL to 2.67 mMSL at the upstream of Punggor river whereas a the upstream of Umbai river it varies from 1.81 mMSL to 1.64 mMSL.

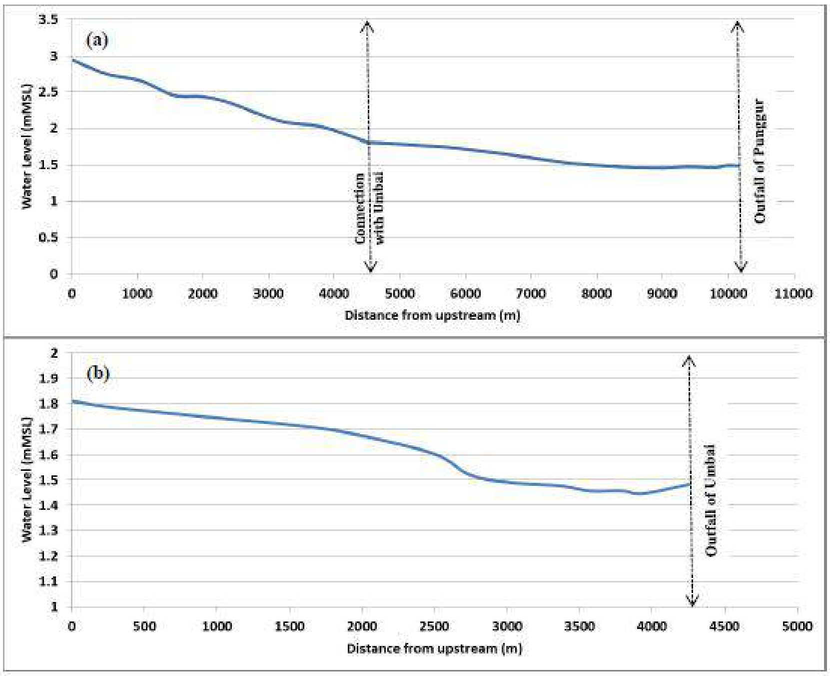


Chart 7.1: <u>Maximum Water Level at (a) Sg. Punggor and (b) Sg. Umbai at 100ARI</u>

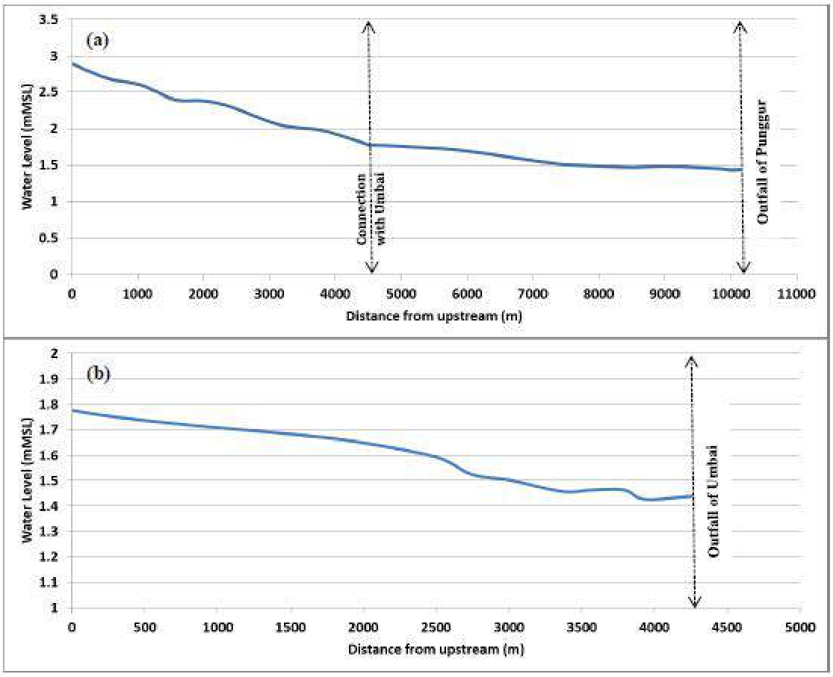


Chart 7.2: <u>Maximum Water Level at (a) Sg. Punggor and (b) Sg. Umbai at 50ARI</u>

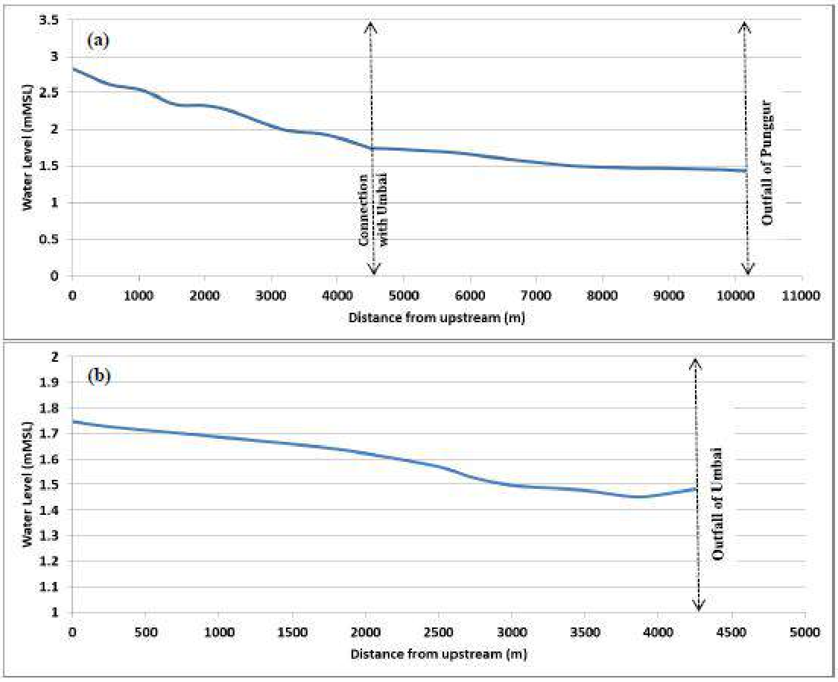


Chart 7.3: Maximum Water Level at (a) Sg. Punggor and (b) Sg. Umbai at 25ARI

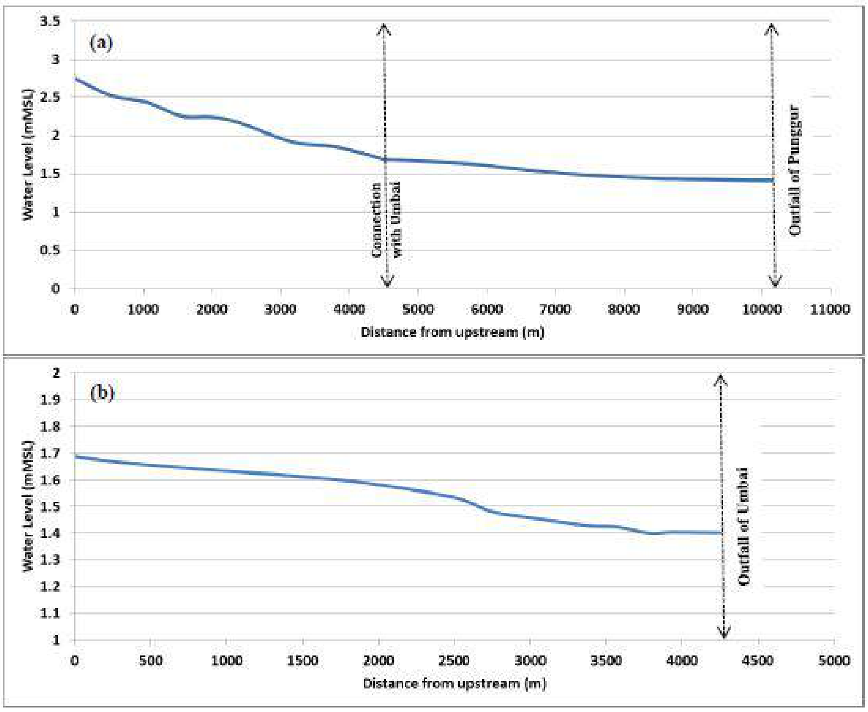


Chart 7.4: Maximum Water Level at (a) Sg. Punggor and (b) Sg. Umbai at 10ARI

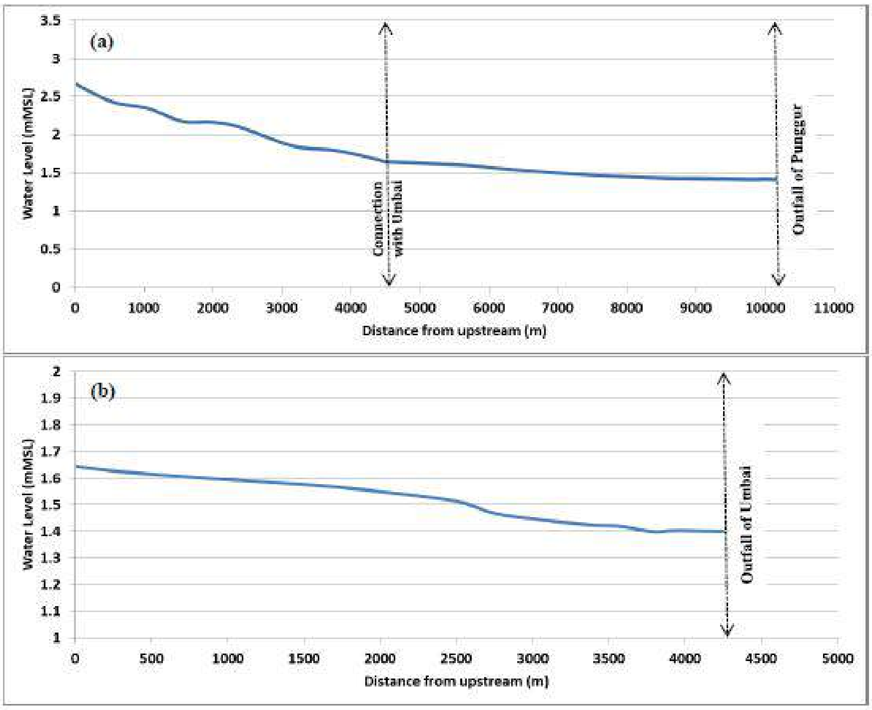


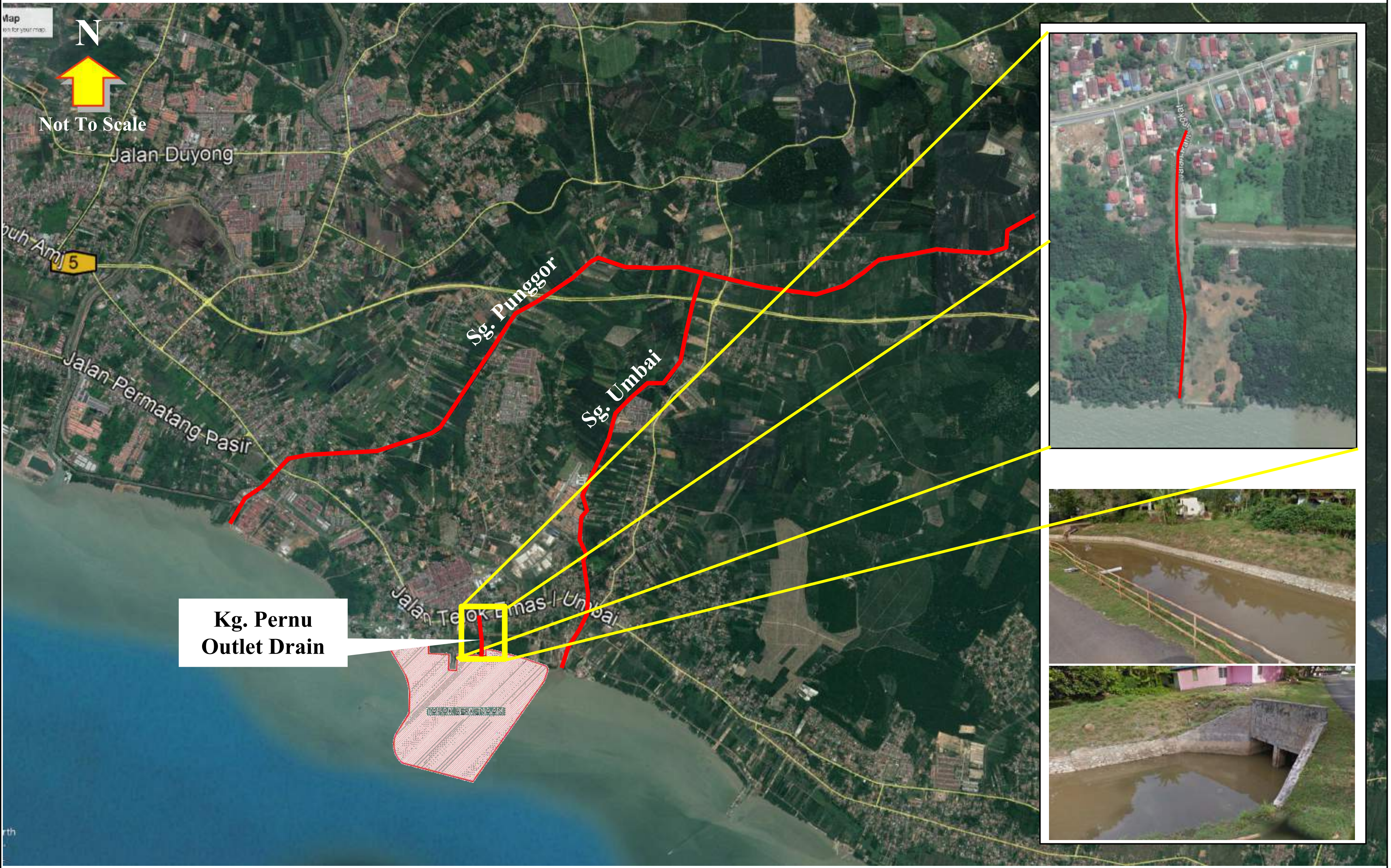
Chart 7.5: Maximum Water Level at (a) Sg. Punggor and (b) Sg. Umbai at 5ARI

7.3.2 Kg. Pernu Drainage Assessment Before and After Reclamation

Kampung Pernu is one of the residential areas which is located between Kampung Punggor and Kampung Umbai. This residential area is located near to the proposed reclamation area where one of the discharge outlets is flowing. **Figure 7.8** shows the Kg. Pernu outlet and **Figure 7.9** shows the Kg. Pernu catchment area.

Kampung Pernu catchment area is estimated to be 163 ha. Area A is estimated to be 25 ha and Area B is estimated to be 138 ha. The discharge of the outlet totally depends on the flow to the sea. Considering the importance of the outlet, the project proponent has decided to remain the channel flow (see **Figure 7.10**). The Kg. Pernu discharge outlet design is calculated based on the ARI 100 years as per the below calculation. The drainage design is also designated to cater the discharge level for future as well.

Drainage calculation is based on rational method from JPS Malaysia, Manual Saliran Mesra Alam (MSMA)



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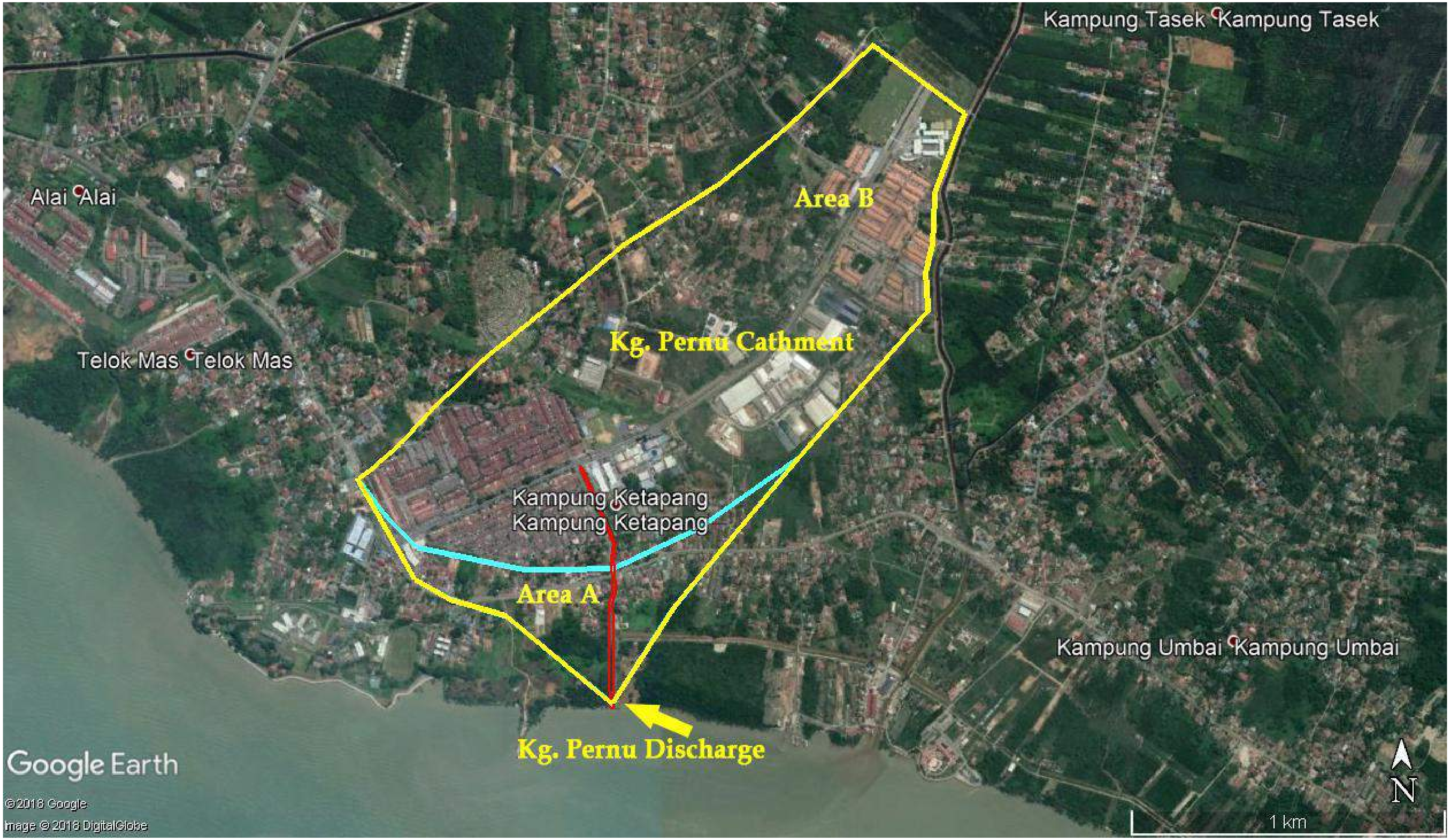
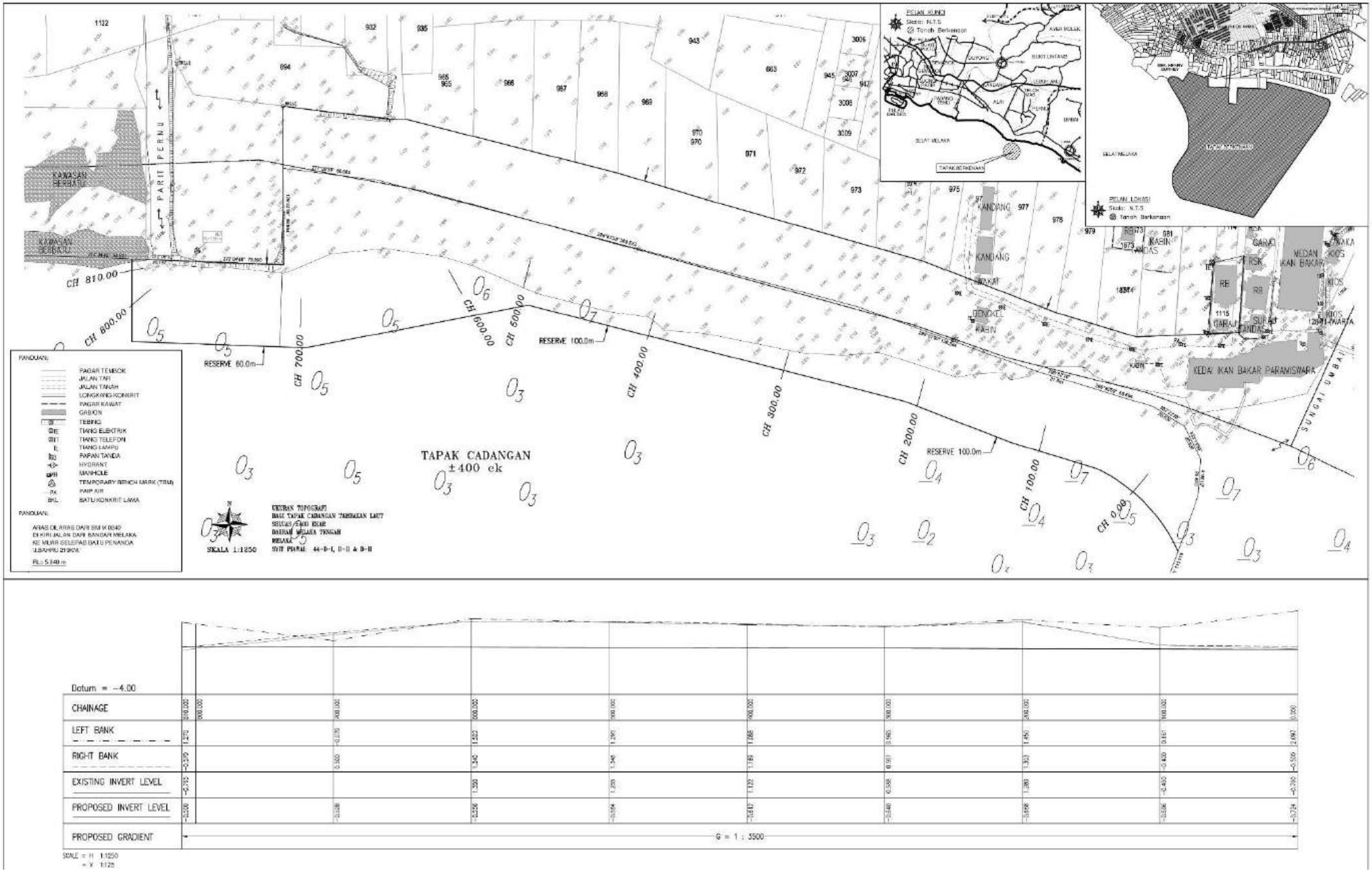
Source: Hydraulic Report, 2019

Figure 7.8: Kg. Pernu Outlet Drain



7-10b	CIRI SELASIH SDN. BHD. ENVIRONMENTAL & TRAFFIC CONSULTANT	*Source: Hydraulic Report, 2019*	**Figure 7.9:**Kampung Pernu Catchment Area and Discharge Outlet



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Source: Hydraulic Report, 2019

Figure 7.10: Long Section for Kg. Pernu Discharge Outlet

Catchment Area, A = 163 ha

Runoff Coeficient C

Composite, C	$= \frac{138 \times 0.85 + 25 \times 0.65}{163}$
	= 0.82
Overland flow Length	= 50 m
Average Slope %	= 0.2
Average Grass Surface, n	= 0.045
Overland flow time, t_0	= 24 minutes (Design Chart MSMA)
Length of stream	= 2500 m
Average Velocity	= 0.65 m/s
Time in drain, t_d	= 69 minutes
Time of concentration, t_c	= 93 minutes

Rainfall Intensity (ARI 100)

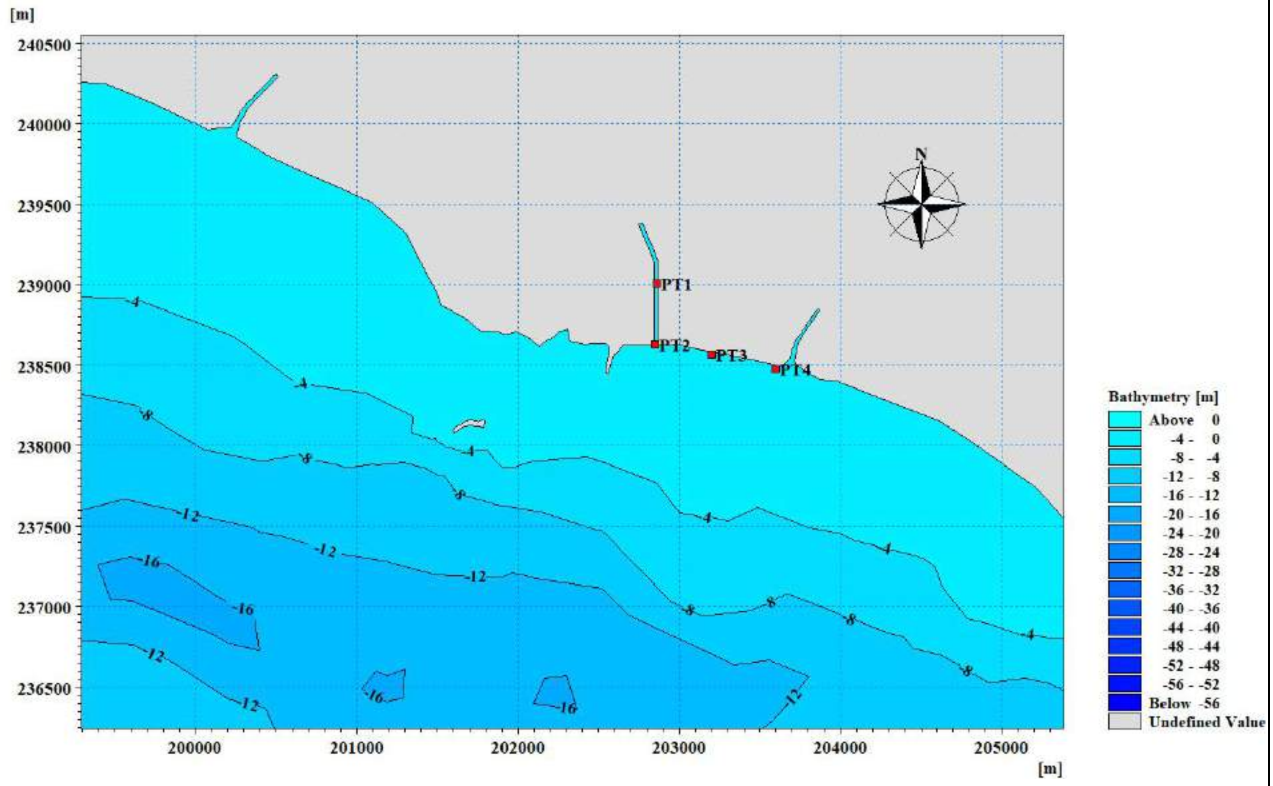
I_{100}	= 86.12 mm/hr

Discharge, Q

Q_{100}	= CIA / 360
	= 0.82 X 86.12 X 163 / 360
	= 31.97 m^3/s

The hydraulic modelling considers the maximum ARI 100 to be 31.97 m^3/s. Hydraulic modelling is developed to analyse impact of the flow before and after the reclamation. **Figure 7.11** and **Figure 7.12** show the results of the modelling.

Based on the results, the discharge value of the channel is estimated to be 31.97 m^3/s for all the estimated four points chosen to be analysed. All the results show that the current/discharge flow and water level from Kg. Pernu indicated almost the same flow level. This current flow indicates that changes of the flow is very minimal. This allowances of the flow are important and ensure that back flow of the current do not happen in the channel.



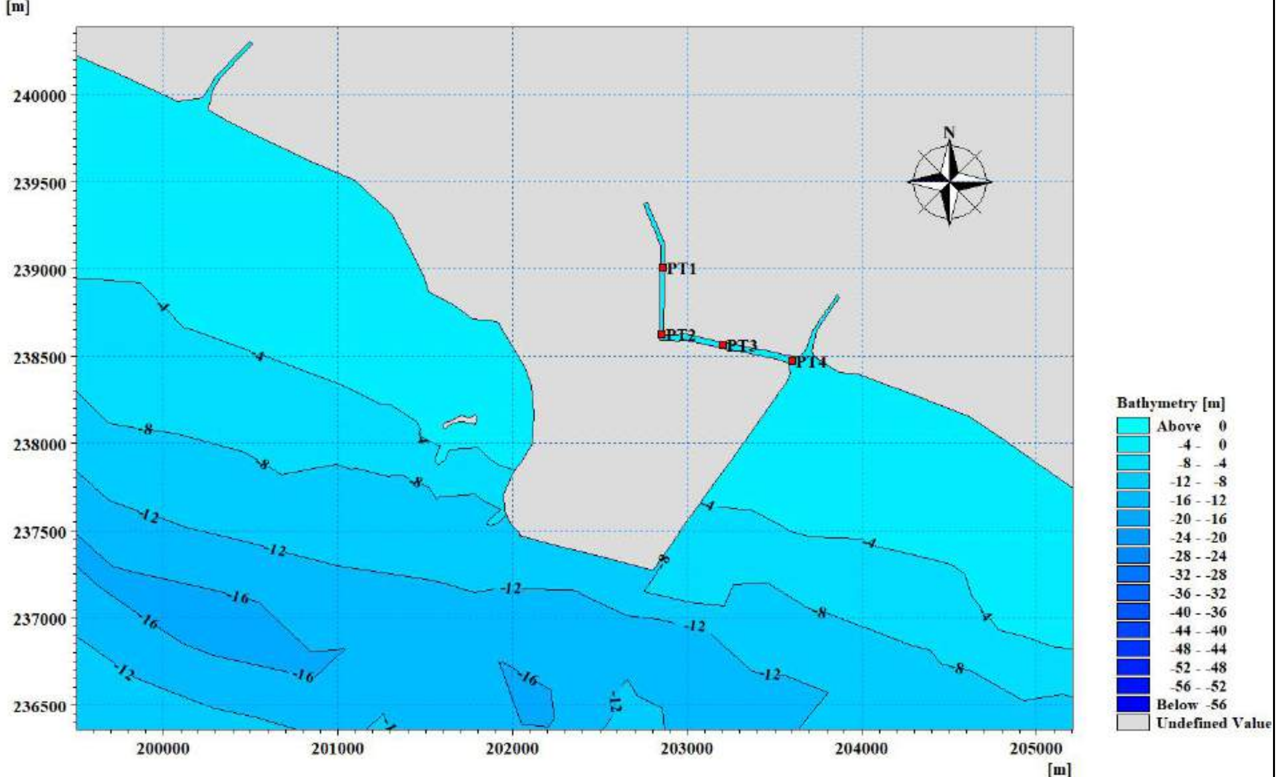


Figure 7.11: Current Flow Comparison Before and After Reclamation

CURRENT SPEED								
Sample ID	Coordinate		NE MONSOON		DIFFERENCE	SW MONSOON		DIFFERENCE
	X	Y	BEFORE	AFTER		BEFORE	AFTER	
PT1	202858.5	239006.1	0.044452	0.030026	0.0144256	0.044414	0.030048	0.0143653
PT2	202852.8	238627.2	0.072567	0.051403	0.0211644	0.074066	0.051363	0.0227027
PT3	203202.9	238563.7	0.052998	0.058672	-0.005674	0.051985	0.05857	-0.006585
PT4	203597.6	238474.5	0.051418	0.069237	-0.017819	0.049663	0.068999	-0.019336

WATER LEVEL														
Sample ID	Coordinate		NE MONSOON						SW MONSOON					
			MIN		DIFFERENT	MAX		DIFFERENT	MIN		DIFFERENT	MAX		DIFFERENT
	X	Y	BEFORE	AFTER		BEFORE	AFTER		BEFORE	AFTER		BEFORE	AFTER	
PT1	202858.5	239006.1	-1.12146	-0.75636	-0.365105	1.39653	1.39593	0.0006	-1.12167	-0.75763	-0.364038	1.39789	1.39768	0.00021
PT2	202852.8	238627.2	-1.16128	-0.756	-0.405283	1.3969	1.39507	0.00183	-1.16075	-0.75731	-0.403442	1.39812	1.39663	0.00149
PT3	203202.9	238563.7	-1.14071	-0.7564	-0.384308	1.3962	1.39443	0.00177	-1.14017	-0.75757	-0.382599	1.39738	1.39583	0.00155
PT4	203597.6	238474.5	-0.79268	-0.81684	0.024155	1.39553	1.39394	0.00159	-0.7924	-0.8198	0.027401	1.39669	1.39525	0.00144

Source: Hydraulic Report, 2019

Figure 7.12: Current Flow and Water Level Comparison Before and After Reclamation at Kampung Pernu

7.4 Waste Generation

7.4.1 Solid Waste

During Construction Phase

During construction phase, solid wastes would originate from 2 sources i.e. the labour camps (if any) and the reclamation activities.

i. *Waste From Labour Camps / Base Camps*

Waste from the labour camps (if any) would comprise mainly of domestic waste that, if not collected and disposed properly would result in unsanitary conditions giving rise to health hazards to the workers and residents / visitors at the neighbouring residential and commercial areas. Thus, proper measures should be adopted by the Contractor to collect and dispose off the waste at an authorised dump site.

ii. *Construction Waste / Surplus From Construction Activity*

During construction, all types of solid and liquid waste will be generated either from the construction itself or from machinery and equipment. The hazardous wastes such as spent oil and grease, chemical solutions etc. are required to be separated from the solid waste and disposed off in a proper manner to be conducted by a licensed waste collector. The hazardous wastes which are as stipulated in the Environmental Quality (Scheduled Waste) Regulation 2005 need to be appropriately disposed off by a licensed waste collector as buried on-site or on-site disposal is strictly prohibited.

Construction waste is generally comprised of non-organic materials such as excess construction materials in the form of steel rods, plastic and concrete etc. which if not reused, would have to be properly disposed off-site. This is to avoid adverse impacts such as providing habitats for disease vectors e.g. mosquitoes, rats and rodents, creation of fire hazards, leaching of toxic matter and creating eyesore. Should this happen, it will jeopardise the public's safety and the ecosystem of the surrounding areas.

Post-Reclamation Phase

Solid waste is not expected to be generated after the reclamation activities are completed.

7.4.2 Scheduled Waste

Scheduled waste can be defined as any waste that falls within the categories of waste listed in the First Schedule of the Environmental Quality (Scheduled Wastes) Regulation 2005. This category of waste is commonly recognised as one of the significant pollutants to the natural environment, whenever it is not properly handled, managed, stored or accidentally leaked to the surrounding environment, especially during the construction stage.

During Construction Phase

The volume of scheduled waste generated during construction stage is strongly dependent on the material used and the construction method applied. The activities that would undoubtedly produce toxic and scheduled waste during the construction stage are the maintenance of machineries / heavy vehicles on-site / boats and ocean transportation and the use of chemical for the construction works. The refuse from the maintenance activities which have been recognised as toxic and scheduled waste may include, but not limited to the following:

- Scrap batteries or spent acid / alkali;
- Used engine oil, hydraulic fluids and waste fuel;
- Spent mineral oils / cleaning fluids from machines; and
- Spent solvents / solutions for cleaning activities.

The potential significant impacts that are likely to derive from the above activities are deliberated in the following paragraphs.

Maintenance of machineries and vehicles during the construction stage will generate spent oil, viz., lubricating oil and hydraulic oil. The spent oils from the maintenance works are categorized as scheduled waste under code SW305 and SW306 in the Environmental Quality (Scheduled Waste) Regulations 2005.

This category of waste if not handled or managed accordingly, would inevitably appear as the prominent contaminants that could cause a significant detrimental impact to the water quality at the nearby area. Spent oil is highly potential to create water pollution during the construction phase whenever it leaks or spills from machines or temporary storage containers. It would form a layer of unsightly oil sheen floating on the top of the water column and affects the aquatic ecology in the river creating an anaerobic condition.

In addition, spent oil is also considered as pollutant as it will release Hazardous Air Pollutants (HAPs) and Volatile Organic Compounds (VOCs), whenever it is exposed to extreme temperature. Low level of exposure of the emission from the spent oil will cause irritation to eyes, nose, throat and skin. More seriously, it may cause negative health symptoms, such as headaches, dizziness and nausea.

On top of that, the use of chemical will pose a threat to the surrounding soil, if it is not properly managed and disposed during the construction stage. The chemical substance may affect the characteristic of soil, should soil contamination takes place. The active ingredient in the chemical compound will degrade the quality of the soil and alters the properties of the soil.

Subsequently, the contaminants will directly contribute to the degradation of the surrounding ecology. For instance, higher content of heavy metal in the sea water will affect the microbial process as well as the food chain of the aquatic organism, viz., phytoplankton and benthos.

Post-Reclamation Phase

Scheduled waste is not expected to be generated once the reclamation works are completed.

7.5 Water Quality Assessment

The pertinent impacts on water quality during reclamation are shown in **Table 7.5**. The increase of turbidity, oil and grease, wastes, nutrient and heavy metals will cause declines in seawater quality and lead to detrimental impacts on the productivity and function of marine ecosystem.

Table 7.5: Impacts on Water Quality

Activities	Turbidity	Oil & Grease	Wastes	Nutrients	Heavy Metals
Construction phase:					
Construction of access roads and tracks	/				
Base camp	/	/	/		
Sourcing of sand and dredging	/			/	/
Transportation of fill material via barge	/	/		/	/
Bund construction	/			/	
Laying of geotextile	/			/	/
Material filling	/			/	/
Soil compaction	/				
Revetment	/				
Post Reclamation	/				

7.5.1 Turbidity / Suspended Solids

High turbidity can result in low levels of transmitted light and can negatively affect the functioning of light-dependent organisms such as phytoplankton as well as visual predators such as fish. It is anticipated that the suspended solids concentrations and hence the turbidity of the water bodies will increase due to most of the activities during reclamation as follows:

<u>During Sourcing of Sand and Dredging</u>

During sand mining, the seabed disturbances will cause dispersion of sediment, thus turbid the surrounding water bodies resulting in a deterioration of the water quality of the surrounding area.

<u>During Transportation of Fill Material</u>

During transportation of fill material, accidental spillage of fine materials or oils along the way may occur unexpectedly. Seawater pollution is anticipated as the sand carrier used for transportation is able to transport a large batch of fill material per trip. This volume of fine material may cause spread of sediment plume along the route if any accidental spillage happens. As sediment plume need time to settle, this will resulting in deterioration of the water quality along the route.

<u>During Filling Process</u>

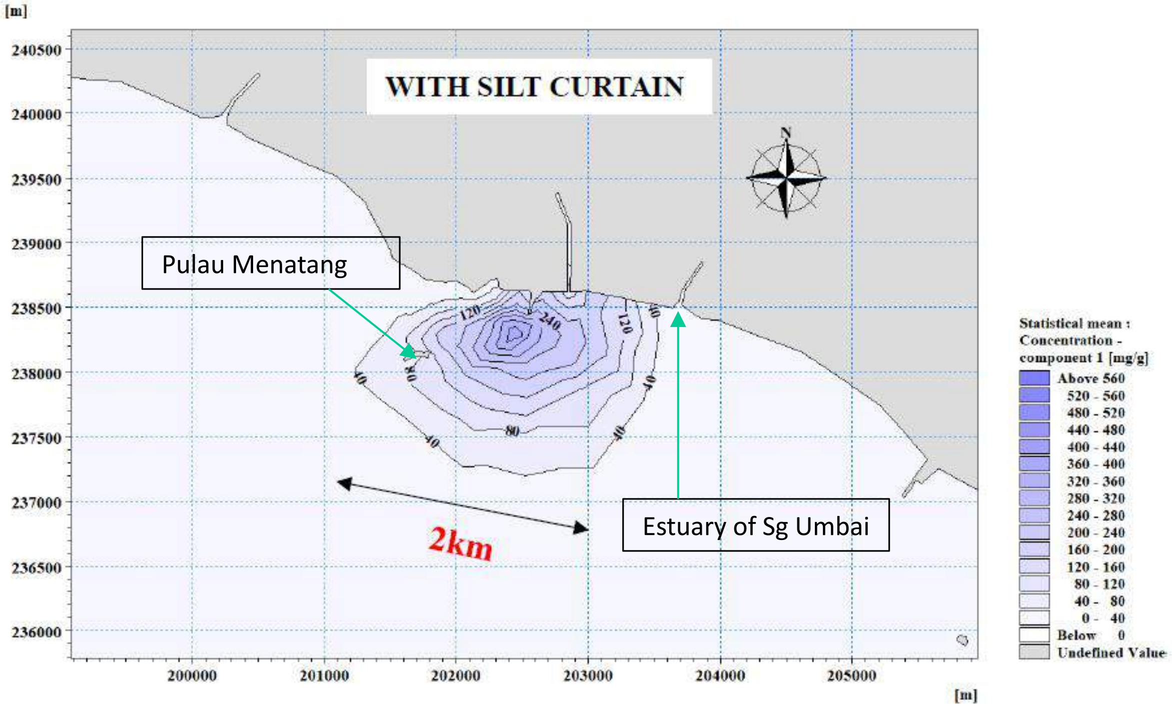
During the filling process for reclamation, sediment plume dispersion will happen. The simulation of sedimentation dispersion pattern has been conducted in the hydraulic study using MIKE 21 models for northeast monsoon. Sediment plumes originating from the reclamation operation were simulated in two scenarios viz with silt curtain and without silt curtain during reclamation works.

The spill rate and the total spill will be highly dependent upon work procedures, scheduling and reclaimed material characteristics. Each conveyor barge with a capacity of 1,250 m^3 is assumed to operate for 12 hrs (from 7 am to 6 pm) on a daily basis. Each barge has a pumping rate of 0.1 m^3/s. The spill concentration is 4.0 kg/m^3 for without silt curtain condition and 0.8 kg/m3 for with silt curtain condition. Results from the spill are presented in mean suspended sediment concentrations showing the extent and concentration over the simulation period for spring and neap tide at four different points or sources (Coastal Hydraulic Study, Final Report, 2018).

The sediment plume patterns indicate that excess suspended sediment concentrations generated from the reclamation work found only at the project site and nearby. The mean plume extent approximately up to 2.0km and 2.8km during neap tide with and without silt curtain at all sources respectively. During spring tide, mean extent of sediment plume is 3.0km within and without silt curtain at all sources. On the other hand, the maximum plume extent approximately up to 6.8km during spring tide with and without silt curtain; 3-3.5km during neap tide without and with silt curtain respectively. (Coastal Hydraulic Study, Final Report, 2018).

The mean excess spill is expected to affect Pulau Menatang located to the west of the project site during neap tide. While during spring tide, estuary of Sg. Umbai will experience higher excess spill concentration. Contrarily, the mean spill concentration at other ESAs (Pulau Besar, Pulau Serimbun, Pulau Burong, Pulau Lalang, Estuary of Sg. Punggor, Anjung Batu Jetty etc.) are generally insignificant (see **Figure 7.13** and **Figure 7.14**).

The increase of surface runoff on the exposed reclaimed land, especially during the heavy downpour is also expected to contribute to the increased suspended solids in the receiving watercourses which subsequently affect the seawater quality of Straits of Melaka.



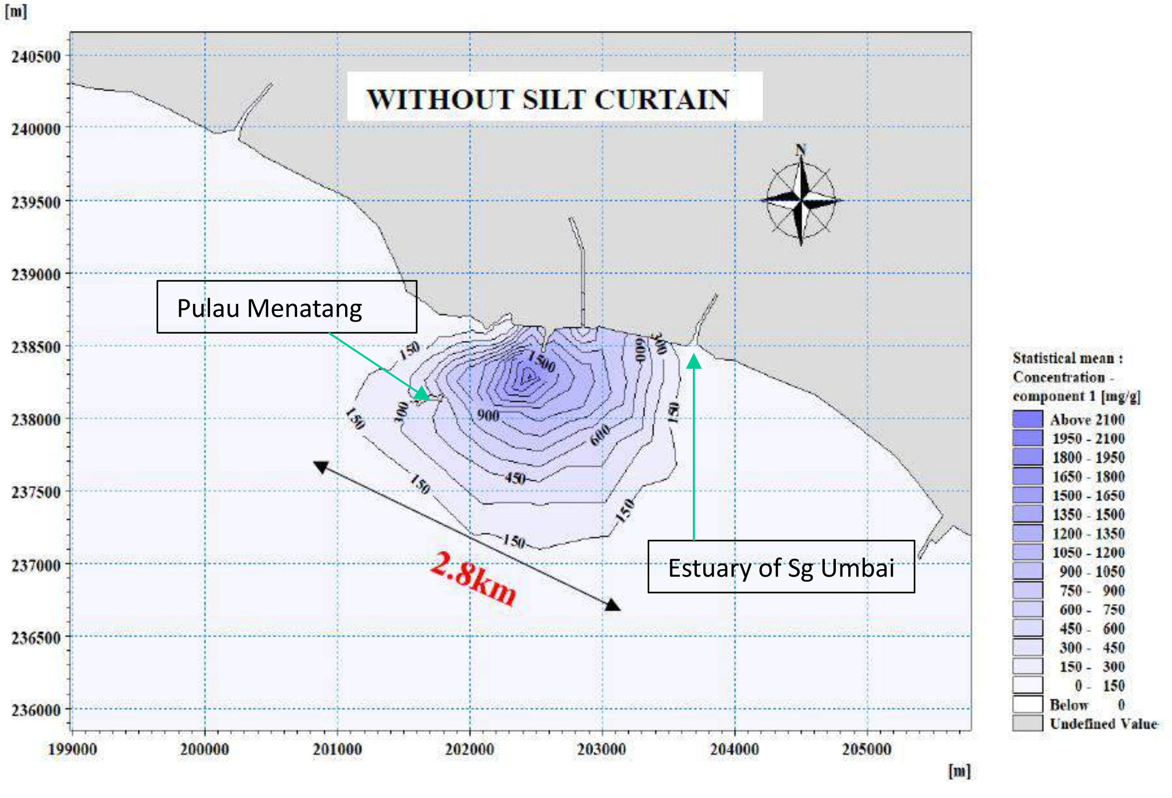
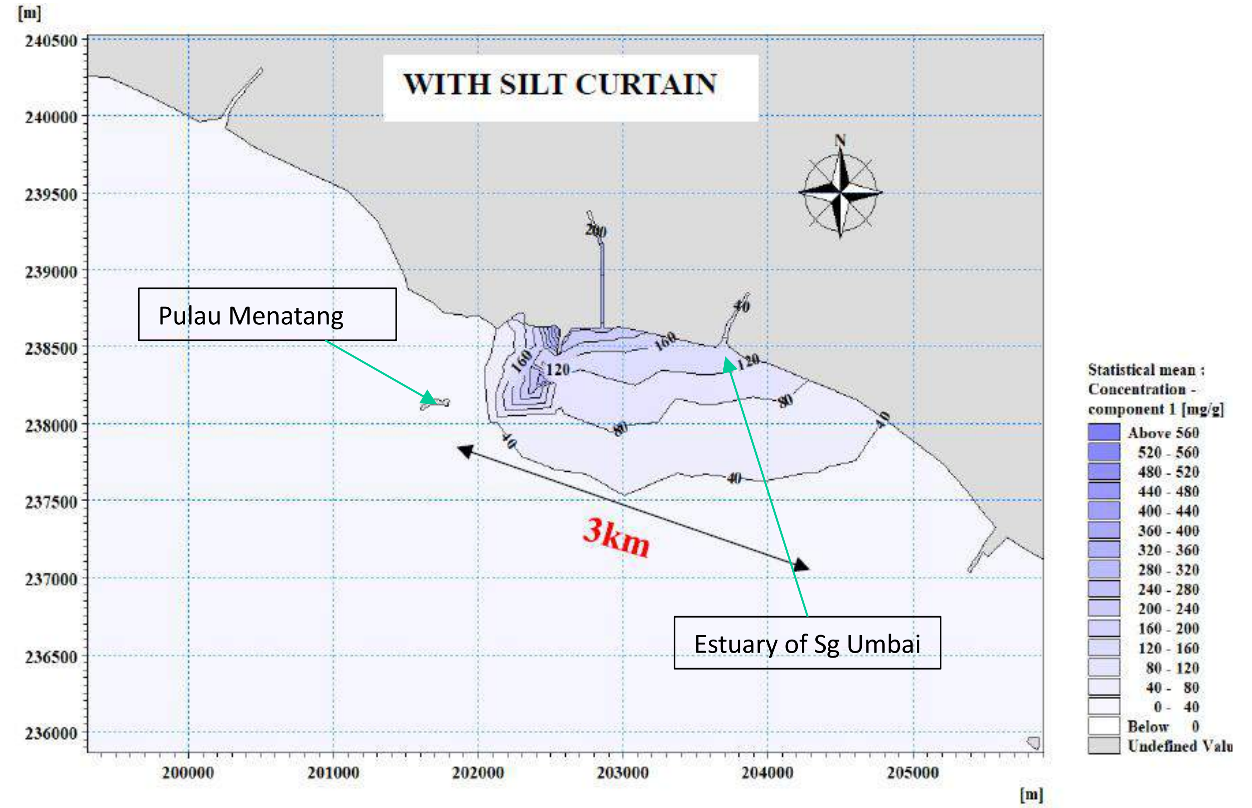
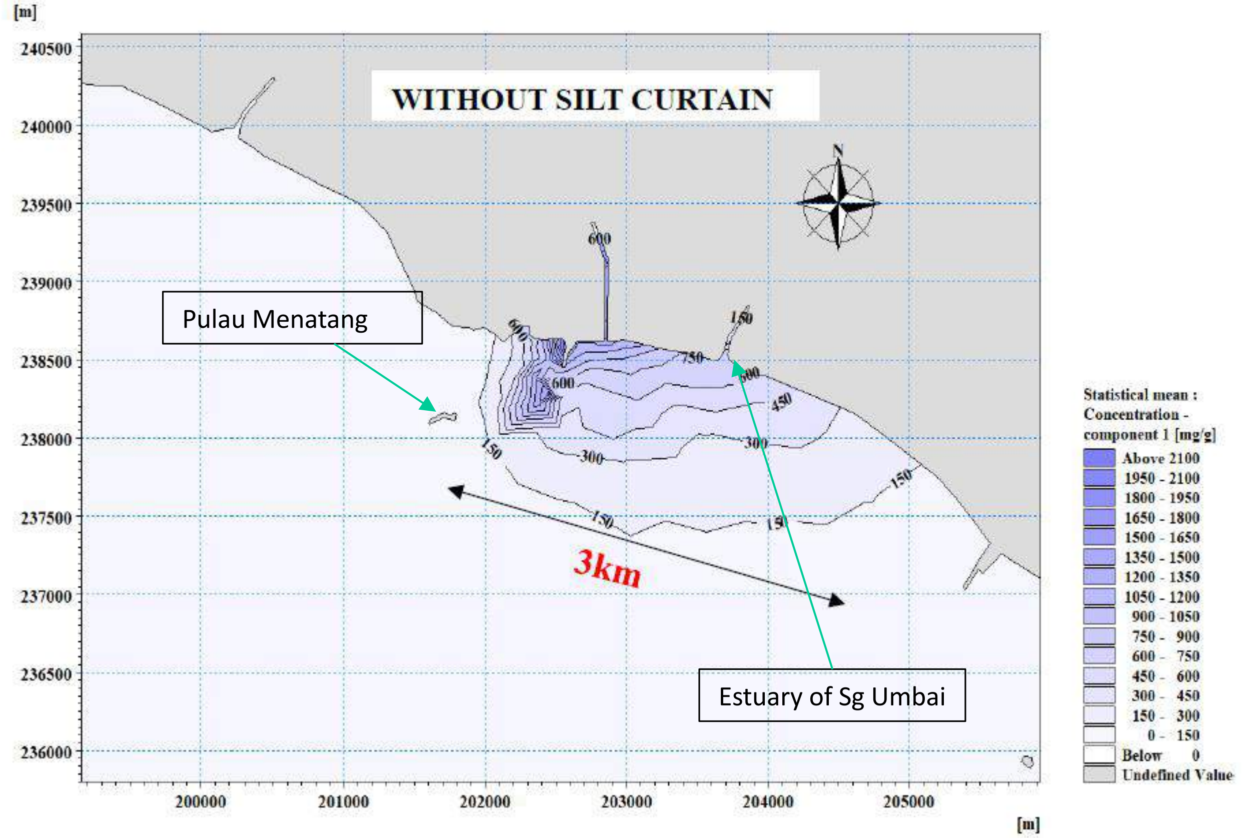


Figure 7.13: Mean Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Neap Tide With and Without Silt Curtain at All Sources



WITH SILT CURTAIN
Pulau Menatang
Estuary of Sg Umbai
3km
N
Statistical mean : Concentration - component 1 [mg/g]
Above 560
520 - 560
480 - 520
440 - 480
400 - 440
360 - 400
320 - 360
280 - 320
240 - 280
200 - 240
160 - 200
120 - 160
80 - 120
40 - 80
0 - 40
Below 0
Undefined Valu
[m]



WITHOUT SILT CURTAIN
Pulau Menatang
Estuary of Sg Umbai
3km
N
Statistical mean : Concentration - component 1 [mg/g]
Above 2100
1950 - 2100
1800 - 1950
1650 - 1800
1500 - 1650
1350 - 1500
1200 - 1350
1050 - 1200
900 - 1050
750 - 900
600 - 750
450 - 600
300 - 450
150 - 300
0 - 150
Below 0
Undefined Value
[m]

Placement of Rock Revetment

Placement of the rock revetment will also cause resuspension of the bottom material resulting in increase in turbidity. Although the increase in TSS level here may not be as serious as when the reclamation activities are carried, a proper mitigation measures must be taken to prevent the dispersion of the suspended materials away from the proposed project area.

Post Reclamation

During post-reclamation stage, silt curtain will be removed from the project area. Normally fine sediment will tend to accumulate on the silt curtain. The removal of the curtain will inevitably cause re-suspension of the fine sediment and further increase the turbidity of the seawater at the project vicinity. Although the impact will be localised, proper mitigation measures shall be carried out to minimize the re suspension of sediment.

The water quality of the natural water drainage, estuary of rivers within the project vicinity shall not be disrupted. This is to ensure the interchange of nutrients and animal species between the freshwater, brackish and saline water. Some of the reclamation activities may cause change of waves and tides which further affect the nutrient accumulation rate near the estuary. The discharge of high rate nutrient potentially leads to harmful alga blooms threatening ocean organisms and causing die-offs among fish and shellfish population. MIKE 21 and MIKE 11 modelling results showed that after reclamation, impact on morphological, waves and tides changes around the project area is insignificant.

7.5.2 Oil & Grease

Oil and grease can cause lethal effects on fish; asphyxiation of benthic life forms; and adverse aesthetic effects of fouled shorelines. Increase in oil and grease in water would be expected due to oily wastewater discharge from tugboats and sea vehicles as well as accidental oil spillage. Ship related operational discharges of oil include the discharge of bilge water from machinery spaces, fuel oil sludge and oily ballast water from fuel tanks may also cause sea water pollution especially surrounding the project site.

If the base camp also functions as a station for construction equipment and fuel storage, then improper handling of fuel can lead to spillage. This will also contribute to the increase in oil and grease level of the receiving water bodies.

7.5.3 Wastes (Solid Wastes, Effluents and Wastewater)

Generally, base camp will only affect water quality if sewage, sullage and garbage are improperly discharged into the receiving water bodies. Sewage is characterised by high levels of biochemical oxygen demand (BOD), ammonia and *E.coli* count. This will result in damaging the river and sea life and may cause problems associated with foul smell (malodour) in addition to diseases associated with contaminated water. Besides, increased organic loading will result in the depletion of dissolved oxygen in the water course. High ammoniacal nitrogen levels in the drains or rivers can cause algal eutrophication.

During construction, a small workforce of about 50 PE is expected. The waste loads projected for sewage are shown in **Table 7.6**.

Table 7.6 : Projected Waste Loads under Construction Scenario

Parameters	Waste Loads (kg/day)	
	Untreated Sewage	Treated to Standard A
BOD_5 Loading	2.80	0.225
SS Loading	3.40	0.563

Estimated workers : 50 PE
Wastewater : estimation based on 225 l/person/day
BOD5 Loading : estimation based on 56 g/person/day (Malaysian Sewage Industry Guideline)
SS Loading : estimation based on 68 g/person/day (Malaysian Sewage Industry Guideline)

Besides, improper disposal of various solid wastes will lead to the increase of debris in surface run-off, resulting in pollution of the receiving water bodies, the river or drain and eventually to the sea.

7.5.4 Nutrients

Activities that involve dislodging of soil sediments will lead to sudden release of products from biochemical breakdown of organics to the water bodies such as ammonia, phosphates and nitrates. The release of chemically reducing compounds to the water bodies will also exert an immediate oxygen demand which cause low DO and has the potential to cause some damage to the ecosystem.

Nitrogen, silicates and phosphates released to the water bodies will become available to promote algal growth. Moreover, the effects of nutrients are relatively prolonged compared to suspended sediment as nutrients may disperse longer in the water bodies.

7.5.5 Heavy Metals

Dredged material used as material filling will release heavy metal into the sea. The environmental impact on this depends very much on the metal contents of the dredged material (sediment) and their solubility. As the sediment is submerged, the concentration in water should already be in equilibrium with the concentration of heavy metal in the sediment and the dredging should not lead to sudden dissolution of metals unless a pH change occurs. The extent to which the dredging activity and the use of dredged material for material filling will release polluting levels of metals can be determined by carrying out the standard elutriation.

7.6 Air Quality

7.6.1 During Construction Phase

Air pollution is the presence in the atmosphere of one or more contaminants in such quantities, characteristics and duration as to make them actually or potentially injurious to human, plant, animal or to property, or which unreasonably interferes with the comfortable enjoyment of life and property. The project activities might affect the quality of the air in the surrounding areas if the project is not conducted in a proper manner.

Reclamation works will involve machineries / equipment which emit gases such sulphur dioxide, carbon monoxide and hydrocarbons from the exhausts. The potential impacts of air pollutants to human health and the environment are summarised as follows:

Impacts on human health

The major pollutant expected from a development will be Suspended Particulate Matters (PM). PM which is smaller than 10 µm in diameter is more harmful to human health than larger particles (*Source: United States Environmental Protection Agency*). Particulates may be generated from the burning or combustion of fossil fuels or derived from the incineration of domestic and commercial wastes as well as particulates generated by wind and vehicle movements.

Impacts on Environment

Black smoke due to incomplete combustion of fuels (especially solid fuels) and dust derived from various sources have significant visual effects on the environment. It becomes a general nuisance when deposited on cloth, food and buildings and may affect the surrounding area.

However, as the construction would be done gradually, air pollutants from the project are expected to be minimal and unlikely to draw any adverse impacts to the environment. **Appendix VII** shows the Ambient Air Quality Standards.

7.6.2 Post-Reclamation Phase

No impact on air quality is expected upon completion of the reclamation works.

7.7 Noise Level

7.7.1 During Construction Phase

The major problems relating to noise might arise during construction phase when each of the activities mentioned in **Section 7.1** is being implemented. Noise generated by these works is mainly due to machineries and equipment. These include (but not limited to):-

i. Reclamation equipment and other vessels for transportation purposes;
iii. Material handling equipment such as cranes and concrete mixers;
iv. Stationary equipment such as pumps, generators and air compressors.

The WHO Recommended Noise Exposure Limit as in **Appendix VIII** remarked that for noise less than 85 dB (A) (8 hours exposure per day) will not likely to have identifiable risk of hearing damage, except for prolonged exposure. However, noise emission from the equipment is intermittent and exposure times are short. Hence the risk of hearing damage is insignificant. Furthermore, noise impacts during construction are mainly short term and confined to the period of works.

7.7.2 Post-Reclamation Phase

When completed, the main source of noise will be from the marine traffic / fishing vessels. Nevertheless, this impact is not expected to be significant.

7.8 Land Traffic

7.8.1 During Construction Phase

The proposed project will generate an increase in road traffic in the area during the construction especially at Jalan Melaka - Muar. The traffic increase during construction will generally be in the form of construction vehicles like tippers, dozers, cranes etc. which is temporary. The proposed access to the site during construction is as shown in **Figure 7.15**.

Since the access is from Jalan Melaka – Muar which is a single-lane carriageway, it is expected that the temporary increase of road traffic will lead to some disturbance to the nearby areas especially in terms of road safety. The comfort of the road users might also be affected with the implementation of this project. Nevertheless, the impact is only temporarily during the construction phase.

7.8.2 Post-Reclamation Phase

There will not be any increase to land traffic after completion of the reclamation works.

7.9 Marine Traffic

7.9.1 During Pre-Reclamation Phase

This phase is expected to draw only the occasional vessel for survey, bathymetric and other preparatory requirement prior to the pre-reclamation stage. Therefore, there is little increase of vessel traffic due to the project activities.

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Figure 7.15: Construction Access

7.9.2 During Reclamation Phase

i. Maritime Traffic

This phase is the most crucial part where the process of constructing and reclamation will probably draw barges, supporting vessels and tugs to the site. As this proposed project is located within the area of fishing activities as well as within Melaka Port limit, it is expected that there will be an additional traffic movement of about 4 to 8 vessels per day. This reclamation work is situated close to Umbai Jetty and the fishermen's jetty. This may directly impact the operation of the jetty and cause marine traffic congestion and increase the risk of collisions or close quarter's situation.

ii. Fisheries Activities

Reclamation work may cause sedimentation and deposition of total suspended solid that will smother the seabed, causing change in the ecology of the seabed and its living organism. Fisheries activities in the vicinity may be affected and there will be partial loss of fishing ground within the project area. Also, once the operation started, it may dissipate school of fish and there will be risk to the nets like cut by passing vessels. The additional vessels in the project area may cause congestion and the movement of working vessels may limit the fishing ground. Therefore, local communities who depend on fish and other marine life for their source of income may be forced to find alternative fishing ground and it will increase their operational cost.

iii. Anchoring – Physical Environment

It is common for vessels to lie at anchor while waiting to access port facilities. Anchoring reduces fuel consumption and emission as well as prevents vessels from drifting towards land, thus minimizing the risk of groundings and collisions. However, vessels at anchor may cause damage risk to the seafloor and its biota. A ship's anchor can shift, and its mooring chain may swing across the seabed, causing abrasion of the seafloor and damage to benthic ecosystems; this phenomenon is known as 'anchor scour'. Anchor scour typically remain evident on seabed for a considerable period of time (Davies *et al.,* 2016). Anchoring operation may occasionally result in creations of larger craters/depression in seabed if anchor raising operations disturb seabed to such an extent as to cause defluidation (release of shallow liquid or gas).

iv. Anchoring - Underwater Noise

Underwater noise is generated from propellers and thrusters of vessels (loudest source) which disturbs marine animal behaviour or psychology (very loud noise source) and at the same time affects native marine mammal population. Underwater noise includes typical supply vessels and guard vessels even though they are semi-continuous noise sources.

v. Activities Using Tugboats and Barge Positioning – Noise

Environmental comfort level is 60 dBA while noise level in working area is expected to be higher than that. In fact, according to Malaysia Occupational Safety and Health Act (1974), the actual reading is easily exceeding 85 dBA. Long exposure to this level of noise could possibly cause temporary noise induced hearing loss and could lead to becoming permanent hearing loss if continuous exposure is sustained.

vi. Activities Using Tugboats and Barge Positioning – Air Pollution

During the burning process in marine diesel engines and boilers of supporting vessels, it gives off significant amounts of black smoke, particulate matter (PM), nitrogen oxide (NO_x), unburned hydrocarbons (UHC), sulphur oxide (SO_x), carbon monoxide (CO), and carbon dioxide (CO_2). These pollutants have attracted a great deal of public concern because they are detrimental to the health of living beings, may deplete the ozone layer, enhance the greenhouse effect, and produce acid rain (Chul-hwan Han, 2010).

Fugitive emissions from diesel storage and cooling/refrigeration systems could release dust/particulates, volatile organic compounds (VOC_s), and nitrogen oxide (NO_x: NO or NO_2) which can contribute to the formation of low-level ozone, photochemical smog, and have implications for human health including lung function (Hayman, 2000). Acid gases includes sulphur dioxide (SO_2) and nitrogen oxides (NO_x) that dissolve in atmospheric water, may increase the acidity of precipitation which can result in vegetation damage, acidification of surface waters and land as well as damage to buildings and infrastructure.

vii. Activities Using Tugboats and Barge Positioning – Hydrocarbon Spills

Spills of fuels, lubricants and hydraulic fluids may result in visible surface sheen on sea surface which further pose a threat to the locality and mortality of marine organisms. They might face breathing problems as oxygen cannot dissolve into the water that is covered by oil slicks. The extent of the pollution depends largely on the size of leak and durations.

7.9.3 During Post-Reclamation and Development Phase

After reclamation and development phase is established, it is expected that there will be an increase of recreational boating with the existence of residential, commercial, light industrial properties and resorts along the coastline of Umbai area. The development of marine facilities and marine recreation activities will require special arrangements to ensure the multiple use of restricted water do not cause a conflict of users and this may include closed areas and traffic zones or special lanes for powered vessels, non-powered vessels and sailing vessels. This will be a subject to be tackled in the future depending on the development of facilities on land not presently determined.

7.10 Social Impact Assessment (SIA)

7.10.1 Level of Awareness and Acceptance of the Project

Based on the community social survey done, the level of awareness of the project among the local community was only 53.11% (**Table 7.7**). This result indicated that the awareness of the communities on the project was still low. However, within the community, fishermen were more aware, with 65.91% of them having knowledge of the proposed project.

Table 7.7: Level of Awareness of the Communities on the Project

Profession	Level of Awareness (%)	
	Beneficial	**Not Beneficial**
Fishermen	65.91%	34.09%
Businessmen	50.70%	49.30%
Government Servant	47.06%	52.94%
Private Sector Worker	43.90%	56.10%
Pensioner	66.67%	33.33%
Overall	**53.11%**	**46.89%**

The perceptions on the benefits of the project among the community depends on which professions the respondents are from. Overall, an average of 43.98% of the communities surveyed felt that the project is beneficial with a high approvals among pensioners (72.22%), businessmen (49.30%) and private sector workers (48.78%). The fishermen group strongly felt that the project is not beneficial, especially for fishing activities, with only 2.27%. The fishermen were more aware of the possibilities of how their fishing activities would be affected and how they have to make adjustments.

Table 7.8: Perceptions on the Benefits of the Project among the Communities

Profession	Perception (%)	
	Beneficial	**Not Beneficial**
Fishermen	2.27%	97.73%
Businessmen	49.30%	50.70%
Government Servant	41.18%	58.82%
Private Sector Worker	48.78%	51.22%
Pensioner	72.22%	27.78%
Overall	**43.98%**	**56.02%**

The feedback on project awareness and benefits to be accrued are summarised in **Table 7.9**. Overall, an average of 44.81% of those surveyed felt that the project would be acceptable with a high approval among pensioners (50%), businessmen (52.11%) and private sector workers (46.34%). The fishermen group strongly felt that the project was not acceptable on account of how they would be potentially affected. The fishermen were worried on how their fishing activities would be affected and the kind of assistance that would be needed to help them adapt to the changed circumstances.

Table 7.9: Level of Acceptance of the Project among the Communities

Profession	Perception (%)	
	Agree	Disagree
Fishermen	2.27%	97.73%
Businessmen	52.11%	47.89%
Government Servant	44.12%	55.88%
Private Sector Worker	46.34%	53.66%
Pensioner	50.00%	50.00%
Overall	**44.81%**	**55.19%**

7.10.2 Perception of Project Planning Process

A concern often raised by local communities was inclusivity in the context of decision making involving activities in their locality. 98.76% of those surveyed felt that they were not referred to prior to any mooting of the project (**Table 7.10**). Only 1.24% felt that they had been approached about the project. Among occupations, none of the fishermen felt that they had been referred to. Other communities, too, almost all felt similarly.

Table 7.10: Locals' Engagement with Project Proponent

Profession	Engagement With Project Proponent	
	Yes	No
Fishermen	0.00%	100.00%
Other Communities	1.52%	98.48%
All Communities	**1.24%**	**98.76%**

Sources of information on the project varied. The most popular of sources of information were from friends and the Village Community Management Council (MPKK) involving 54.66% and 28.57% of the respondents respectively (**Table 7.11**). Other sources of information were from consultants undertaking investigations at the villages (3.73%), the mass media such as newspapers (3.11%), village heads (1.86%) and from the District Office (1.24%). There were respondents reporting receiving information on the project from the internet and non-governmental organisations. A breakdown of the sources of information on the project among the fishermen group and the rest of the communities showed a different pattern. Among the fishermen, information was obtained from the MKKK (8.07%), village friends (11.18%) and from members of the public (2.48%), whereas other community members also relied on information from other sources such as from the District Office, Village Chief, and the mass media.

Table 7.11: Sources of Information on the Project

Sources	Type of Community		
	Fishermen	Other Communities	All Communities
MPKK	8.07%	20.50%	28.57%
District Officer	0.00%	1.24%	1.24%
Village Chief	0.00%	1.86%	1.86%
Mass Media	0.00%	3.11%	3.11%
Internet	0.00%	0.00%	0.00%
NGO	0.00%	0.00%	0.00%
Consultant	0.00%	3.73%	3.73%
Village Friends	11.18%	43.48%	54.66%
Members of Public	2.48%	4.35%	6.83%

The respondents felt that the project proponent should have had prior direct engagements with them as 93.75% felt that they were not aware of how to provide feedback concerning any matter relating to the project (**Table 7.12**).

Several avenues were provided on potential feedback channels for the community (**Table 7.13**). The most important channel was direct meetings with community representatives either through the MPKK (39.17%), state assemblyman (7.5%) and Area Fisherman's Association (Persatuan Nelayan Kawasan) (6.67%).

Other important feedback channels identified were directly from the project proponent (10.0%), relevant Government agencies related to fishery regulation and fisherman management agencies (29.17%) and consultants / researchers (4.58%). According to a small proportion of the community (2.92% of the survey respondents), if all failed then the communities may want to resort to the mass media to seek attention and potential redress.

Table 7.12: Feedback Channel Availability

Type of Community	Feedback Channel Availability	
	Yes	No
Fishermen	4.23%	95.77%
Other Communities	7.10%	92.90%
All Communities	**6.25%**	**93.75%**

Table 7.13: Local Channel to Provide Feedbacks Regarding the Project

Channel	Type of Community		
	Fishermen	Other Communities	All Communities
MPKK	36.36%	39.80%	39.17%
Government Agencies	25.00%	30.10%	29.17%
Consultants / Researchers	4.55%	4.59%	4.58%
State Assemblyman	6.82%	7.65%	7.50%
Area Fisherman Association	25.00%	2.55%	6.67%
Project proponent representative	0.00%	12.24%	10.00%
Mass media	2.27%	3.06%	2.92%
Total	**100.00%**	**100.00%**	**100.00%**

Although 44.81% of the local community accepted the proposed project, the level of uncertainty or wariness among local community regarding the proposed project was still high. Out of a rating 1 (very negative) to 10 (very positive), 53.65% of all communities rated ≤ 4 showing that they were worried about the potential impacts from the proposed project to their community (**Table 7.14**). However, there was a wide variation in perception between the fishermen and other communities. 95.46% of the fishermen were Very Waried (81.82%) or Waried (13.64%) while the equivalent for other groups was 44.39%.

Table 7.15 provides the most important negative and positive reasons for the feelings of wariness among the fishing community and the rest of the community. The negative reasons pertain to the concerns to fishermen's livelihood and the degradation of the ecosystem and environment. The positive reasons pertain to the considerations upon national and local economies but at the risk of ecological degradations.

Table 7.14: Locals Level of Wariness Regarding the Project

Level of Wariness	Type of Community		
	Fishermen	Other Communities	All Communities
Very Waried (1-2)	81.82%	30.10%	39.58%
Waried (3-4)	13.64%	14.29%	14.17%
Indifferent (5-6)	4.55%	9.69%	8.75%
Positive (7-8)	0.00%	26.53%	21.67%
Very Positive (9-10)	0.00%	19.39%	15.83%

Table 7.15: Local Community's Reasons for Wariness

Reasons of Uncertainties and Wariness	Type of Community		
	Fishermen	Other Communities	All Communities
Negative			
Fishermen's livelihood affected	54.55%	13.20%	20.75%
Degradation of the ecosystem	9.09%	10.66%	10.37%
No benefit to the local community	9.09%	4.57%	5.39%
Environmental pollution	4.55%	3.55%	3.73%
Loss of Malay rights	4.55%	3.05%	3.32%
Positive			
Development of the nation	0.00%	23.86%	19.50%
Local economy will be more stable	2.27%	14.21%	12.03%
Despite potential contribution there will be degradation	2.27%	5.08%	4.56%
Despite contribution to community there will be fishermen's loss	0.00%	4.57%	3.73%

7.10.3 Perceived Impacts During Construction and Implementation of Project

An attempt was undertaken to obtain the respondents' perception regarding the social impacts of the project during project construction.

The list of local community perceptions of the construction phase is provided in **Table 7.16**. Among the more frequent perceived impacts raised were declines in the income of the fishing community (63.33%) and elimination of mussel farming (11.67%). The second category of impact concerned the degradation to the ecosystem (46.25%) and environmental pollution (16.25%). The third category of impact concerned risk to fishing activities due to barge movements (16.67%) and loss of natural aesthetics coastal landscape (10.83%). The next impact category concerned employment. There was a major concern on the likely influx of foreign workers that was felt by 37.50% of the respondents. Though 19.17% felt that impacts on employment would be positive for all and to locals (7.08%), the respondents did have reservations on job availability for locals, where the communities actually have expressed facing competition from both people living outside the surrounding project area and from foreign workers (16.25%).

Table 7.16: Local Community Perception on the Impacts of the Project During Construction

No.	Impacts	Positive impact	Negative impact
1a	Declining fishermen's income	0.00%	63.33%
1b	Destruction of clam culturing	0.00%	11.67%
2a	Degradation to the ecosystem	0.00%	46.25%
2b	Environmental pollution	0.00%	16.25%
3a	Risk to fishing activities	0.00%	16.67%
4a	Loss in natural aesthetic beauty of coastal landscape	0.00%	10.83%
5a	Influx of foreign workers	0.00%	37.50%
5b	Locals have to compete for employment opportunities	7.08%	16.25%
5c	Employment opportunities for all	19.17%	3.75%

Since the fishermen are directly to be affected by the project, their perceptions were also solicited. The perspective of fishermen on the impact of the project was absolutely negative. All the fishermen argued that their source of income would be negatively influenced.

According to them, their fishing area was smaller because of various reclamation projects in the State and also the varieties and quantities of fish were also getting fewer. The mussel culture operators were most disappointed as they claimed their mussels were of high quality. As the result, their income would be reduced and their lives would get harder. Besides, all fishermen also claimed that the local communities would be marginalized from the development. They feared that the developers might consider their own self-interest and once they got project approval, they would ignore the objections and concerns of local communities. However, they did not deny that the overall standard of living in the area would improve, benefiting the rest of the communities, though not themselves.

7.10.4 Perceived Impacts During the Operation Phase

The topside development is expected to include the establishment of mixed commercial activities including retailing, restaurants, hotels and apartments. The list of perceived impacts of the operation phase of the project are provided in **Table 7.17**. There were five categories of perceived impacts. The first concern was on continued and permanent income loss from capture fisheries (61.25%) and mussel farming (11.25%).

The next impact category concerned opportunities relating to employment, business and property value escalation. The impacts on employment may have positive elements to all (35.00%) and business opportunities from rising visitors and tourists to the area (25.00%), and there is an expectation that real estate values would rise (13.33%). But the communities did have reservations over jobs for locals, and the respondents reported facing competition from both people living outside the surrounding project area and from foreign workers (19.58%).

The third category concerned perceived negative feeling felt by villagers that they would be marginalised (5.42%) and that housing and accommodation project would be beyond the means of the local community (3.75%).

The fourth category concerned the presence of foreign workers and investors. There is major concern on the likely influx of foreign residents into the area (23.75% of the respondents).

There was a particular concern on the possible dominance of Chinese citizens into the area (9.17%). 11.67% feared that presence of foreign residents would cause local culture and norms to disintegrate (11.67%).

The fifth category relates to the concern that the presence of foreign residents would lead to increase in crime rate (14.58%) and social problems (3.75%).

Table 7.17: Local Community's Perceptions on the Impacts of the Project During Operation Phase

No.	Impacts	Positive impact	Negative impact
1a	Loss of fishermen's income will continue	0.00%	61.25%
1b	Destruction of clam culturing	0.00%	11.25%
2a	Locals have to compete for employment opportunities	9.58%	19.58%
2b	Employment opportunities for all	35.00%	4.17%
2c	Increase in visitors and tourist	25.00%	2.50%
2d	Expectation of rise in real estate values	13.33%	0.00%
3a	Villagers' felt that they be marginalised	0.00%	5.42%
3b	Housing and accommodation project beyond means of local community	0.00%	3.75%
4a	Influx of foreign residents	0.42%	23.75%
4b	Predominance presence of Chinese citizens	0.00%	9.17%
4c	Local culture and norms will disintegrate	0.00%	11.67%
4d	Negative influence on local cultural values	0.00%	3.33%
5a	Increase in crime rate	0.00%	14.58%
5b	Increase in social problems	0.00%	3.75%

7.11 Economic Valuation of Impacts

It is common for reclamation project to have some negative impacts that cannot be completely mitigated as well as the degradation in services obtainable from the disturbed natural environment. Hence, justifying the need to quantify these impacts in monetary terms. Such valuation exercise is useful in demonstrating that there are significant value of the environmental losses or changes due to the proposed reclamation. These economic losses to different stakeholders will be quantified so that informed decisions to ameliorate these inconveniences could be recommended. The valuation process is facilitated by several valuation methods and evaluation processes that allow for the computation of reliable monetary estimates of the value of losses in environmental services. Overall, the aim is to quantify the gains and losses in environmental services that can be attributed to the Project.

7.11.1 Objective

The objective of the economic valuation is to quantify and monetize the impacts of the Project on the flow of environmental services. This requires valuation in monetary terms of the changes (both negative and positive if any) in environmental services arising from project implementation over an assessment period that is long enough to capture these losses. For short term impacts, the assessment period follows the length of the duration of impacts. For long term impacts, a period of 50 years was used as beyond this period, the contribution to the cumulative total is quite small.

7.11.2 Methodology

Environmental resources are scarce, and consequently its degradation and even loss, would require having an economic valuation of various significant impacts. In this case, coastal areas will be reclaimed for the development purposes in the future. Typically, the coastal reclamation will cause permanent loss of existing natural resources or environmental services on site. In the provision of environmental services, prices usually do not appear and this raises the need for alternative approach in measuring the value of this services in monetary term.

The impact of proposed project might have positive and/or negative impact that directly or/and indirectly affect the surrounding environment ecosystem as well as the other relevant stakeholder. Therefore, in economic valuation approaches, the initial step is to establish a clear and valid link between project impacts on the physical functions of the environmental and other affected stakeholders.

The standard process for undertaking an economic valuation involves eight distinct steps as follows:

i. Defining the "With Project" versus "Without Project" scenario. For this proposed project the "With Project" scenario is defined as the situation where the project is implemented involving the reclamation works at the depicted coastal area. The "without Project" scenario is depicted as the status quo situation in which the proposed project is not implemented.

ii. Identifying and describing the potential environmental impact and establishing the linkage between the degradation in environmental services to the affected parties.

iii. After establishing the significant potential physical impacts of the project, these impacts on the environment over a selected reasonable project are quantified. These physical impacts of the project on the environment are either explained and quantified via scientific assessments provided by the physical environmental and technical consultants, or as perceived by the communities surveyed.

iv. Monetizing the impact. The quantified impacts estimated in the previous steps are valued in monetary terms using market and non-market valuation techniques. Value parameters of similar environmental services obtained in other studies can also be used as reference points for the valuation exercise termed benefit transfer approach.

v. Costs and benefits of the potential impacts occur over time. To add these values, they would have to be discounted to the present values. Several discount rates are used ranging from 4%, 6% and 8%. The period of discounting is over 50 years which are typically used for valuation of similar coastal land reclamation projects. In particular, the economic valuation of the impacts from similar coastal reclamation projects such as in the EIA reports of the Kuantan water front project by DNA consultants and of the Kuala Kedah reclamation project by Yes Enviro Sdn Bhd has used similar duration of analysis. The 50-year timeframe is chosen because the present value of future costs and benefits beyond 50 years tend to become quantitatively insignificant.

vi. Determining the aggregated net present values (NPV) of the potential impacts of the project. The ccomputation will involve adding up the discounted values of the losses and gains in environmental services.

vii. Performing a sensitivity analysis on the NPV by using different discounted rate as in step v. in order to demonstrate the impact of variation in discount rates on the NPV of the environmental costs and benefits.

viii. Making appropriate recommendations in consideration of the contributions of the various physical impacts to the aggregated net present values. Where appropriate mitigation measures are recommended to ameliorate the significant impacts.

7.11.3 Valuation of Significant Change in Environmental Services

The proposed Project location which is located nearby the existing fishermen's bases of *Pengkalan Nelayan of* Pernu, Telok Mas, Sg. Punggor and Sg. Duyung, as well as at the productive mudflat area at the project site. These existing locations are environmentally and socially sensitive. These reasons further intensify the importance of assessing and evaluating any possible impacts that may occur from the project activities. Thus, the impact assessment begins with the identifying the key environmental issues and subsequently predicting the potential impacts from the Project activities. Following is the expectation of possible environmental issues:

1. Loss of mudflat due to the reclamation
2. Socio economic-effect to the incomes of fishermen, middlemen *(peraih)*, restaurant owners, hawkers and locals.
3. Recreational services: mainly involving angling enthusiasts who often use the coastal area
4. Land traffic inconveniences from the coastal land reclamation project. Influx of heavy vehicles that are using the existing road to the proposed development which eventually create a traffic congestion and damaging further the road.
5. Potential risks to fishing boats plying along the project area

Based on the above potential issues mentioned above, the environmental impacts perceived as significant have to be assessed for their losses in economic values as listed in **Table 7.18**.

Table 7.18: Environmental Issues Potentially Affected by the Proposed Project

Impacted Individuals/ Communities and location	Environmental Issues	Suggestion on Evaluation assessment Methodology
Fishermen and local communities deriving benefits from marine resources will likely be impacted.	Loss of mudflat	Benefit transfer; Estimated Average Loss per annum in Environmental Services (per hectare per year) from Mudflat by Service Types of losses based on existing economic valuation studies. Since the loss is permanent, then the present value of annual losses is computed.
Fishermen which are mostly focus in four main jetties namely Jetty Pernu, Telok Mas, Sg. Punggor, Sg. Duyung.	Socio economic-effect: Effect on gross income and fishing expenditure that have eventual effects on fishermen's net income.	Opportunity cost- of having to incur more travel time for fishing, cost of relocating to new fishing areas and additional expenditure at maintaining and repairing fishing gears and boat engines.
The middleman (*peraih*) for Horseshoe crab (*Belangkas*), mussel (*Kupang*) and fishes that directly acquired from the fish landing at jetty Pernu, Telok Mas, Sg. Punggor and Sg. Duyung	Socio economic-effect: Loss in income	Change in productivity Incremental cost (to acquire marine stock elsewhere)
Mussel aquaculture mainly situated adjacent to the Telok Mas Jetty	Socio economic-effect: Permanent loss in income	Change in productivity
SME: Restaurant Owners having lesser customers and incurring lower sales especially during reclamation activities.	Socio economic-effect: Change in Productivity	Loss/gain in income using Change in productivity approach
Recreationalists constituting mainly anglers as this group is the primary users of environmental services of the coastal areas near to the proposed site.	Recreational services: Visitor decision to make revisits and to experience lower satisfaction of angling are affected by the reclamation project.	Travel cost method can be used to assess the decline in consumer surplus that measures satisfaction loss from being not able to undertake angling peacefully at or adjacent to the proposed site.
Locals that are residents within 5km radius of the proposed site	Occurrences of traffic inconveniences including and disturbances from project activities such from sound or dust or air pollution during the reclamation activities	Contingent valuation method of estimating the willingness to pay (WTP) by residents to avoid the above mentioned inconveniences and disturbances to livelihood.

7.11.4 Loss of Mudflat Due to Reclamation

The estimated size of mudflat area that will be lost to make way for the project is relatively small. The impact is confined to the strip of mudflat that will have to make way for the construction of the proposed coastal reclamation. Reclamation will result in permanent loss of the seabed habitat which eventually results in some reduction in the amount resources important to support marine lives.

Amongst the important marine resources provided by the muddy seabed or mudflat area is like cockles, bivalves, gastropods/snails and shrimps. However, not all mudflat areas in each state still have the aforementioned marine species. In Melaka, for instance, the cockles production is difficult to obtain in the state based on the study by Maritime Institute of Malaysia (MIMA) which only listed four (4) states as a major cockles producers in Peninsular Malaysia namely Kedah, Penang, Perak, Selangor and Johor (NAFIS, 2008). However, the other marine production of bivalves, gastropods/snails, shrimps and fish is still available in Melaka mudflat area especially at this site.

In economic valuation assessment for computing the direct value loss of mudflat, two pieces of information are needed namely, (1) the unit value of aforementioned marine species in the muddy habitat and (2) the size of affected muddy area. In order to compute the unit value, we need to estimate the annual production of each aforesaid marine species (measure in ton) and multiplied with unit price of each species respectively. However, the past valuation studies have tended to use average nationwide average productivity as a basis for valuing the loss of environmental services produce by mudflats. The use of this benefit-transfer approach is understandable because local studies are typically non-existent. This study initially uses such an approach, but subsequently makes some adjustment to the values to better reflect local conditions.

The common reference done by previous studies related to the estimation of these coastal marine species produce by mudflats is based on the estimated value used in a study done by Sasekumar and Chong (1998). Sasekumar and Chong (1998) has computed the production value of cockle, bivalves, gastropods/snails, shrimps and fish by multiplying the estimated quantity of production by the unit price of USD 2,600 per ton (bivalve), USD 600 per ton (gastropods/snails) and USD 200 per ton (shrimp and fish) respectively. This multiplication therefore yields the estimated value of production per annum for cockle, bivalves, gastropods/snails, shrimps and fish at the value of USD26.4 million, 17.6 million, USD 0.3 million, USD 2.9 million and USD 2.2 million respectively. To arrive at the net value of harvesting the researchers then applied the net revenue factor of 60% for cockles and bivalve, 30% for gastropods/snails and shrimps, and 25% for fish to deduct for the costs involved in harvesting (**Table 7.19**).

Table 7.19: Estimated Value of Environmental Services (per hectare per year) From Mudflats in Malaysia

Environmental services (Production)	Unit Value (RM per hectare per year)
Direct use value	
Cockles	372.34
Bivalves	2,490.70
Gastropods/snails	24.35
Shrimps	204.74
Fish	129.43
Total	**3,221.56**

Of interest to this project site is the loss in environmental service from cockle harvesting. The feedbacks received from fishermen and shell collectors are that cockles harvesting at the coastal waters of Malacca, is perceived to have significantly lower yield. Hence the value needs to be adjusted to suit the local situation. Therefore, it is assumed that the cockle harvesting is about 10% of the existing estimated value, hence the adjusted unit value used will be RM 372.34 per hectare per year. After the adjustment, the total loss of environmental services from mudflat then is therefore only RM 3,221.56/hectare/year.

The annual value of environmental services forgone from the loss of mudflat is obtained by multiplying the size of the affected area (i.e. 2.57 hectares) by the estimated value of environmental service produced per hectare (i.e. RM RM 3,221.56/hectare/year). Hence the loss of mudflat will be estimated at **RM 8,279.41** per annum. As the loss is permanent, the net present value of mudflat services is estimated at RM 103,493, RM 137,990 and RM 206, 985 when discounted at the rates of 8%, 6% and 4% respectively.

7.11.5 Impact of Income on Fishermen

The common presumption when the reclamation taking part is an increase in fuel cost for fisherman due to the loss of fishing ground. However, due to this proposed project, the impact to the fishing community is slightly different from the common issue of lost in fishing ground. The argument behind this claim is mainly due to the reason of proposed reclamation area is not an usual place for the fishermen putting their fishing nets. Moreover, the distance of reclamation land from the coastal is less than common distance of fishing area. To have better understanding of the issue is by only take into account fishing area and the sea route that commonly used by the fishermen as shown in **Figure 7.16**.

During fieldwork, we were informed by fishermen that the fishing area usually begins after 500 meters to 600 meters from the coastal line as shown by the bold redline in **Figure 7.16**. Then the distance of travel is approximately 4km to 5km to the open sea (red shaded area in **Figure 7.16**). Hence, the issue of loss of fishing ground does not arise here, but they are worried about the nearby areas facing the issue of fish shortage as the coastal areas mainly for the fish seed have been disturbed. Eventually, it will affect the fishermen from the need to raise the travel distance and also the time spend at sea to seek new fishing areas due to the shortage of fish in the nearby areas. Secondly, fishermen are worried about the damaged mudflat area, so there will be a phenomenon of dying shellfishes leaving behind dead shells. This dead shell will result in potential damages to fishing nets. Thus, this will increase the risk of rising costs to fishermen to repair their damaged fish nets. Finally, the opportunity cost incurred by fishermen from the additional hours of working and greater fuel consumption.

This study notes that in estimating the impact of reclamation, double counting the loss in catch due to a reduction in fish feeding ground must be avoided since it is already captured in the computation of the loss of seabed habitat in the mudflat area. Therefore, this matter is taken into account in computing the socio-economic effect to the fishermen due to this proposed project is only on:

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Figure 7.16: The Common Fishing Ground and the Distance Route Used by Local Fishermen

1) Additional fuel cost due to increment in distance per trip
2) Additional maintaining cost for repairing nets and boat engine
3) Opportunity cost from the additional working hours

In total, the number of registered and active fisherman in the four pengkalan of Persatuan Nelayan accounted for 319 persons. The breakdown of fishermen number by jetty location within 5 km radius of project site is as listed in **Table 7.20**.

Table 7.20: Numbers of Outboard Engine Boats Operating Within the Project Zone

Location	Numbers of outboard engine boats
Jetty Pernu	45
Jetty Telok Mas	22
Jetty Sg. Pungguh	76
Jetty Sungai Duyung	176
Total	**319**

Source: South Malacca Fishermen Association (PNK Melaka Selatan)

7.11.5.1 Additional Fuel Cost to be Borne by Fishermen

It is determined that the fishermen generally use outboard engines ranging from 15 to 60 horsepower and it is very seldom to have the fishermen owning engines with more than 90 h.p. The average number of fishing days is 25 trips in a month. This figure is derived from the survey conducted on the fishermen. Moreover, a liter of subsidized petrol costs the fishermen RM 1.60. However, for economic valuation the real cost as reflected by unsubsidized market price should be used. Therefore, for this assessment, a market price of RM 2.20 per liter is applied to determine the fuel cost.

In order to assess the likely increase in the cost of fuel consumption as a result of the reclamation, the following assumptions are employed:

1) On average, the local fishermen fuel usage per trip according to different number of trips or days is as follows:

Table 7.21: The Fuel Usage According to Different Engine Horsepower

Engine h.p	Min. usage		Max. usage	
	Liter per trip	No. of trips per month	Liter per trip	No. of trips per month
15	10	12	20	13
30	20	12	30	13
60	25	10	40	15

2) The proportions of boats belonging to the 15, 30 and 60 horsepower categories are approximately 30%, 50% and 20% respectively. This is based on observation made at the jetties; and
3) The additional fuel cost for trips is computed based on extra hour spend on the sea. The average increase of fishing hours is estimate at 50% based on the responses received from the local fishermen. For example, the initial hours spend at the sea is around four (4) hours, 50% increase will result in an average of six (6) hours spend at sea or in other words an extra two (2) hour is needed.

The additional fuel cost per month can then be computed for each engine size based on the following steps: (example for 15 h.p engine)

Step 1: compute the fuel consumption per hour at the current situation

$$= \frac{(20 \text{ liters X } 13 \text{ days}) + (10 \text{ liter X } 12 \text{ days})}{4\, hours\ (25\ days)} = 3.47 \text{ liter/hour}$$

Step 2: By using information in step 1, calculate the additional fuel cost per month considering the information in assumption (3) mentioned above

= (3.47 liter/hour) X (extra hours) X (RM 2.20) X (25 trips) = RM 358.29 liter/month

The above computation of additional fuel cost will be applied for each type of boat engine and then aggregated over all engine size to arrive at the total increase in fuel cost. Overall, the total incremental fuel cost for affected fishermen accounted for RM 176,841.00 per month and RM **2,122,093.00** per year (see **Table 7.22**). The following is the breakdown of incremental fuel cost for the three groups of fishermen based on engine capacity.

Table 7.22: Total Incremental Fuel Cost (RM/month)

Description	Engine Capacity (h.p)		
	15 h.p	30 h.p	60 h.p
Total fishermen population[1]	96	160	64
Average fuel consumption per hour (RM)	3.47	5.40	8.50
Average Additional hours	1.88	1.75	2
Incremental fuel cost per fisherman (RM)	358	520	935
Sub-Total Incremental fuel cost (RM/month)	34,288	82,900	59,653
Total (RM/month)	**176,841**		
Total (RM/year)	**2,122,093**		

[1] Based on 30%, 50% and 20% for 15, 30 and 60 hp respectively. Total population of fishermen owning boat is as in Table 7.20.

7.11.5.2 Additional Maintenance Cost for Repairing Nets and Boat Engine

Aforementioned, the fisherman expected a change in the maintenance cost of nets, engines and fiber boat during the implementation of the proposed project. This change in cost is necessary when the current condition of the seawater has changed due to pollution or changes in ecological conditions. First of all, it is expected to increase the frequency of net repairs when there is a project due to the phenomenon of dead shells and the possibility of various debris on the seabed that will damage the nets when it is stuck. Secondly, the increase in the cost of maintaining the boat and the engine due to the increasing frequency of fishing activities to the sea.

However, the changes in maintenance cost will not involve all fishermen in the listed jetty. This is because these expectations are more widely expressed by fishermen who often use the route around the project site which is close to Jetty Pernu and Telok Mas. Hence, the number of affected populations is expected to be composed of fishermen in these jetties comprised of 67 persons or 21% of total affected fishermen.

During the interview session, fisherman was being asked the estimated costs that were incurred by them related to the fishing activities. Fisherman surveyed commonly give a total value for a single year since the cost incurred is not always necessary for every month. This data then will be dis-aggregated into monthly basis by dividing it with 12 months. Then, fishermen are asked to state the probability of changes in costs that may arise when the project is present. Based on the past experience of existing coastal reclamation projects, the potential impacts that fishermen have to bear are the maintenance costs of nets, engines and boats. The following is a summary of the cost breakdown that was successfully recorded from the field study.

Table 7.23: The Breakdown of Maintenance Cost for the Fisherman

Description	Cost Category (RM)		
	15 h.p	**30 h.p**	**60 h.p**
Total fishermen population	**96**	**160**	**64**
'Without project'- Nets repair/replace[1]	1,000	1,408	1,550
'With project'- Nets repair/replace[1]	1,218	1,915	1,870
Incremental cost of nets repair/replace (RM/year)[2]	218	507	320
Total incremental cost of nets repair/replace (RM/year)[3]	**20,815**	**80,880**	**20,416**
'Without project'- maintenance of boat/engine (RM/year)	488	1,310	1,310
'With project'- maintenance of boat/engine (RM/year)	706	1,990	1,990
Incremental cost of boat/engine maintenance[2] (RM/year)	219	680	680
Total incremental cost of boat/engine maintenance (RM/year)[3]	**20,934**	**108,460**	**43,384**

[1] Frequency of repair / replace of nets on average is four (4) times a year.

[2] Different between 'without' and 'with' project scenario for respective cost category.

[3] Multiplication of incremental cost per year with total fishermen population for each engine group respectively.

Overall, after adding (**Table 7.23**) the accumulated value of total incremental cost of nets repair/replace for all affected fisherman is estimated at **RM 122,111 per annum** while the accumulated value for boat and engine maintenance is estimated at **RM 172,778 per annum**.

7.11.5.3 Opportunity Cost of Fishermen

Aforementioned, usually fishermen spend an average of four (4) hours at sea. When the reclamation takes place, fishermen are expecting a reduction in fishery catch around the project area. Therefore, to ensure the rate of fish catch is as before, fishermen expect a two (2) hours increase in working hour at the sea making the average fishing time of 6 hours per trip. Hence, these additional working hours is the loss of potential gain from initial alternatives measured as opportunity cost incurred by fishermen.

In order to compute the value of opportunity cost, we need to gather several information as follows (see **Table 7.24**):

i) Average numbers of month and days catch for different species. The weighted also imposed in term of percentage of possible minimum and maximum weighted catch applies to a month and a year.
ii) The minimum and maximum weight per trip for different species.
iii) The value of various species per kilogram

As shown in **Table 7.24**, all species listed are available only for a certain number of month and days. It is unlikely possible to determine the exact species catch and average weight of every catch per trips and for the whole years. As for that reason, the minimum and maximum weight capture per trips is acquired as well as weighted catches had been assigned to the number of months and days involved in catching indicate the priority of catch in accordance to different species.

Thereafter, the average catch per hour will be determined by calculating the average monthly catch using the information in **Table 7.24** as follows:

Table 7.24: Details Regarding Fish Landing by Species

Local Name	Scientific Name	No. of month	No. days in a month	Average weight capture per trip		Weighted catches (%)		Average retail price (RM/kg)	
				Min.	Max.	Min.	Max.	Min.	Max.
Udang Pengantin	*Penaeus merguensis* (Grade A)	8	5	2	6	90%	10%	60	85
Udang Belang	*Parapenaeopsis sculptilis*	7	8	2	6	80%	20%	35	40
Udang Kawan	*Penaeus* spp/*Metapenaeus* spp.	7	8	2	6	80%	20%	45	50
Ikan Gelama	*Pennahia* spp. / *Johnius* spp.	6	4	3	10	60%	40%	6	7
Ikan Duri	*Arius* spp. / *Osteiogenoisus* spp.	8	6	3	10	50%	50%	8	15
Ikan Sembilang	*Plotosus* spp.	8	6	5	9	80%	20%	13	18
Ikan Belanak	*Mugil* spp./ *Liza* spp./ *Valamugil* spp.	8	7	5	12	70%	30%	5	15
Ikan Senangin	*Polynemus* spp.	10	8	5	20	60%	40%	12	16
Ikan pari	*Himantura* spp. / *Dasyatis* spp./ *Neotrygon* spp.	9	4	4.5	15	70%	30%	10	14

1. Compute annual catch by species (RM/ year) separately for minimum and maximum catches before summing it together.

(% weighted) X (no. of month X no. of days) X (Average weight capture per trip) X (Average retail price) *(1)*

2. Assuming initial daily trip is 4 hours and 25 trips per month, the average catch per hour is computed as follows:

*Average catch per hour = Total annual catch / (daily trip*25 trips*12 month)* *(2)*

Table 7.25: <u>Average Annual Catch and Value per Hours According to Different Species.</u>

Local Name	Scientific Name	Total annual catch (RM)	Catch per hour (RM)
Udang Pengantin	*Penaeus merguensis* (Grade A)	4,016	3.35
Udang Belang	*Parapenaeopsis sculptilis*	3,123	2.60
Udang Kawan	*Penaeus* spp/*Metapenaeus* spp.	3,994	3.33
Ikan Gelama	*Pennahia* spp. / *Johnius* spp.	335	0.28
Ikan Duri	*Arius* spp. / *Osteiogenoisus* spp.	1,638	1.37
Ikan Sembilang	*Plotosus* spp.	2,230	1.86
Ikan Belanak	*Mugil* spp./ *Liza* spp./ *Valamugil* spp.	1,480	1.23
Ikan Senangin	*Polynemus* spp.	5,005	4.17
Ikan pari	*Himantura* spp. / *Dasyatis* spp./ *Neotrygon* spp.	1,096	0.91
Total		**22,916**	**19.10**

The total opportunity cost of all affected fishermen was computed by multiplying the average catch per hour of individual fisherman with 2 incremental hours and the total numbers of 319 fishermen. Subsequently, the total annual loss from the incremental working hours was multiplied with the opportunity cost over 25 trips per month for the whole year. Individual fisherman opportunity cost accounted for RM 35.09 which resulted in a total value of opportunity cost approximately being RM 11.19 thousand. Overall, the total annual opportunity cost loss from the incremental working hours estimated to be RM 3.36 million per annum (**Table 7.26**).

Table 7.26: The Opportunity Loss From Increment of Working Hour by Fishermen.

Description	RM
Average Catch per Hour	19.10
Total Opportunity Cost[1]	11,193.70
Annual Loss[2]	**3,358,110.31**

[1] Opportunity cost = *Average Catch per Hour* X *Incremental of working hour (e.g. 2 hours)* X *number of fishermen*

[2]Annual Loss = *Opportunity Cost* X *numbers of monthly trips (i.e. 25)* X *12 month*

7.11.6 Economic valuation for Middlemen, Mussel Aquaculture and Restaurant

At the area, there are only a few middlemen who collect the marine catches from fishermen within the 5km impact radius from the proposed project site area. Even that these middlemen in the area have also to rely on collecting fish supplies from fishermen who are base out of the local pengkalan Persatuan Nelayan. Among the main factors is that local produce is unable to provide consistent and continuous supply requirements. Similarly, with mussel farming (mainly production of *Perna viridis* or *kupang*) activities, the capacity of mussel supply here is not at the commercial level and sometime barely enough to meet the local market. However, the impact on them is very significant in which livestock production is expected to be completely disrupted. If there is a disturbance to the marine livestock, then indirectly the business activity of nearby restaurant operators is also disturbed. In our case, it is difficult to determine the exact number of middlemen, mussel farming and restaurant owners who will be significantly affected. Consequently, the determination of the impacted parties population is based on the views of the respondents who have been interviewed and the observation at the research site by the researchers (see **Table 7.27**).

Table 7.27: The Numbers of Possible Impacted Middleman, Mussel Aquaculture and Restaurant Owner

Stakeholder	Frequency
Middleman	14
Mussel aquaculture	12
Restaurant Owner	30

Incremental Cost Incurred by Middleman

To avoid double counting, we will not be using the total value of fish stock unavailable after the project is implemented. Nonetheless, we are computing the extra cost to acquire similar species which are previously available at the jetty nearby but need to get it somewhere else. This incremental cost for having supplies of fish elsewhere is the estimate total loss to the middlemen. Every interviewed middleman will be asked about the sales of their customary fish species and the average weight of the supplies being collected on a daily, weekly or monthly basis. Meanwhile, the other relevant information that is also recorded is listed in **Table 7.28**.

Subsequently, the middleman was asked to estimate the percentage from the total weight for every fish species being supplied from outside of the study area. After a brief description of the project, they were also asked to quantify the percentage of increase in fish supply to be taken outside the study area when there was expectation of a reduction in local marine stocks. To facilitate the calculation, every information recorded is based on an average value and does not necessarily reflect the exact value as such information is difficult to be determined by the respondent.

Among the assumptions adopted are:

1. Impact of cost increases will only involve 50% of the total identified middlemen. Therefore, we expect seven out of 14 middlemen to have a significant impact.
2. On average, under 'with' project scenario, the respondents are expecting 10% increase from quantity of supply to be taken from other areas while the possibility of supply of *kupang* and *kerang* will need to take 80% and 50% from outside local area respectively since much of the productive either will be reclaimed or degraded.

Table 7.28: Computational Components for Increased Transportation Costs by Species Borne by Middlemen

Local Name	Scientific Name	Average Monthly stock (kg/month)	% stock taken from other area	Transportation cost per trip (RM)	No. of Trips per month
Belangkas	*Tachypleus gigas*	250	0.75	150	16
Udang Pengantin	*Penaeus merguensis* (Grade A)	75	0.6	30	15
Udang Belang	*Parapenaeopsis sculptilis*	250	0.6	30	15
Udang Kawan	*Penaeus* spp/*Metapenaeus* spp.	100	0.6	30	15
Kupang	*Perna viridis*	375	0.2	25	25
Kerang	*Tegillarca granosa*	250	0.5	25	25
Ketam Bunga	*Portunus pelagicus*	25	0.8	25	20
Pari Beting	*Himantura gerrardi*	240	0.7	70	20
Pari Tanjung	*Dasyatis zugei, Himantura walga, Himantura jenkinsiii, Himantura oxyrhyncha*	160	0.7	70	20
Pari Rimau	*Himantura uarnak, H. undulata, Neotrygon kuhlii*	100	0.7	70	20
Sembilang	*Plotosus* spp.	250	0.5	25	25
Gelama	*Pennahia* spp. / *Johnius* spp.	375	0.6	25	25
Senangin	*Polynemus* spp.	375	0.6	25	25

In order to compute cost of transportation, all information given in **Table 7.28** need to be calculated based on following arrangement:

$$\text{Transportation cost per kg} = \frac{(transportation\ cost\ per\ trip\ X\ no.of\ trips\ per\ month)}{(average\ monthly\ stock\ X\ \%\ stock\ taken\ from\ other\ area)}$$

Next, under the condition of 'with' project scenario, we impose a 10% increase in stock supply for all species except Kupang (ie 80%) and Kerang (i.e. 50%) resulting in information as shown in **Table 7.29**. Considering only seven (7) middleman that may be affected from this project then total annual incremental cost of transportation is **RM 391,930** (i.e. RM55,990 X 7 people).

Table 7.29: Incremental Cost of Transportation for Middleman

Local Name	Scientific Name	Transportation cost per kg (RM/kg)	Incremental stock acquired from other area (kg/month)	Incremental cost of transportation (RM/month)[1]
Belangkas	*Tachypleus gigas*	12.80	25	320
Udang Pengantin	*Penaeus merguensis* (Grade A)	10.00	7.5	75
Udang Belang	*Parapenaeopsis sculptilis*	3.00	25	75
Udang Kawan	*Penaeus* spp/*Metapenaeus* spp.	7.50	10	75
Kupang	*Perna viridis*	8.33	300	2500
Kerang	*Tegillarca granosa*	5.00	125	625
Ketam Bunga	*Portunus pelagicus*	25.00	2.5	63
Pari Beting	*Himantura gerrardi*	8.33	24	200
Pari Tanjung	*Dasyatis zugei, Himantura walga, Himantura jenkinsiii, Himantura oxyrhyncha*	12.50	16	200
Pari Rimau	*Himantura uarnak, Himantura undulata, Neotrygon kuhlii*	20.00	10	200
Sembilang	*Plotosus* spp.	5.00	25	125
Gelama	*Pennahia* spp. / *Johnius* spp.	2.78	37.5	104
Senangin	*Polynemus* spp.	2.78	37.5	104
Total Monthly Incremental cost of transportation				4,6666
Annual Incremental cost of transportation		**55,990**		

[1] multiply the value for 'Transportation cost per Kg' with 'Incremental stock acquired from other area'

Total Income Loss of Mussels Farming

The local *kupang* aquaculture is operating on a small traditional farming basis and not fully commercial scale that would require a large cage design and also using kupang seedlings purchased from breeders. Local *kupang* supplier is using a simple cage design consisting of two basic materials namely PVC pipe and used nets with *kupang* seeds obtained naturally rather than purchased from breeders. The drifting kupang seedlings will be stuck on the nets and will naturally reproduce and grow at this cage. Therefore, *kupang* seedlings here are entirely dependent on the amount of *kupang* seedlings that live in the area. Thus, when the *kupang* habitat is destroyed, the *kupang* farmers interviewed expect the yield of mussels to be completely disrupted. It is suggested that the opportunity cost of the project to these *kupang* farmers are the anticipated foregone income streams from *kupang* production in the future (**Table 7.30**).

Table 7.30: Earning and Cost Structure of a Small Scale Mussel (Kupang) Aquaculture.

Annual production of mussel (kg/year)	880
Annual revenue (RM/year)	7,424
Annual maintenance costs of nets (RM/year)	(432)
Net total income per year (RM/year)[1]	**6,992**

[1] annual revenue less annual maintenance cost

Generally, the significant cost involved in the mussels rearing is the maintenance of a damaged net by changing it to a new one. On average, *kupang* suppliers have three cages and each cage needs 120 pieces of net at a cost of RM4 per piece. Every year, it is expected that 30% of the nets will have to be changed due to the damage. As indicated in **Table 7.30**, the average income stream from an individual *kupang* aquaculture is RM6,992 a year. Information during the interview suggests that there are 12 operators who are earning a total income stream of RM 83, 904 per annum. This figure would be the opportunity cost from foregone mussel aquaculture.

The Income Effect to Restaurant Owners

As for the restaurant owners, there are the occurrences of two possibilities on account of the implementation of the proposed project. Based on the interviews that have been conducted, a summary of the perceived impacts to local restaurant owners is as follow:

1. Possibility of a reduction from 20%, 30% or 40% over sales under the 'with' project scenario. There are two reasons for this opinion, first is the possibility of local marine stocks decreasing that would cause the restaurant owners having had to charge higher prices especially when the fishery stocks are taken from other locations. It is more aggravating if the owner needs to take out several seafood cuisines from the menu due to irregular raw material supply. Secondly, there are no guarantee that the fishery supplies purchased elsewhere can provide the same quality as local fishery stock. When this situation persists, the attraction of visitors to enjoy food here could diminished and this will definitely affect business sales. This latter view is based on a majority of interviewed restaurant owners, whom comprise 70% of the number of restaurant owners interviewed.
2. On the contrary, there is also a view that felt no significant change could occur from the proposed project. In fact, these restaurant owners are of the opinion that there will be an opportunity to increase food prices as the reduced fishery market supplies are opportunities to generate more income than before but with the assumption that the rate of visitation remaining unchanged. This is the opinion of the remaining 30% of the interviewed seafood restaurant owners.

To calculate the surplus or the reduction of restaurant traders' income, the following information should be obtained first (**Table 7.31**).

Table 7.31: The Average Earnings and Cost Structure of a Range of Seafood Restaurants

Restaurant Size[1]	**80 seats**	**60 seats**	**40 seats**
No. of affected restaurant owner[2]	6	15	9
Average monthly revenue (RM/month)	78,000	40,000	24,000
Average expenditure on raw material for fishery supplies (RM/month)[3]	15,420	11,480	7,734

[1] Restaurant size determination is limited to 80, 60 dan 40 seats as this is the common restaurant capacity at the study area.

[2] The distribution of restaurant owner based on restaurant size is 20%, 50% and 30% for restaurant with capacity 80 seats, 60 and 40 seats respectively

[3]Among the types of fishery supplies considered are *belangkas, udang, kupang, kerang, pari beting, pari tanjung, pari rimau* and other miscellaneous type of fish from the local source.

Next, the incremental gain or loss will be based on the following assumption:

1. The estimated loss of income: It only involves 70% of the number of restaurant owners. The percentage of revenue reduction by 20%, 30% and 40% is perceived by restaurant size of 80, 60 and 40 seats respectively.
2. The estimated gain in income: It only involves 30% of the number of restaurant owners. It was suggested that the restaurant owners have the opportunity to raise prices of the goods raising revenues by 30% with the increase in cost anticipated to be around 15%.

Table 7.32: The Net Economic Value For Restaurant Owners

Restaurant size	**80 seats**	**60 seats**	**40 seats**
Loss in income	(246,660)	(282,520)	(82,986)
Gain in income	150,601	174,591	60,226
Net economic value	**(96,059)**	**(107,929)**	**(22,760)**

Overall, considering the total net loss of economic value for the restaurant owners estimated to be RM 226,748 per annum.

7.11.7 Estimation of Anglers Travel Cost

On the demand side, consumers namely angling enthusiasts would incur a gain or perhaps a loss of opportunity to fish recreationally. This change in consumer surplus is computed.

An investigation was undertaken with the objective to determine:

- How important the affected coastal area is to the anglers and how much they value the trip to this coastal area within the impact radius?
- Whether the recreational services are perceived to be affected by the proposed project and if so by how much?

The travel cost method (TCM) is the appropriate valuation procedure to use when estimating the value of outdoor recreation such as angling along the coast (about 5 km) from Pernu jetty to Sg Duyung Jetty as well as those that rent a boat to the deep-sea waters approximately 4 to 8 km from the coast. First, the TCM requires fitting a trip generating function (TGF) that represents the demand for the angling activity. The economic value is obtained by calculating consumer surplus (CS) which is the area below the demand curve but above the travel cost of the anglers (as illustrated in **Chart 7.6**).

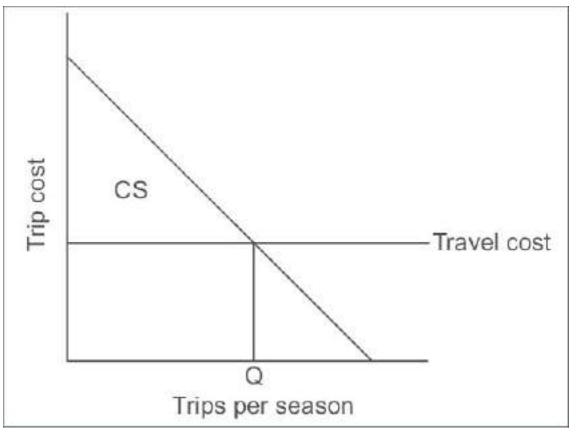


Chart 7.6: Travel Cost Method Demand Curve

A survey from anglers was undertaken along the coast during weekdays and weekends. The profile of the anglers is provided in **Table 7.33**. This profile represents the typical angler that is fishing at the coast as well at the middle of the sea along the shoreline of Umbai and Pernu.

Table 7.33: <u>Profile of Anglers</u>

Profile	**Frequency of respondent (%)**
Origin	
Local (within district)	40%
Other district	35%
Other state	25%
Age	
Below 25 years old	10%
25 to 35 years old	80%
More than 35 years old	10%
Income	
Below RM1,600	15%
RM1,600 to RM2,000	40%
More than RM 2,000	45%
Distance from home	
Less than 10km	40%
10 to 50 km	40%
More than 50km	20%
Average time spend on site	
Below 6 hours	15%
6 to 10 hours	65%
More than 10 hours	20%

The common form of estimated TGF is the linear and semi-logarithmic forms that are useful for obtaining the consumer surplus using travel cost method. Base on theoretical consideration (negative coefficient for travel cost) and statistical diagnostics, the better estimated TGF function is linear and the results is provided in **Table 7.34** that gives the following function:

Annual Visitation per person (V) = 6.0523 – 0.00224 *Travel Cost* -0 .1318 Education

Table 7.34: Estimated Semi logarithmic and Linear TGFs For Angling Within 5km Radius From Proposed Site

Functional Form	**Linear**	
	Coefficients	***t* Stat**
Intercept	6.052375	8.60***
Travel Cost	-0.00224	-4.07***
Education	-0.13184	-2.30**
Adj. R Square	69.68%	
F Statistic	22.83***	

The function is overall relatively well-fitted with two independent variables after being estimated in a step-down regression process beginning with 6 independent variables that also included visitors income, age, time spent at site and substitute site. The F statistic for the function is statistically significant at the 1% level and a coefficient of adjusted multiple determination (R^2) of 69.68% was obtained. The coefficient for travel cost was negative as required while that for education was also negative. The latter implies that more well educated individuals may have higher incomes and tend to do angling in more challenging environment such as renting a boat and fishing at islands in deep seas.

From the TGF function the average consumer surplus per visit is estimated by the following formula and the results presented in **Table 7.35**.

Consumer Surplus per Visitor = - Average number of angling trips / (2 x coefficient of TC) while

Consumer surplus per trip = - 1 / (2 x coefficient of TC)
= - 1/ (-0.00124)
= RM 3.51

Table 7.35: Consumer Surplus Estimates

	Consumer Surplus
Per Angling Individual	454.73
Per Angling Trip	3.51

Hence, the economic values gain by anglers for each fishing trip is estimated to worth RM 3.51 per visit. It was estimated that during a working day, an average of 10 people is angling along the coastal area while during weekends, the number of anglers increased to 30 individuals resulting in an estimate of 5,280 angling trips per year. Using the estimated consumers surplus of RM 3.51 per trip, the total consumer surplus is estimated at RM18,533 per year indicating the gain by society under the status quo or 'without project' option.

The second component of the investigation is to estimate how much changes in recreational services would anglers experience from the proposed project. From the surveyed anglers, it was found that 'with the project' option, a handful of respondents which comprise of anglers along the coastal area is expecting that the attraction of the said coastal area for angling activities might be slightly reduced during the implementation of the project. A percentage weighted average was done among groups who felt visiting rates might decline with those who felt that this Project would not affect their frequency of trips. With this feedback it was estimated that the annual number of trips would reduce by 20% or 4,224 per year. This allows a computation of the reduction in economic value 'with the project' of RM14,826 per year and an incremental reduction on economic values of angling of RM3,707 per year (**Table 7.36**).

Table 7.36: Impact of Project on Angling Opportunities

	Trips/year	**Consumer Surplus (RM/year)**
Without Project	5,280	18,532.80
With Project	4,224	14,826.24
Reduction	**1,056**	**-3,706.56**

7.11.8 Local livelihood - Willingness to Pay (WTP)

The community living close to the project site who have been enjoying the environmental coastal vista for so long, may experience a change in their satisfaction and utility with the proposed project. Further during the construction stage of the project, these community would also be facing some inconveniences from the presence of foreign workers, traffic and noise of machinery at work. This change in coastal vista and social inconveniences resulted in a decline in economic welfare. One common technique to estimate the value of this loss is to adopt the approach also known as contingent valuation method (CVM). It is implemented by means of surveys, aims to assess how individuals would hypothetically react to changes in environmental quality. In particular, it elicits from respondents how much they would be willing to pay to avoid a hypothetical reduction in environmental quality. There are many approaches to estimating "willingness to pay" (WTP), we use an open-ended questionnaire which asks people directly how much they are willing to pay to support efforts to conserve and ameliorate a particular benefit/function/service of a surrounding environmental service function that would change from proposed reclamation project and monitor the traffic and work environment of the project. For example, "What is the maximum amount you would be willing to pay towards a fund to support a non-governmental organization watchdog service e such as RELA or environmental NGO volunteer watchdog to monitor the Project construction and implementationin order to keep environment clean andtranquility of local livelihood?"

There are seven steps for conducting Contingent Valuation Method (CVM) as follows.

Step 1. Select the relevant stakeholders/beneficiaries
Step 2. Decide sampling size and composition
Step 3. Questionnaire Design
Step 4. Preparing for the survey
Step 5. Input data
Step 6. Estimating Willingness to pay (WTP)

See reference: Wattage *et al*. (2008); Morrison *et al*. (2000)

The WTP method is most suited to valuing those benefits that do not have a market value, in particular intrinsic worth benefits such as local environment and livelihood. It is important to determine the relevant stakeholders for computing the CVM. In this case, locals are affected stakeholders of construction activities that may occur. In short, the population is expecting some unpleasant circumstances when the proposed project will be implemented in the near future. Among their concerns are influx of heavy vehicle and foreign workers. Additionally, the developer's working arrangements may not be subject to reasonable time of work. Therefore, it is important to identify all relevant stakeholder that might be facing this common problem so a representative sample of the most important stakeholders/beneficiaries can be surveyed.

The willingness to pay (WTP) part of the survey should include the following four (4) components depending on the hypothetical scenario or benefit we want to value as follows.

1. details of Project work during construction stage should be explained
2. the impact of this proposed project on local current environment and possible social impact should be described.
3. the details of payment vehicle should also be explained.
4. pictures of proposed project site should be also attached in the questionnaire and shown to interviewees during interviews.

The project area is at the district of Melaka Tengah but the zone of impact if stretched to within 5km would also cover the district of Jasin. For simplicity, in order to estimate the numbers of population, the statistical data has been referred and the distribution of the population is based on the number of populations in the mukim of both districts in Melaka Tengah and Jasin. The number of populations according to these two districts is as shown in **Table 7.37** and sample selection by cover area is as listed in **Table 7.38**.

Table 7.37: The Population Breakdown by Affected Mukim

District	**Mukim**	**No. of Household**
Melaka Tengah	Pernu	1,494
	Telok Mas	1,720
	Alai	1,953
	Kandang	1,084
	Bukit Lintang	2,174
Jasin	Umbai	8,989
Total		**40,313**

Table 7.38: Sample Selection for Estimating WTP

Distance area	Name of village	Sample size
Within 2km from the project site	Kg. Pernu	124
	Bukit Ketapang	
	Kg Ketapang	
	Kg. Alai	
	Kg. Bukit Larang	
	Kg. Teluk Mas	
	Taman Seri Teluk Mas	
	Taman Alai Perdana	
	Kg. Bukit Punggor	
	Kg. Anjung Seri Minyak	
	Kg Tambak Bugis	
2km to 5 km from the project site	Kg. Balik Bukit	**117**
	Kg. Bukit Kechil	
	Kg Pulai	
	Kg. Bukit Tembakau	
	Kg. Umbai	
	Kg. Tanjung Batu	
	Kg. Bukit Lintang	
	Taman Pulai Jaya	
	Taman Sri Emas	
	Kg. Permatang Pasir	
	Kg. Bukit Meta	
	Kg. Pangkalan Renggam	
	Kg. Umbai Permai	
	Taman Bukit Tembakau	
	Kg Berangan	
Total		**241**

The respondents were asked to give an estimate of their WTP as a contribution to the effort for reducing the environmental impact of the Project to a fund to finance an NGO watchdog to enhance monitoring and conservation efforts. WTP value is in RM per year and the mean and total value of WTP for monitoring and conservation efforts for each sample is shown in **Table 7.39**.

The total WTP is equivalent to the mean WTP of each sample multiplied by the number of households in each of the covered area (**Table 7.39**). The total WTP is **RM 634,183** per year based on the study sampled.

Table 7.39: Total of WTP

Covered Area	Mean WTP	No. of household[1]	Total WTP per annum
Within 2km from the project site	17.5	20,742	362,984
2km to 5 km from the project site	13.86	19,571	271,199
Total		**40,313**	**634,183**

[1] it is estimated that 51.5% is the household density from area within 2km and remaining 48.5% is for the area of 2km to 5km.

7.11.9 Total Net Present Value (NPV) for Economic Valuation

In summary, the component of economic loss taken into account is as listed in **Table 7.40**. Hereafter, the discounted sum of various economic loss computed earlier due to the Project will be estimated. For certain impacts the present value streams would cover over the next 50 years for losses incurred by fishermen except for maintenance and repairing costs. Also included would be the loss from angling opportunities. In the event of this project, impacts on marine life and fishing work are not short-term as most marine ecosystem effects take time to recover or improve. Hence, some impact might involve very short period or perhaps within 10 years but some are either in very long period of 50 years or even forever. The breakdown of the NPVs is as provided in **Table 7.41** under the three different discount rates namely 8%, 6% and 4%. The cashflows of the economic values of these impacts are presented in **Appendic IX** at the different discount rates namely 8%, 6% and 4%.

Table 7.40: Economic Loss

Description	Estimated number of years of impact	RM/year
Loss of mudflat	Permanent	(8,279)
Incremental fuel cost-fishermen	At least 10 years	(2,122,093)
Total incremental cost of nets repair/replace (RM/year)-fishermen	At least 10 years	(122,111)
Total incremental cost of boat/engine maintenance (RM/year)-fishermen	At least 10 years	(172,778)
The Opportunity Loss from Increment of Working Hour by Fishermen	At least 10 years	(3,358,110)
Annual Incremental cost of transportation-middlemen	At least 10 years	(391,930)
Net total income loss of mussels aquaculture per year (RM/year)	50 years	(83,904)
The net economic loss for restaurant owners	At least 10 years	(226,748)
Reduction in anglers 'consumer surplus'	During 2 years construction	(3,707)
Local WTP	During 2 years construction	(634,183)

Table 7.41: Total NPV for Respective Discount Rate (8%, 6% and 4%)

	Loss of mudflat	Incremental fuel cost-fishermen	Total incremental cost of nets repair/replace (RM/year)-fishermen	Total incremental cost of boat/engine maintenance (RM/year)-fishermen	The Opportunity Loss from Increment of Working Hour by Fishermen	Annual Incremental cost of transportation-middlemen	Net total income loss of mussels aquaculture per year (RM/year)	The net economic loss for restaurant owners	Reduction in anglers 'consumer surplus'	Local WTP	Grand total
Total NPV (discount rate=8%)	-103,493	-16,361,510	-941,486	-1,332,132	-25,891,301	-3,021,812	-1,110,342	-1,748,246	-16,730	-1,765,099	-52,292,152
Total NPV (discount rate=6%)	-137,990	-17,740,882	-1,020,859	-1,444,439	-28,074,092	-3,276,569	-1,406,387	-1,895,633	-17,032	-1,796,889	-56,810,772
Total NPV (discount rate=4%)	-206,985	-19,334,168	-1,112,541	-1,574,162	-30,595,390	-3,570,833	-1,886,345	-2,065,877	-17,348	-1,830,312	-62,193,963

Conclusion

Tables 7.40 and **7.41** show the streams of discounted loss of environmental services over a period of 2 year, 10 years and 50 years for which relevant that can be attributed to the project. The 8% rate is chosen to reflect the market rate of interest conventionally used for project evaluation while 6% and 4% are the more appropriate rates for social evaluation. The corresponding values for 8%, 6% and 4% discount rate are 52.29 million, 56.81 million and 62.19 million respectively. This study noted that the sum should not be considered as indicating project feasibility. Rather, they provide some indication of the magnitude, in monetary term, of reduction or gain in the flow of environmental services as a result of the implementation of the Project over the said evaluation period.

7.12 Marine Ecology, Fisheries & Aquaculture

7.12.1 Introduction

An impact is any change to the existing condition of the environment caused by human activity or other influences. Impacts can be positive (beneficial) or negative (adverse). Both positive and adverse environmental impacts can arise during the reclamation works and post – reclamation of the proposed project.

The various activities associated with proposed reclamation at the project site will invariably bring about environmental impacts on different aspects of the marine environment (aquatic fauna, sediment communities, water quality, mangroves and coral reefs) and consequently on the immediate coastal environment as well as fisheries and aquaculture activities that depend on its health. The nature and intensity of these impacts would depend on the extent, intensity and timing of the activities and can be of a short or long-term nature.

Short-term impacts would mainly arise during the actual reclamation and construction phase, including dredging, shipment and transfer of spoil/fill material to the site. Long-term effects would include residual impacts remaining after construction activities have been completed as well as during the operational phase of the project. After completion of the project, potential impacts arising would relate largely to the manner in which it is being run and managed.

The potential impacts that would arise from the proposed project are outlined and further elaborated in the following discussion.

7.12.2 Impact on Marine Productivity

7.12.2.1 Plankton

Primary and secondary productivity is important indicators of the available forage base for marine planktivorous organisms. These organisms, in turn, play an important part in the marine food web (Chong *et al*., 1990). Many commercially important pelagic fish species are, in fact, directly dependent on primary and secondary producers. The impacts of plankton populations are not restricted to a specific area and relate closely with primary and secondary productivity along the entire coastline.

The extent of primary and secondary productivity in a given environment is dependent on a number of factors including light levels, nutrient levels, temperature and favourable hydrographic conditions (Alongi and Cristoffersen, 1992). Under local conditions, where light intensity and duration are constant throughout the country, nutrient levels primarily mediate plankton densities.

The hydraulic study undertaken as part of the EIA was reviewed to establish the impact of changes to current flow, wave and sediment dispersion accompanying the reclamation on the marine ecology, fisheries and aquaculture activities in and around the project site.

The results of the hydraulic modeling are discussed below.

- Current Speed

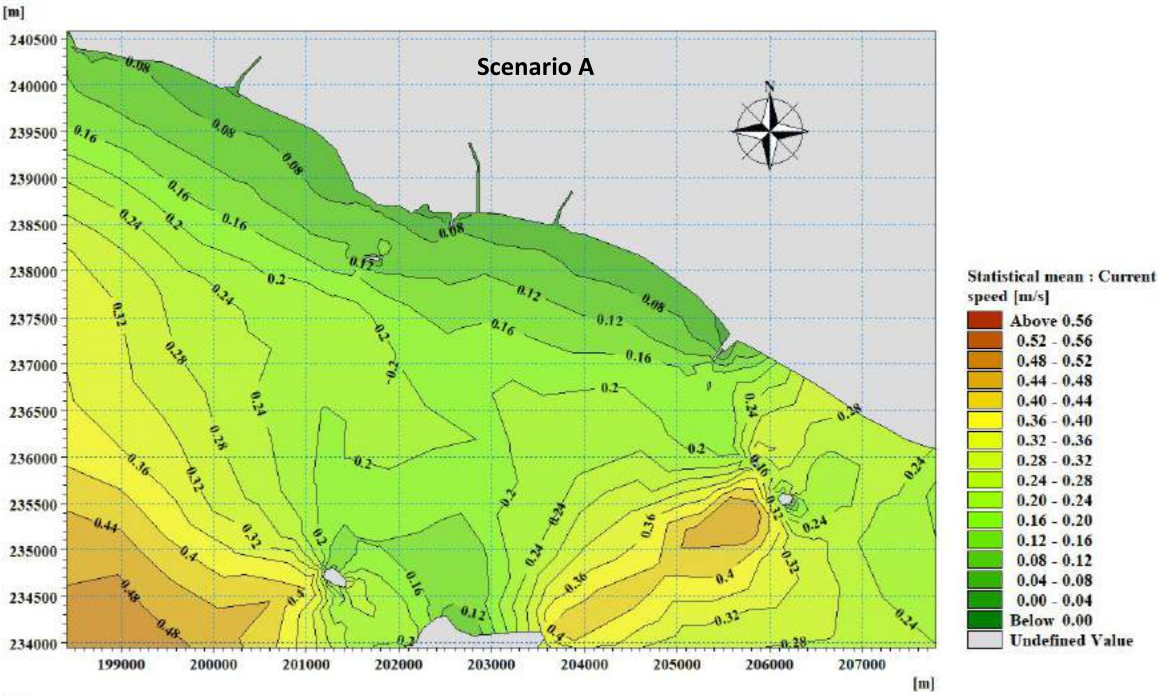
The existing mean current speed in the project site is 0.04 - 0.2 m/s. The hydraulic study indicated that, there would be no changes in the mean current speeds with the proposed reclamation during both northeast and southwest monsoon (**Table 7.42; Plates 7.1 – 7.2**).

Planktons are highly dependent on the currents for their movement in the open waters. The impact of changes in current speeds on the plankton community is considered negligible, since no changes are expected. In addition, there is also no impact on the fishing activities are expected due to the current speed.

Table 7.42: Mean Current Speeds in Project Area

Scenario	Monsoon	Mean Current Speed (m/s)
Scenario A (baseline)	Northeast Monsoon	0.04 - 0.2
Scenario B (proposed reclamation)	Northeast Monsoon	0.04 - 0.2
Scenario A vs Scenario B	Northeast Monsoon	-0.045 - 0.105
Scenario A (baseline)	Southwest Monsoon	0.04 - 0.2
Scenario B (proposed reclamation)	Southwest Monsoon	0.04 - 0.2
Scenario A vs Scenario B	Southwest Monsoon	-0.045 - 0.105

Plate 7.1: Mean Current Speed in Study Area During Northeast Monsoon



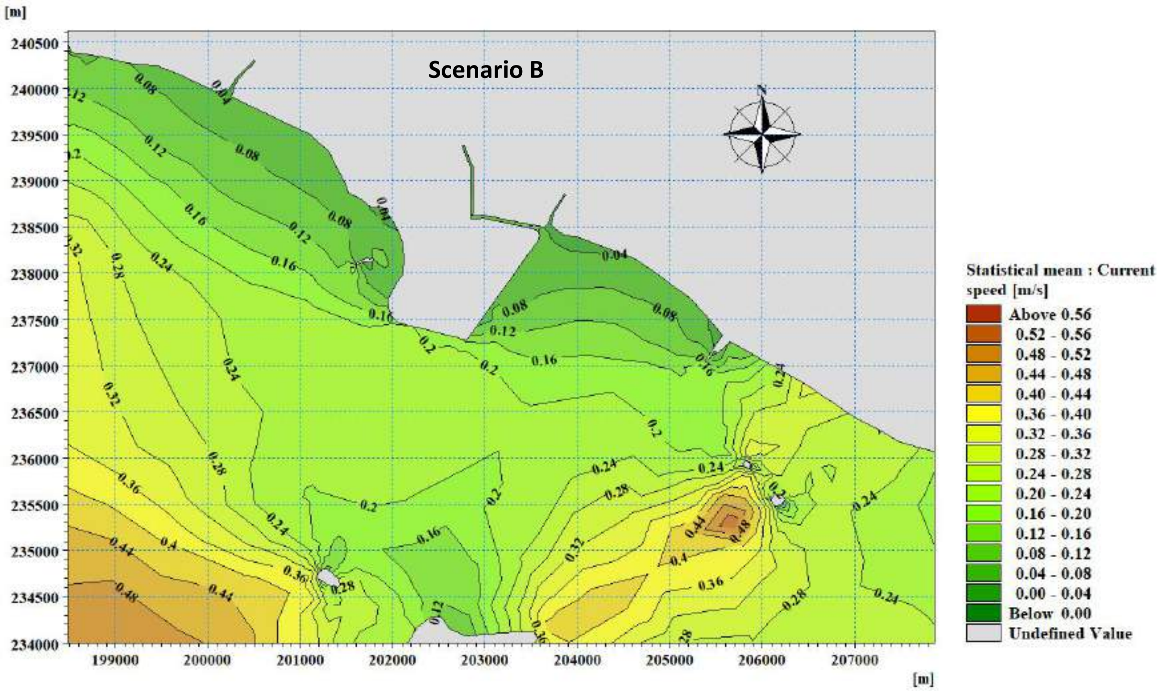
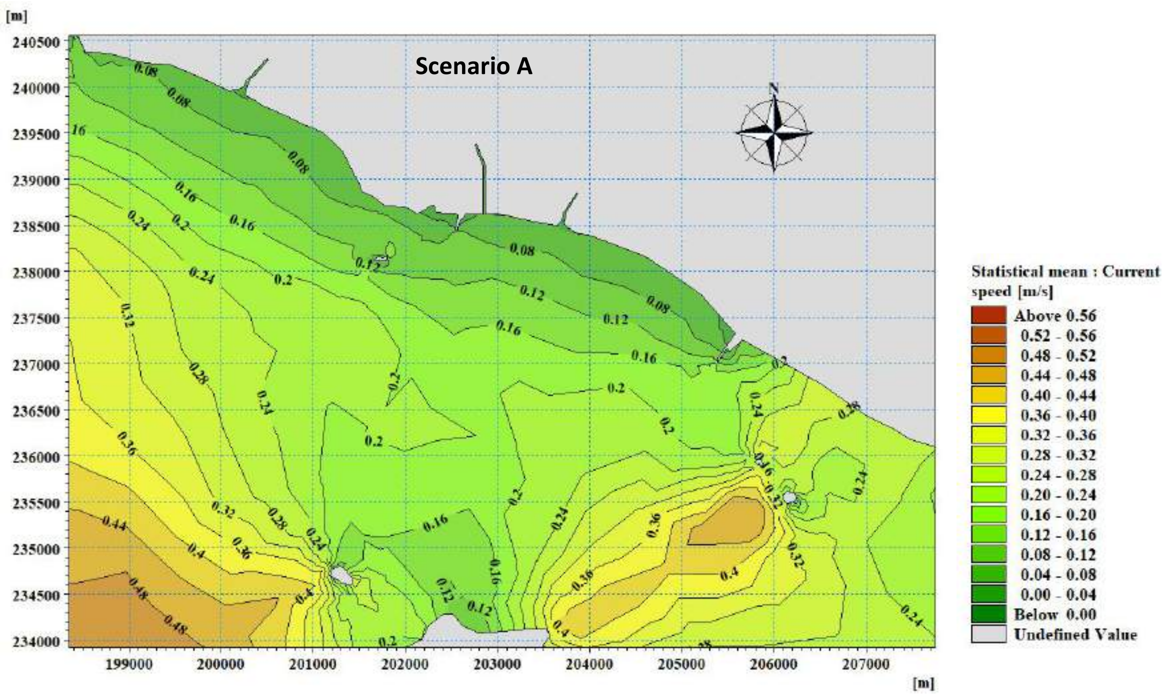
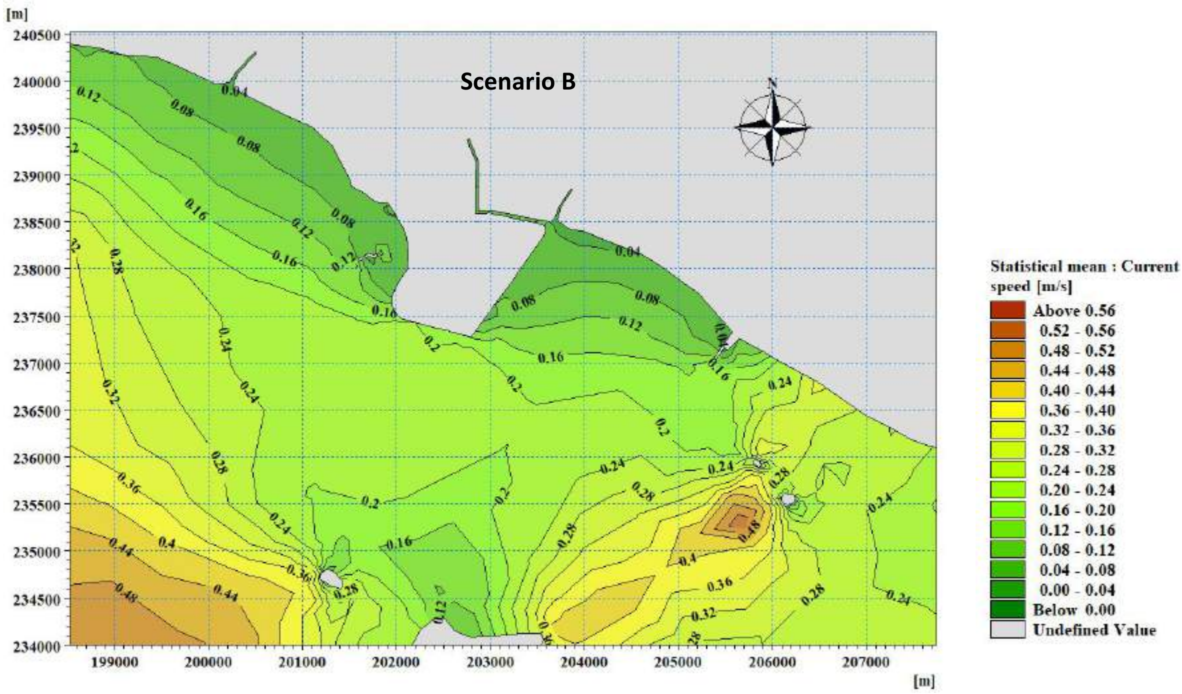


Plate 7.2: <u>Mean Current Speed in Study Area During Southwest Monsoon</u>



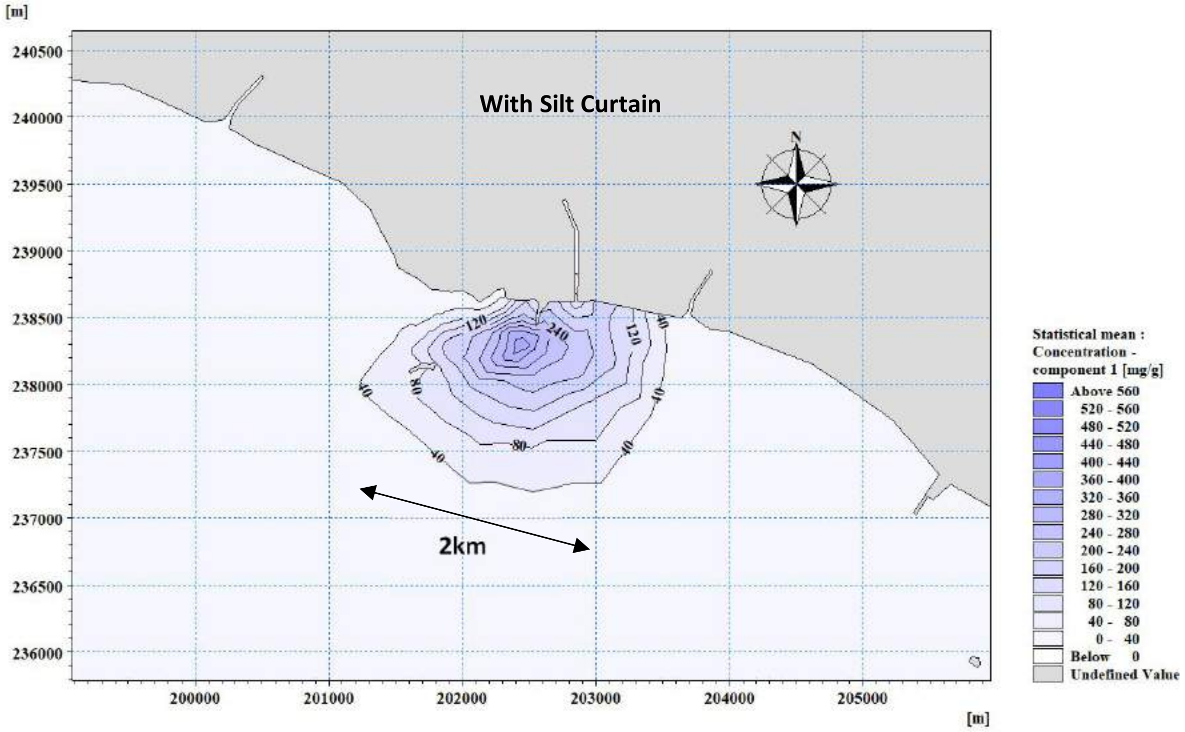


- Suspended Sediment

Based on the hydraulic study, the plume patterns indicate that excess suspended sediment concentrations generated from the reclamation work are expected within vicinity of the proposed reclamation site. With installation of silt curtain, the mean sediment plume dispersion of 40 mg/L is expected extended to approximately up to 2.0km during neap tide and 3 km during spring tide. On the other hand, without installation of silt curtain, the mean suspended sediment of 150 mg/L is expected to extended to 2.8 km during neap tide and 3 km during spring tide (**Plates 7.3 – 7.4**).

The recommended safe limit for aquatic organisms is <80 mg/L (Boyd, 1998), thus indicated that the reclamation would have an impact on the plankton distribution. However, the study by Wilber and Clarke (2010) found that the zooplankton communities, fish eggs and larvae were significantly affected when the level is >500mg/L. A significant increase in suspended sediment would retard primary production and, by extension, the rest of the marine food web. Decreasing availability of food due to reduced photosynthesis (Pequegnat, 1978) would likely induce migratory of herbivorous organisms out of the area to search for food. Hence, the action will continue to disrupt the food web in the area by depriving food from the higher trophic, causing imbalance to the community there.

Plates 7.3: <u>Mean Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Neap Tide With and Without Installation of Silt Curtain</u>



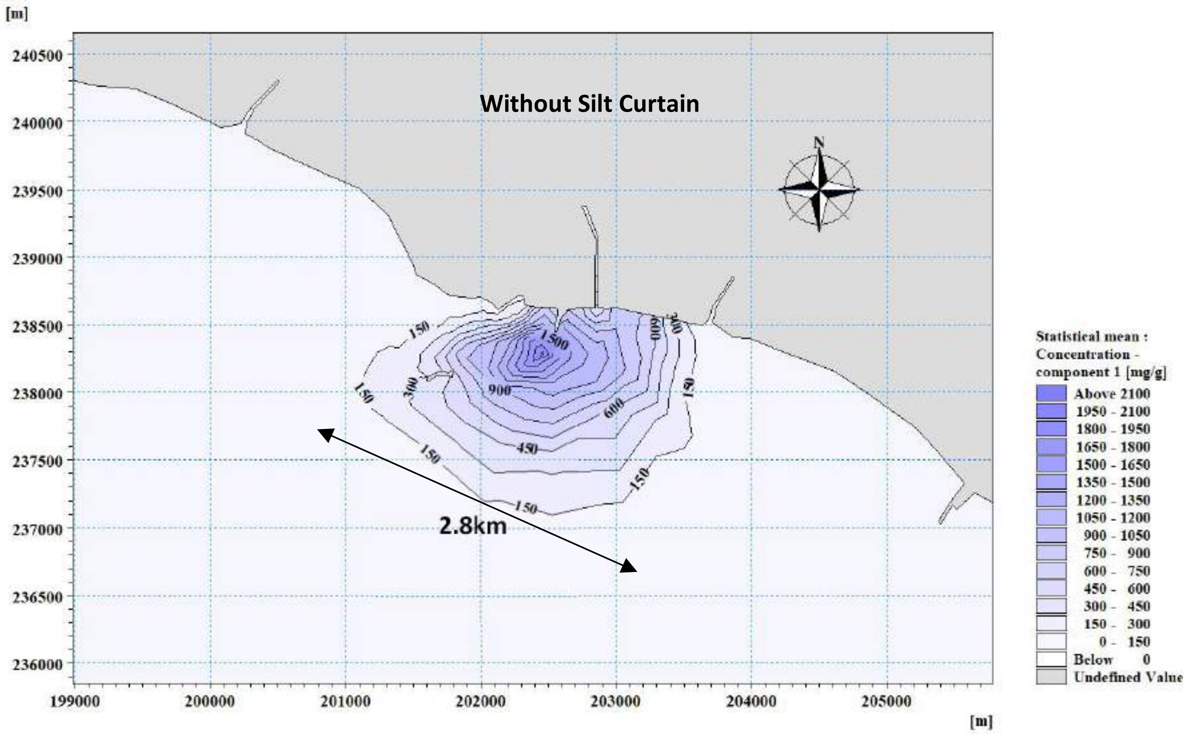
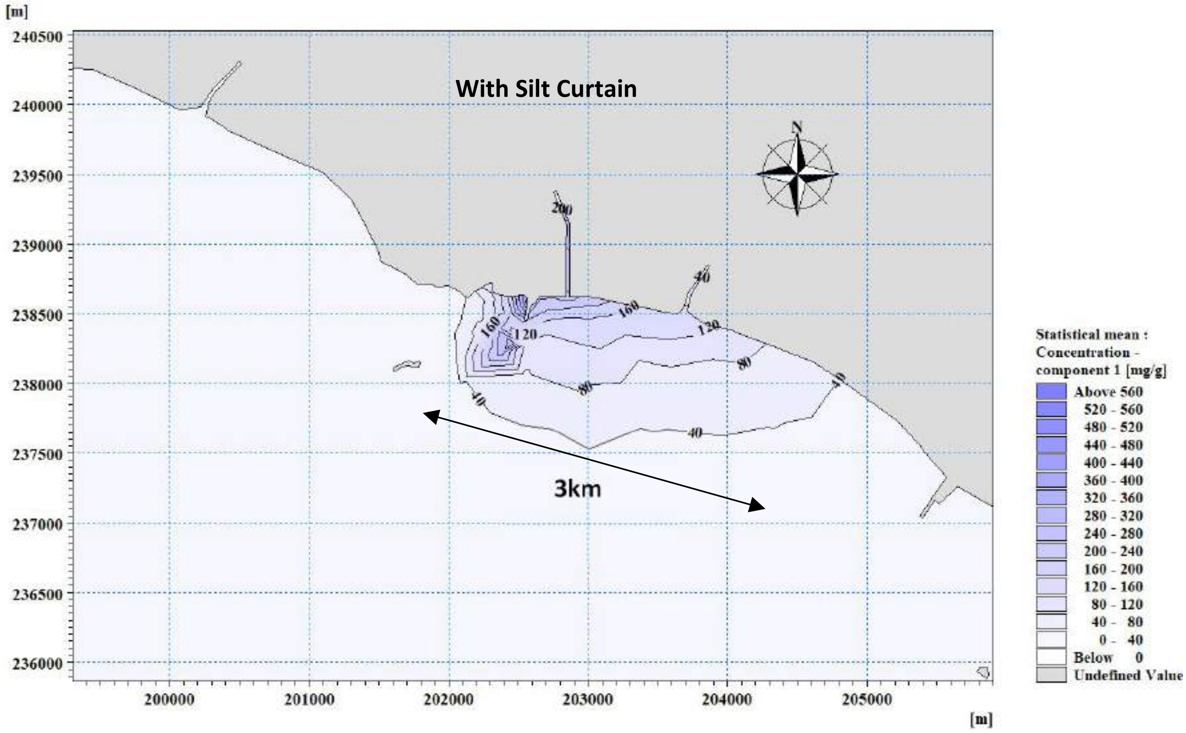
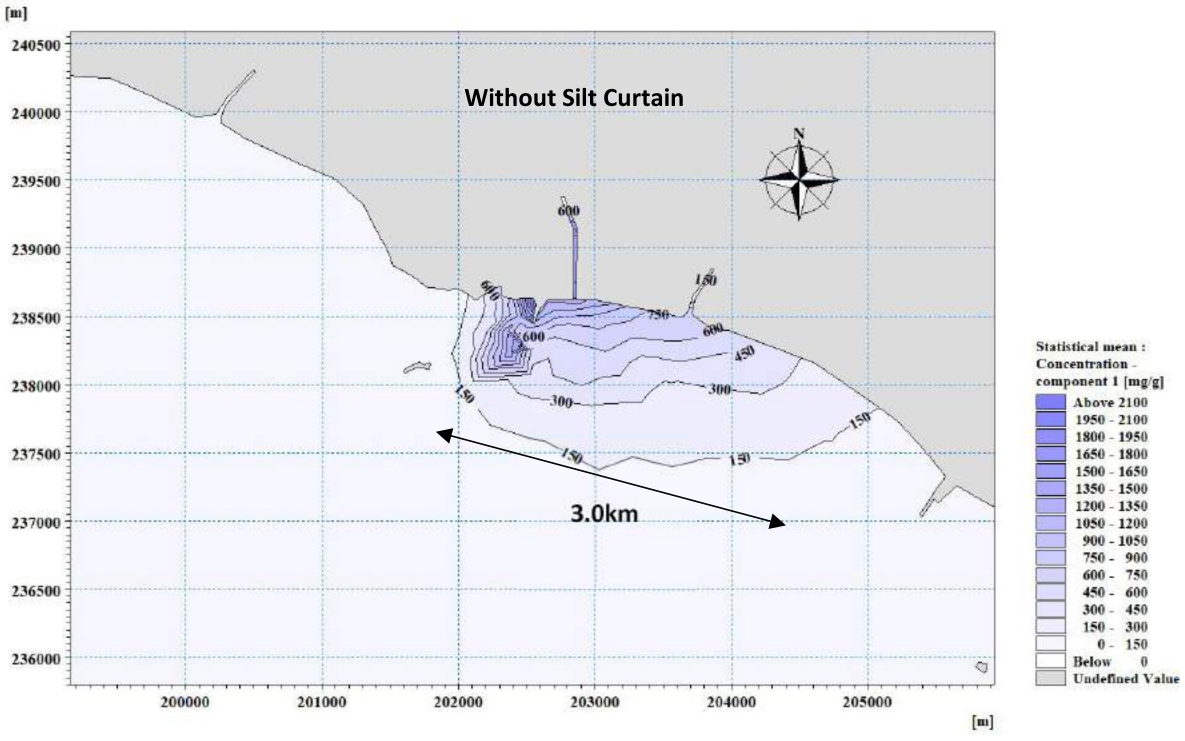


Plate 7.4: <u>Mean Extent of Sediment Plume Dispersion from the Proposed Reclamation Work during Spring Tide With and Without Installation of Silt Curtain</u>





7.12.2.2 Macrobenthos

Sediment communities play a critical role in the food chain for a wide spectrum of marine organisms (Chong *et al.*, 1990). Benthic macrofauna are also one of the most important food sources for marine demersal fish (Sasekumar, 1984; Sasekumar *et al.*, 1984; Erfetemeyer *et al.*, 1989). Thus, the loss of macrobenthic fauna at and adjacent to the site would clearly impact on fish fauna currently found there. Sediment communities relate closely with primary and secondary productivity along the entire coastline. Therefore, the direct effects of construction works on these organisms and disturbance to the seabed communities can also deleteriously affect organisms on higher trophic levels in adjacent area by depriving them of forage.

Crustaceans such as shrimps and molluscs (gastropod and bivalves), which have limited mobility and are largely dependent upon for food and shelter on the foreshore area, would be seriously affected due to reclamation and dredging activities. This in turn, would reduce the abundance these organisms. In addition, Ingle (1952) reported that high levels of suspended sediments have been shown to kill bivalves. Other impacts arising from the disturbance of seabed would be the destruction of spawning areas and smothering or suffocation of sessile organisms in the area (Pennekamp and Quaak, 1990).

The hydraulic study indicated that, there are no changes in the current speed at the proposed project site during both northeast and southwest monsoon (**Table 7.42; Plates 7.1 – 7.2**). The transportation and dispersal of benthic organisms, in particularly their larvae and juveniles stages is dependent on the current movements. Since, there is no changes in current speeds, the shift in the currents would, thus, not likely affect their population dynamics. However, currents indirectly play important parts in influencing primary and secondary production as well as carrying food sources to the benthic communities (Rosenberg, 1995).

As for sediment dispersion, the hydraulic study indicated that, the suspended sediment dispersion is expected to be worse within vicinity of proposed reclamation area, where high level of suspended sediments is expected (240 - 1,500 mg/L) (**Plates 7.3 - 7.4**).

The recommended safe limit for aquatic organisms is <80 mg/L (Boyd, 1998), thus indicated that the reclamation would have an impact on the benthic distribution in the reclaimed area. This is especially true to suspension feeders, as high concentrations of inedible suspended sediment particles can directly interfere with the food intake i.e. by clogging the filter structures, thus affecting growth and its condition. On the other hand, while deposit-feeders and grazers are not directly affected by the increase of suspended sediments, the limitation of food in terms of microphytobenthos would also affect them (Nicholls *et al*., 2003). It has been observed that in estuaries with high turbidity, the contribution of the microphytobenthos to the overall primary production is very low, thus creating a chain-reaction of fewer number of epiphytic grazer in the area (Kromkamp *et al*., 1995).

7.12.2.3 Fish Fauna

The immediate impact on fish fauna would be migration of fish and free-swimming or mobile marine life to safer or less disturbed areas (generally deeper waters) as a natural response to changes in the marine environment (Wildish and Power, 1985; Pennekamp and Quaak, 1990) thus avoiding direct deleterious effect. The important source of pollution during the reclamation and dredging activities would be the discharge of silt as a consequence of disturbance of the seabed.

High silt loads are highly deleterious to aquatic environment and has number of effects on fish life. Certain fish species are susceptible to high levels of silt in the water, which can abrade and clog their gills causing severe hemorrhaging, osmotic imbalance and respiratory difficulties (Redding and Midlen, 1991; Hodgson, 1994). Abrasion by particles may remove the protective coasting of mucus and increase the susceptibility of fish to disease (Everhart and Duchrow, 1970).

In addition, high level of suspended sediments leads to light reduction and visual impairment thus fish may have difficulty seeing prey (Bouma, 1976). Furthermore, mating and territorial behavior patterns that are reported to be highly dependent on visual cues (Thresher, 1984) might be disrupted by turbid water conditions. This could result in a reduced reproductive rate that would eventually reduce the abundance and diversity of fish. Unfortunately, little is known about the absolute sediment tolerance thresholds of most commercial fish species.

For each organism, injury will occur above a different threshold concentration of suspended sediments and also vary among the different life stages (egg, larva, juvenile and adult). The younger stages of the fish would be most vulnerable and sensitive to this effect (Hodgson, 1994).

In addition, there is potency for fish fauna to be disturbed by noise and vibration as a result of motors or heavy construction work on site as well as movement of vessels during dredging works. According to McCauley (1994), the response of fish fauna to acoustical emissions can range from no effect to various behavioral changes. However, fish fauna are highly mobile and would avoid acoustical emissions, when reach levels that may cause pathological effects. The out-migration of fish fauna from the existing fishing grounds adjacent to the project site will affect fish landings as well as fishermen income. Nevertheless, the out migration of fish stocks from the affected area is expected to be temporary in nature and can be expected to return to normal once the reclamation operations cease. However, the actual decline in catch and the time required for their rehabilitation can only be assessed through a monitoring regime that would provide the necessary data for the purpose.

The hydraulic study indicated that, there are no significant differences in the current speed, with current speed in the project site recorded between 0.04 – 0.2 m/s (**Table 7.42; Plates 7.1 - 7.2**). The effects of ocean current on the fishes varied according to age and species. Eggs as well as larvae are considered as plankton, thus relied heavily on the ocean currents for movement. However, at later stage i.e. juvenile and adult, the fish could swim against the current, which they could propel themselves to either find food, seek shelter or breeding.

In terms of suspended sediment dispersion, the situation is expected to be high within vicinity of reclamation areas (240 - 1,500 mg/L) (**Plates 7.3 - 7.4**). The recommended safe limit for aquatic organisms is <80 mg/L (Boyd, 1998), thus indicated that the reclamation would have an impact on fish fauna. However, fish are known to avoid areas where the TSS level has reached a certain threshold level, depending on the species and individual life history. For example, a study in Catham Rise in New Zealand found that demersal and pelagic species (Atlantic cod and mackerel) avoided TSS at concentrations of approximately 3 – 5 mg/L (Page, 2014). However, benthic fish species have lower avoidance threshold i.e. 50 mg/L (FeBEC, 2013). Higher concentrations would lead to fish migration to other safer areas.

7.12.3 Impact on Marine Habitat

7.12.3.1 Loss of Foreshore Area and mudflat as Fisheries Habitat

The nature of reclamation is such that it is expected to lead to an irreversible change in the area to be reclaimed. The original physical, biological resources and productivity of the reclamation footprint would be lost permanently, particularly the coastal mudflats and its associated flora and fauna. Losses of such magnitude are likely to be key drivers of declines in biodiversity and ecosystem services in the intertidal zone of the region.

Impacts to biological resources can also come from physical and chemical environmental alterations associated with reclamation activities. These physical and chemical changes can come from increases in suspended sediments, sedimentation, release of biogenic chemicals and reduction in dissolved oxygen. The biological impacts of reclamation would be the disturbance and removal of benthic infauna and epifauna and alteration of the substrate upon which colonization depends. This, in turn, can affect its stability as a fish or shellfish habitat. Where the remnant substrate is identical to the original sediment, disturbance is unlikely to be permanent and the extraction area can be re-colonized, although the time scale would vary depending on the nature and location of the sediment communities currently there.

7.12.3.2 Mangrove

Mangroves were found at several locations especially at Sg. Duyong, Sg. Punggur, Alai, Telok Mas, Pernu, Umbai, Anjung Batu, Pantai Siring, Kg. Pulai, Kg. Serkan, Pulau Besar, Pulau Burong Besar, Pulau Burong Kecil and Pulau Menatang (**Figure 7.17)**. Based on the hydraulic simulation results, high sedimentation is expected to occur at the mangroves area, particularly at Pernu (T6 and T7) and Umbai (T8 and T9) (**Plates 7.3 - 7.4**).

Mangroves are known to be very tolerant towards the range of suspended sediment loads that may be generated from dredging and reclamation activities (Doorn-Groen and Foster, 2007). According to Thampanya *et al.* (2002), the mangroves that are sensitive towards sedimentation are those with pneumatophore root (e.g. *Avicennia* sp.), though they are highly unlikely to be stressed, except when the sedimentation reach levels from 10 cm up to 30 cm for a prolonged period. The seedlings, however, are susceptible to sedimentation as the lenticels, which carry out the gas exchange may be blocked by sediment (Thampanya *et al.,* 2002). On the other hand, erosion may cause destabilization of the river bank, which in turn will uproot the mangroves trees.

7.12.3.3 Coral Reef

Coral were recorded at Pulau Besar, Pulau Serimbun, Pulau Terendak, Pulau Burong Besar and Pulau Burong Kecil (**Figure 7.18**). The hydraulic study indicated that, the coral reefs areas are not affected by the reclamation activity, since the extent of sediment plume does not reach Pulau Besar, Pulau Serimbun, Pulau Terendak, Pulau Burong Besar and Pulau Burong Kecil (**Plates 7.3 – 7.4**).

However, it is important to note that, high turbidity and sedimentation would have an impact to the coral reef distribution. These two factors create shading caused by decrease in ambient lighting as well as sediment cover on the coral's surface. Suspended sediments block sunlight from reaching the zooxanthellae, thus decreasing food availability and consequently leading to mortality (Masalu, 2000). The growth

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Figure 7.17: Location of the Mangroves Transect Lines at the Study Area

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Figure 7.18: Location of Coral Survey Transect Lines at the Study Area

forms of many corals are focused on trapping light and, thus are not optimized for sediment-shedding (Sanders and Baron-Szabo, 2005). In addition, sedimentation also creates problem of costly energy spent by the corals due to mucus production, sediment clearance and also impaired feeding (Erftemeijer *et al*., 2012).

Though some corals can grow and survive in turbid waters, however, they experience more stressful conditions compared to the clear water conditions. It has been demonstrated that increased turbidity and siltation in the coastal zone are potential causes of coral reef degradation (Terney Pradeep Kumara, 2010). High sedimentation does not necessarily lead to mortality, but it could still have sub-lethal effects i.e. reduced growth, lower calcification rates and reduced productivity, bleaching, increased susceptibility to disease, physical damage to coral tissue and reef structures (breaking and abrasion), and reduced regeneration from tissue damage (Erftemeijer *et al*., 2012). The coral re-colonization is also expected to be restricted if high sedimentation occur (Masalu, 2000; Miller, 1999; Delbeek and Sprung, 1994). Thus, this could lead to changes in reef community structure i.e. decrease in density, diversity and coral cover, and will shift towards the dominances of non-coral species, such as sponges and algae.

Another potential impact arising from the reclamation project on the coral reefs is the movement of boats and barges carrying materials into the reclamation site. The movement can potentially create wake that could have affect the coral reefs, though currently there is no study on the impact of boat and barges wake onto the coral reefs. However, the wake is known to disturb the water circulation and altered tidal patterns that can disrupt the reef's nutrient supply (Asplund, 2000). The wake of the boats and barges are also known to induce turbidity, which is known to be detrimental to the corals.

7.12.3.4 Marine Turtles

There were 19 turtle landing sites in Malaka coastline. The main species landed were Hawksbill Turtle (*Eretmochelys imbricata*). The nearest landing site to the proposed reclamation area are Pulau Burong and Pulau Lalang. However, in 2017, no turtle landings recorded at these islands. Landing of Hawksbill Turtle (*E. imbricata*) at these islands was only recorded in 2011 (7 landings) (Department of fisheries, 2018-unpublished).

Even though, no turtle landing and sightings recorded in during the recent survey, it is important to note that, the noise and vibrations generated from the reclamation activities could potentially affect turtles. According to Bonin *et al*. (2006), turtles in general perceive low frequencies and ground vibrations. An electro-physical study has indicated that the best hearing range for sea turtles is 100–700 Hz. However, no definitive thresholds are known for the sensitivity to underwater sounds or the levels required causing pathological damage (McCauley, 1994).

Another impact that may arise from the reclamation process is the light spill from the barges and earthwork machinery. Potential impacts include attraction of marine turtles to the moored barges, especially during night-time. Nesting females could confuse between artificial lights and natural lights as well as shifting the topography horizons, which are used as guidance mechanisms (Witherington, 1992; Lohmann and Lohmann, 1998).

There is potential for discharge of solid wastes such as litter into receiving waters. Plastic bags, in particular, are a major source of concern where turtles are concerned. Turtles are unable to distinguish between plastic bags and sponges, which constitute their basic diet. Sea turtles are particularly susceptible to the effects of marine rubbish due to the internal structure of their throats and die a slow and painful death. They have downward facing spines in their throats, which prevent them from regurgitating. The plastic gets trapped in the gut, preventing food from going down and the spines prevent it from coming back up. The trapped food decomposes, leaking gases into the body cavity and causing the animal to float. The turtle then slowly starves to death or succumbs to other secondary life threatening conditions such as boat strike.

7.12.4 Impact on Fisheries and Aquaculture

7.12.4.1 Loss of Fishing and Nursery Grounds

The area is a fishing grounds for the fishermen from Sg. Duyong, Sg. Punngur, Telok Mas, Umbai, Najung Batu and Pantai Siring. The fishery activity at these area are expected to be affected and, to some extent will be lost, with the implementation of the project. This can potentially lead to decrease in fish landings and directly affect the income and livelihood of fishermen fishing in the area.

The proposed project also would be involved transportation of materials using sand suction dredger and transportation of dredged spoil using barge. The continuous movement of dredgers and barges would cause increased risk of collision as well as damage boats and fishing nets. Additionally, pipeline linking the anchorage area to the reclamation site could potentially affect bottom gill nets that are the mainstay of fishing industry at the study area since the pipeline will sit on seabed. The anchorage site clearly has to be a no-fishing area further depriving the fishermen of fishing grounds.

The impact of the loss on the fishing economy and, in particular, is difficult to assess on a quantitative basis. Fishermen are, by nature, opportunistic and will seek out other grounds to sustain the catch. Without accurate resource data, however, it is not possible to establish the extent to which these grounds would compensate for the loss in catch that will accompany the reduction in fishing area.

What is clear, however, is the fishermen would have to move further out from the proposed project site to fish, leading to an increased operational cost, particularly fuel. There is a distinct possibility that the fishermen will end up encroaching into fishing grounds of other fishermen, leading to greater fishing effort and intensity in such areas.

Catch per unit effort may decline with the greater number of fishermen operating in a given fishing ground. There is, hence, the possibility of conflict of interest as their encroachment into these other grounds may not be welcome. However, this would depend on a number of factors, particularly, the numbers that actually end up fishing in those areas, and the target species involved.

7.12.4.2 Impact on Mussel Farming

The main aquaculture activity undertaken within the impact zone is mussel farming (*Perna viridis*), which was operated off coastal area from Telok Mas to Anjung Batu. The most impacted farms are those operated within the reclamation footprint. As farm operated outside reclamation footprint, they could potentially be affected by the high sedimentation derived from the proposed reclamation works. Based on hydraulic study, high sedimentation expected at the reclamation footprint up to Umbai areas (**Plates 7.3 - 7.4**). Study by Sin *et al*. (2002) indicated that *Perna viridis* can tolerate up to 1,200 mg/L of suspended solids. However, excessive levels has been shown to irreversibly damage the gill structure and filtering ability.

7.12.4.3 Impact on Recreational Fisheries

The main recreational fisheries activity undertaken within the impact zone is shore based angling, kelong based angling and boat based angling. Shore based angling concentrated at Pantai Siring, Anjung Batu and Umbai, while kelong based at off Pantai Siring. The staging points for boat based angling was at Pantai Siring, Umbai and Pengkalan Punggur. The main angling sites for boat based was at Pulau Besar, Pulau Undan, international lane and coastal area. As proposed project is concerned, the most affected angling activities would be boat-based angling undertaken at coastal area and shore-based angling undertaken at Umbai.

7.13 Abandonment

The abandonment of the proposed project will cause the situation to be as it is presently. If the reclamation works has started, some of the sea bed would have been touched and affect the aquatic life. Construction materials and construction equipment / machineries would be at the site. Removal of these is necessary. Should abandonment occur, it should be handled properly to avoid any unwanted impact to the surrounding environment. **Table 7.43** lists the typical issues and impacts that might occur if the project is abandoned.

Table 7.43: Typical Issues and Impacts During and After Rehabilitation and Abandonment Stage

Activities	Issues	Impacts
Abandonment during all stages of land reclamation works	Ecology	• Disturbance and possibly loss of coastal and marine habitats. • Water pollution and effects on marine areas (red tide, sediment plume, oil spill etc.). • Damage to marine resources. • Loss of fishery resources. • Loss of benthic fauna and sessile organisms, unless translocated.
	Hydraulic and Hydrodynamics	• Altered coastal watercourses. • Changes in wave climate, current speed and direction, tidal conditions and pollutant dispersion patterns. • Impacts on aquatic habitats and coastal users.
	Erosion and Sedimentation / Coastal Erosion	• Soil erosion and sedimentation. • Ecological damage. • Long-term accretion and / or erosion of coastal areas due to hydraulic changes. • Affect aesthetic value of recreational beaches.
	Water Quality	• Impacts on coastal areas e.g. recreational areas, aquaculture farms etc. • Effects of spread of sediment plumes on water quality and offshore fishing sites. • Ecological degradation.
	Communities	• Affects access of the fishing community.
	Socio-economy	• Pollution may affect fishery resources and aquaculture farms.
Abandonment after reclamation works	Hydraulic and Hydrodynamics	• Altered coastal watercourses. • Storm surges resulting in coastal flooding. • Changes in wave climate, current speed and direction, tidal conditions and pollutant dispersion patterns. • Impacts on aquatic habitats and coastal users.
	Erosion and Sedimentation / Coastal	• Soil erosion and sedimentation. • Long-term accretion and erosion of coastal areas due to hydraulic changes.
	Erosion	• Coastal protection requirements.
	Communities	• Affects access of the fishing community.

Source: Environmental Impact Assessment Guidelines For Land Reclamation and Dredging, 2018