ECONOMIC VALUATION OF ENVIRONMENTAL IMPACTS

1. INTRODUCTION

The proposed project is positioned to take advantage of the rising global demand for petroleum storage facilities at a location that confers strategic geographical advantage both from the demand and supply sides perspectives. Due to the fact that one third of the world crude oil trade passes through the Straits of Malacca and the deep waters bordering the proposed site, the project is expected to attract keen interest from oil and gas, port and logistics industrial operators. Beyond construction, participants in the logistics industry and ancillary services will also directly benefit from project implementation.

Notwithstanding these economic benefits, the reclamation, construction of the facilities, along with associated project activities, will negatively impact the flow of *environmental services* that are currently benefiting various stakeholders. Many of these impacts will be effectively minimized, when various mitigation measures proposed in the DEIA are implemented. However, some of the negative impacts cannot be completely mitigated thus justifying the need to quantify in monetary terms, the reduction in environmental services flows from the altered environment during reclamation, construction and operation.

Environmental services that would be degraded (or gained) following project implementation are opportunity cost (or benefit) to society that are often ignored in project feasibility study. This state of affairs is rather unfortunate since non-inclusion of potentially significant loss or gain in the flow of environmental services may result in under or over valuation of project net benefit/loss. Even though the economic valuation of environmental impacts presented in this report is not a complete cost-benefit analysis, it should provide a quantified assessment of the expected loss or gain in services.

The next section outlines the objective of this valuation exercise, followed by a section on methodology, and subsequently the remaining sections deal with the identification and valuation of environmental impacts. This chapter concludes by providing an overall assessment of impacts over the valuation period.

2. OBJECTIVE

The economic valuation of environmental impacts aims at assessing the impacts of the proposed project on the flow of environmental services. This objective is achieved by quantifying the change in service flows from environmental resources (if any) arising from project implementation.

3. METHODOLOGY

A critical step in the valuation process revolves around the need to ensure valid attribution of impacts on environmental services to the proposed project. In order to satisfy this requirement, physical environmental impacts that can reasonably be attributable to the proposed project must first be demonstrated. In other words, the approach requires the establishment of a clear link between project impacts on the physical functions of the environment and the alteration of the quality and quantity of streams of environmental goods and services. The Guidelines on the Economic Valuation of the Environmental Impacts for EIA Projects requires the establishment of explicit links between physical impacts on the flow of environmental goods and services on the one hand, and project development on the other, by stating that:

"… a key issue is to identify and quantify the changes in the flow of goods and services produced by the environment which are impacted by a development project, and then to monetize these changes into costs or benefits".[1]

The valuation procedure can be broken down into nine sequential steps as follows:

Step 1: Determine the project stakeholders.

Various stakeholders that are expected to be affected by the change in the flow of environmental services are identified in this step.

Step 2: Define the "with project" and "without project" scenario.

This step produces a conceptualization of the "with" and "without" project scenarios through a definite differentiation of the "with" and "without" project scenarios. For the current project under evaluation, the "with project" scenario is defined as the specific situation in which the project is implemented that in turn, entails reclamation works, dredging as well as other associated works. "Without project" scenario is regarded as the situation where the project site remains as is. The variance in current and future environmental flows "with" and "without" project scenarios is the object of the economic valuation.

Step 3: Depict the physical impacts.

Description of the potential physical impacts attributable to the project is provided in this step. The description and explanation concentrate on the physical extent of the impact and also the link between the project and its particular effect on the flow of environmental services.

Step 4: Quantify the impacts on the environment over the duration of the project.

This step quantifies the physical impacts of the project on the environment. Quantifications of physical impacts are essential as a way to translate the change in environmental service flows into monetary values. This is accomplished through scientific assessments by the study team that include amongst others marine biologists, air and water quality specialists, and hydraulic specialist.

[1] Guidelines on the Economic Valuation of the Environmental Impacts for EIA Projects, Department of Environment, pg. 7, 2008.

Step 5: Monetize the impacts.

Monetization is attained by employing market and non-market valuation techniques. With regards to this study, values of similar environmental services obtained in other studies are employed as the bases of evaluation. This process is often referred to within the existing literature as the benefit transfer method.

Step 6: Discounting.

Gains and losses of flows in environmental services are discounted to determine their present values.

Step 7: Determine the Net Present Value.

By aggregating the discounted values of the losses and gains in environmental services, the net present value is computed in this step.

Step 8: Perform sensitivity analysis.

In this step different discount rates (2%, 6% and 10%) are applied to demonstrate the impact of variation in discounting rates on the net present value of the environmental gains and losses.

Step 9: Make a recommendation.

An overall assessment is made by referring to the magnitude of Net Present Values at different levels of discount rates.

4. IDENTIFICATION OF INCREMENTAL GAINS AND LOSSES

As indicated earlier, only incremental or marginal impacts on environmental services (losses or gains) are considered in the analysis. Considering only incremental losses and gains means that only changes in environmental services as a result of choosing the "with project" option (instead of "without project") is included in the study.

Table 1 below provides a list of nine environmental services that could potentially be affected by the project. It also shows the corresponding location/s, extent and nature of impacts for each of the component. Further explanations are given for those impacts that require evaluation.

5. VALUATION OF GAINS AND LOSSES

Of the ten items listed in Table 1, five give rise to potentially significant negative environmental impacts that can be quantified and therefore evaluated in this study. These are items:

- 1 (Marine biology - Reclamation)
- 2 (Marine biology - Dredging)
- 3 (Terresterial biology – Loss and regeneration of mangrove)
- 8 (Socio-economy - Loss of fishing ground and direct access to sea)
- 9 (Aesthetic/Recreation - Loss of sea-view and recreational value).

Further description of the impacts and a summary of the valuation methodology are also provided in the same table.

Table 1: Potentially Affected Environmental Services

	Components	Environmental Services Affected[2]	Location and Extent of Impacts /Stakeholders	Additional Notes
1.	Marine Biology (Reclamation)	Productive and consumption services of the mudflat or muddy seabed of the reclamation area (total loss). Mudflat and muddy seabed serve as feeding and breeding grounds for marine organisms. Mudflat is also a habitat for marine organisms that provides harvestable resources for human use and consumption.	Footprint of the reclaimed area. A total of 1,411 hectares (72.6 hectares of mudflat in Phase 3 and 1,338.4 hectares of muddy seabed in all phases) will be affected by the reclamation works. /Fishermen and locals.	The loss in environmental services are quantified using benefit transfer method where resource values from prior studies using market prices are used as the bases of computation.
2.	Marine Biology (Dredging)	Loss in productive and consumption services due to removal of muddy seabed from dredging works (capital and maintenance dredging). Muddy seabed serve as feeding and breeding grounds for marine organisms, some of which are harvested for human consumption.	145 hectares will be dredged during Phase 2 to the east of the reclaimed land. /Fishermen and locals.	Because of maintenance dredging every 4 to 5 years, it is assumed that the benthic communities recover at a constant rate throughout each cycle. This is done to reflect the fact that the benthic communities are relatively quick to recover.
3.	Terrestrial Biology	Loss of disposal, productive and consumption services due to removal of mangrove area for bridge construction. This loss will however be compensated by regeneration of mangrove area once the reclamation	For bridge construction, a small area of mangrove (within the Ramsar site) will be removed. This area is approximately 0.17 hectare in size. The mangrove areas within the Ramsar site on the coastline	Regeneration of mangrove is expected since the reclamation and the berthing structures are seen to provide protection from the incoming wave energy (which is considered one of the main cause of mangrove erosion in the area). It is expected that the coastline will stabilize and

[2] Environmental services refer to qualitative functions of natural non-produced assets of land, water and air. They are typically categorized into: a) disposal services which reflect the functions of the natural environment as an absorptive sink, (b) productive services which reflect the economic functions of providing natural resource inputs and space for production and consumption, and (c) consumption services which provide for physiological as well as recreational and related needs of human beings. (Source: Glossary of Environment Statistics, Studies in Methods, Series F, No. 67, United Nations, New York, 1997).

	Components	Environmental Services Affected[2]	Location and Extent of Impacts /Stakeholders	Additional Notes
		footprint is completed.	east of Tg Piai National Park (North of Tg Piai Monument) fronting the reclaimed land is expected to regenerate. The size is approximately 115 hectares. / Fishermen, locals, visitors and surrounding population.	a small seaward migration of mangrove fringe will take place after the reclamation is in place.
4.	Air Quality	Air emission of TSP, NO_2, SO_2, CO and VOC will affect the general health of the population.	Surrounding area of up to 5 km. /Surrounding population.	The maximum incremental GLC of all pollutants are low and below their respective recommended limits. No valuation is necessary.
5.	Water quality	Increased in suspended TSS during dredging and reclamation.	Water bodies at and around the dredging and reclamation area. Environmental sensitive areas include: - Seagrass along Sg. Pulai and near Tg. Adang; - Corals at Pulau Merambong; - Three (3) RAMSAR sites, namely Tg. Piai, Pulau Kukup and Sg. Pulai;	With mitigating measures (bunding and silt curtain) the sediment plume modelling results indicate that the maximum TSS concentrations of above 250mg/l are confined to the immediate work area. The impact on fish fauna are likely to be behavioural, resulting in avoidance of turbidity plumes by fish fauna rather than lethal or sub-lethal effects. The impact is also negligible for macrobenthos outside of the reclaimed and dredged areas. For plankton, the impact is considered short term. No valuation is necessary. However, see the impact on dredging work on

	Components	Environmental Services Affected[2]	Location and Extent of Impacts /Stakeholders	Additional Notes
				marine biology.
6.	Coastal Morphology	Erosion and sedimentation due to the effect of reclaimed land and jetty to the coastal area, potentially affecting the disposal, productive and consumption services of coastal and marine resources.	Findings of the hydraulic study suggest that erosion is insignificant. No significant negative impact of sedimentation is also expected except for some positive impact of mangrove regeneration on the eastern coastline of the RAMSAR site.	No valuation is necessary because the impact is minor (but see valuation on mangrove regeneration).
7.	Human Safety	Major hazards associated with storage and handling of hazardous substance at the proposed terminal and jetty.	The quantitative risk assessment indicates that the 1×10^{-6} per year IR is within the 300 m Primary Buffer Zone. The IR contour does not encompass involuntary recipients of industrial risks such as residential areas, schools, hospitals, and places of continuous occupancy.	The probable damage to human life is negligible and thus no valuation is necessary.
8.	Socio-economy	The loss in fishing ground to make way for the reclaimed land. There will be additional loss of fishing ground when the port limit requirement is included during terminal operation. The land mass will also hinder direct movements of fishing vessels. Thus some fishermen will incur additional cost of going to and back from	Reclaimed area as well as the area that will be declared as marine exclusion zone for terminal security. /The directly affected stakeholders are 373 fishermen of: - Sg. Belukang, - Perpat Pasir, - Sg. Chokoh, - Sg. Dinar, - Sg. Chengkeh, - Sg. Boh,	Fishermen can no longer fish in the area. The value of loss in fishing ground and direct access to the sea is estimated by the additional fuel cost to go to alternative grounds.

	Components	Environmental Services Affected[2]	Location and Extent of Impacts /Stakeholders	Additional Notes
		the fishing ground.	- Sg. Karang, - Sg. Redan, and - Sg. Punai	
9.	Aesthetic/ Recreational Value	Loss of sea-view, recreational value of waterbody fronting Tg Piai Resort and change from natural environment into built environment. This loss is a loss in consumption service in environmental function.	Tg Piai state park and Tg Piai Resort. /Visitors (locals or outsiders) to the area.	The loss in aesthetic and recreational value is approximated by the change in property value with and without straits view. The basic method is known as the hedonic pricing method.

5.1 Marine Biology (Loss of Mudflat and Muddy Seabed due to Reclamation)

Reclamation will result in permanent loss of the mudflat/muddy seabed. The loss of mudflat will result in some reduction in the amount resources important to support marine lives. The total area that will be affected (i.e. the footprint of the reclamation) is 1,411 hectares (72.6 hectares of mudflat in Phase 3 and 1,338.4 hectares of muddy seabed an all phases). The loss of this area, and hence the environmental services obtainable from it, is permanent.

Some fishery resources like cockles, bivalves and gastropods/snails and shrimps use the mudflat/muddy seabed as habitat. Some of these organisms are food source for fish. The mudflat/muddy seabed also serves as crustacean feeding ground.

Market values for resources harvested from mudflats are reported in several published studies. Sasekumar et al. (1998) estimated that cockle production from mudflats of Peninsular Malaysia in 1995 is worth US$26,370,547. In a different study, Kanagerajah (1984) reported that that the net revenue for cockle production is 60%. When applied to the estimate produced by Sasekumar et al. (1998), a net revenue of US$15.8 million is obtained for the value of cockle.

In the same study, Sasekumar et al. (1998) determined that the market value of bi-valve is US$2,600 per ton, and the total bivalve production was valued at US$17,639,960. Similar to cockle, the net revenue factor of 60% has been adopted by researchers in order to determine the value of bi-valve net of production/harvesting cost.

Gastropods/snails and shrimps are also harvested from mudflats. A price of US$600 per ton and US$200 per ton respectively had been estimated by Sasekumar et al. (1998) for gastropods/snails and shrimps respectively. At these prices, gross revenue of US$344,879 for gastropods and US$2.9 million for shrimps are obtained for further adjustment of a net return factor of 30%. The total production of fish and prawn for mudflats is estimated at US$2.2 million with a net return factor of about 25%.

The total size of mudflats in Peninsular Malaysia is estimated at 35,064 hectares. The direct use value of mudflat per year is determined by dividing the estimates on the annual value of the production by the total size of mudflats. The loss in environmental service (RM/Hectare/Year) by type of organisms due to a reduction in the size of mudflat (adjusted for price increase at the rate of 3% per year) is shown in Table 2.

Table 2: Estimated Resource Value of Mudflat (2014 price)

Type	Unit Value (RM per hectare per year)
Cockles	2,704.53
Bi valves	1,809.13
Gastropods/snails	17.69
Shrimps	148.71
Fish and prawn	94.01
Total	**4,774.08**

Aggregating the losses across organisms gives a total of RM 4,774.08/hectare per year. For the current project, the value of environmental services forgone from the loss of mudflat is obtained by multiplying the size of the affected area (1,411 hectares) by the estimated value of environmental service (i.e. RM4,774.08/hectare/year).

5.2 Marine Biology (Loss of Mudflat or Muddy Seabed in the Dredged Area)

Removal of muddy seabed due to dredging works (capital and maintenance dredging) will take place in an area of 145 hectares during Phase 2 of project implementation, to the east of the reclaimed land. The benthic communities are however known to be relatively quick to recover. This study assumes that the benthic communities recover at a constant rate throughout each dredging cycle.

The estimation of the environmental services lost due to dredging work follows the method used to determine the loss of mudflat due to reclamation (i.e. RM4,774.08/hectare per year). However, unlike the impact due to reclamation, the benthic communities are expected to recover after each dredging cycle. Hence, the loss is reduced as the benthic communities recover until the next maintenance dredging. This method implies that the loss of RM4,774.08/hectare only happens in the first year of dredging and is assumed to gradually fall at a constant rate until no more loss is registered in the fifth year after the area is dredged. The cycle of losses are then repeated again throughout the project period.

5.3 Marine Biology (Loss and Regeneration of Mangrove)

A small loss in mangrove area is expected to make way for bridge construction. The area is approximately 0.17 hectare in size. This loss will however be compensated by regeneration of mangrove area once the reclamation footprint is completed. The mangrove areas within the Ramsar site on the coastline east of Tg Piai National Park (North of Tg Piai Monument) fronting the reclaimed land is expected to regenerate. The size is approximately 115 hectares.

Mangroves that are part of the coastal ecosystems that provide a wide range of economic and ecological services. The environmental services provided by mangrove forest (and hence affected by the proposed project) include:

(a) *Production of charcoal and poles*
(b) *Provision of feeding and breeding grounds for shrimp, fish, crab and molusc*
(c) *Tourism and recreation*
(d) *Provision of traditional goods*

(e) Carbon sequestration function

(f) Shoreline protection

(g) Option, existence and biodiversity values

(a) Charcoal and Poles

Mangrove areas produce timber, fuelwood, and building materials. Sathirathai (2000) estimated that the annual net return from charcoal obtained from Thailand's mangrove forest is estimated to be $91.97. According to Sivakumar and Fernando (1997) Rhizophora sp. used in housing construction generates Rs. 1 million/ha/year in Sri Lanka. Bann (1997) estimated that the net benefit from selective commercial mangrove cutting schemes was estimated to be $ 20 million/ year in Indonesia. This study adopts a current value of RM2,714.73/ha/year of mangrove area after incorporating inflationary factor and exchange rate conversion determined from prior studies.

(b) Shrimp, fish, crab and molusc

Mangroves are feeding and breeding ground for fish. Bann (1999) estimated the direct use value of mangroves from captured fishery at US$ 526/ha/yr in Malaysia. In several other developing countries, the annual value of the fish caught in mangroves, varies between US$900 and US$12,400 per hectare of mangrove (Rodríguez 2001). The economic value of the fisheries function of mangroves has been reviewed or estimated by many researchers including Hamilton & Snedker, (1984); Ruitenbeek, (1991); Gren & Soderqvist, (1994); Hambrey, (1997); Gilbert & Janssen, (1997) and Costanza et al, (1997) The values ranged from $66 to almost $3,000 /ha/yr. Christensen (1982) estimated the fisheries function in Thailand at 130/ha/yr. Lal (1990) estimated the fisheries function of mangroves in Fiji at US$ 100/ha/yr while Ruitenbeek (1992) estimated the same in Indonesia at US$ 117/ha/yr. Janssen and Padilla (1996) estimated the mangrove fisheries function in Philippines at US$ 60/ha/yr.

For this study the environmental services offered by mangroves habitat for fishery feeding and breeding ground is evaluated based on expected total catch (quantity) and market price of fishery resources. Further computation produces an estimate of RM5,861.94/ha/year as the value of fishery resources that are dependent on the mangrove area. This estimate is obtained

after incorporating inflationary factor and exchange rate conversion for values estimated by previous studies.

(c) Tourism and Recreation

This component of the study analyses the economic value of recreation benefits of mangrove forests for both domestic and international tourists. Avoiding degradation or loss in mangrove areas increases the opportunity for recreation, which will lead to the promotion of the tourism industry. Costanza et al (1989) in the United States estimated recreational value of mangroves using both these methods and came up with $ 70.67 per visitor from TCM and $ 47.11 per visitor from CVM.

In Sri Lanka the estimates for recreational and tourism value of mangrove areas have been estimated at US$ 1196 per hectare per year for international tourism and the corresponding value for domestic tourism is US$ 933 (Batagoda 2003). The only Malaysian study on the value of mangrove forest from the tourism perspective can be found in Bennett and Reynolds (1993) that estimated that tourism value derived from mangrove forest in Sarawak was US$ 473.26/hectare/year. Cesar (1996) proposed a net return factor of 60% of revenue thus giving a net benefit of US$283.96. Hence the value adopted for this study is RM1,467.10/ha/year.

(d) Traditional Use

Mangrove forests provide several marketed and non-marketed forest resources in the form of traditional use products like nipah shingles, resins, medicines and cane products. For example, Ruitenbeek (1992) estimated the annual net benefit from medicinal plants to be $15/ ha/ yr. from a mangrove forest in Indonesia. Because the values derived from traditional products are small, this study ignores the traditional use value of mangrove forest.

(e) Biodiversity Values

Mangroves store valuable genetic resources in addition to providing habitats for migratory species. In general, biological diversity helps the mangroves in maintaining ecological (carrier) and regulatory functions, especially in undisturbed state. Several studies have estimated the economic value of biodiversity maintenance by estimating several functions of mangroves. Ruitenbeek (1992) in an Indonesian study, estimated the capturable biodiversity benefits of mangroves if they are maintained intact at US$ 1,500 per square kilometer per year that

translates into US$15/ha/year for mangrove forest in Indonesia. Several other studies have estimated the plant based pharmaceutical value of mangroves ranging from US$0.1 to US$ 61/a/year (Bann 1997). This study uses an adjusted figure of RM 121.41/ha/year for the biodiversity value of the mangrove areas.

(f) Carbon Sequestration

Mangroves play an important role in regulating carbon dioxide in the global atmosphere by absorbing CO_2 and storing it in their biomass. Emission of carbon dioxide leads to greenhouse effect i.e. a process in which the emission of infrared radiation by the atmosphere warms a planet's surface. Carbon sequestration does the reverse. According to the Third Assessment Report of the Intergovernmental Panel on Climate Change (IPPC), the globally averaged surface temperature is projected to increase by between 1.4 and 5.8°C from 1990 to 2100 under business-as-usual, and sea levels are expected to rise by between 9 and 88 centimetres over the same period. If nothing is done to reduce these changes, they will have major consequences for the ecosystem and our economies. With a 5-6°C warming, a real possibility for the next century, models estimate an average of 5-10% loss in global GDP, with poor countries suffering costs in excess of 10% GDP (Stern Review, 2006).

In order to reduce greenhouse gas emission, the international community has agreed (the Kyoto Protocol) on introducing three market-based "flexible mechanisms" that allows for emission trading. Emission trading price (usually quoted in tone carbon dioxide equivalent) provides a good basis for the quantification of the impact of greenhouse gases on the environment. Created in 2005, the European Union Emission Trading Scheme (EU ETS) is the largest multi-national, emissions trading scheme in the world.

Since its introduction, the price of carbon under the European Union Emission Trading Scheme (EU ETS) has been fluctuating over time (anywhere from around €5 to €24). This study adopts a value of €7 (RM28)/tonne for the purpose of valuing the environmental damage resulting from the emission of carbon dioxide since prices had been hovering mostly around €7 per tonne in the last year or so.

Carbon sequestration benefits of a forest can then be estimated by calculating the total biomass per hectare and then applying appropriate conversion factors to obtain carbon equivalents. The daily net CO_2- fixations of several dominant mangrove species found in

Thailand as well as Sri Lanka such as Avicennia marina, Rhizophora apiculata, and Excoecaria agallocha have been estimated at 14,942 mg CO_2 m-2, 24,235 mg CO_2 m-2, and 14,097 mg CO_2 m-2 respectively. Based on these results, average value for carbon-fixation of mangroves in Kanjanadit District in Thailand was estimated at 15.1 tonC/ha/yr.

For this study, the value of mangrove forest service obtained in the form of carbon sequestration function is estimated at RM422.80/ha/year.

(g) Shoreline Protection

Mangroves function as natural barriers of the shoreline from erosion. The shoreline protection value is normally estimated by using the replacement cost approach i.e. the cost of building artificial structures. The cost of constructing protective structures has been estimated at RM 1.36 million/km in Malaysia (Hiew and Lim 1994). Estimates for building a seawall and breakwater is about US$1.2 million/km (Dahuri 1995). Taking the Malaysian study as the basis for computing the shoreline protection service provided by mangrove area, this study determines that the value of this function is RM4,081.10/ha/year.

Table 3 provides the estimated environmental cost of mangrove removal per hectare. The total estimated environmental value from the mangrove area is RM14,669 per year. This rate is applied to both the loss in mangrove area for bridge construction as well as mangrove regeneration on the eastern coastline of Tg Piai Ramsar area. However, in the case of regeneration, the gain of 115 hectares of mangrove is assumed over a period of 20 years.

Table 3: Estimated Environmental Value of Mangrove Area by Service Type (2014 price)

Environmental Services	Unit Value (RM per hectare per year)
Production of charcoal/poles	2,714.73
Feeding and breeding ground and habitat for shrimp/fish/crab/molusc	5,861.94
Tourism and recreation	1,467.10
Traditional use	-
Carbon sequestration	422.80
Shoreline protection	4,081.10
Biodiversity values	121.41
Total	**14,669.08**

5.4 Loss of Fishing Ground and Direct Access to the Sea

Fishing ground will be lost to make way for the reclaimed land. There will also be additional loss of fishing ground when the terminal and its port limit is declared as a marine exclusion zone. The reclaimed land mass will also hinder direct movements of fishing vessels. The directly affected stakeholders are 373 fishermen of:

- Sg. Belukang,
- Perpat Pasir,
- Sg. Chokoh,
- Sg. Dinar,
- Sg. Chengkeh,
- Sg. Boh,
- Sg. Karang,
- Sg. Redan, and
- Sg. Punai.

These fishermen can no longer fish in the area. They will incur additional cost of going to and back from alternative fishing grounds. The additional cost is estimated by the fuel cost to go to alternative grounds.

In estimating this impact, 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 mudflats and muddy seabed. Hence, the loss of fishing ground in the reclaimed and jetty area cannot be regarded as a loss in fishery resources beyond that computed in the loss of mudflats and muddy seabed. Local fishermen do still have other alternative fishing areas. However, they can only do so at a higher cost since they will have to travel further to the fishing ground. In a sense, the reclamation and the construction of the jetty lead to the fishermen losing a type of environmental service from an unhindered coastal area (i.e. direct passage to fishing ground).

Fishermen that routinely fish in the affected area and others who currently gain direct access to their fishing ground by directly navigating through the area will now have to travel around the reclaimed land and jetty area.

The said fishermen typically use three types of outboard engine to go fishing: 60 horse power, 30 horse power and 15 horse power engines. The corresponding estimated fuel usage per day are 60 litres, 35 litres and 20 litres respectively. A litre of petrol cost RM2.60. For economic evaluation, the relevant cost is the world market price of a resource, not the subsidized price.

In order to assess the likely increase in the cost of fuel, the following assumptions are employed:

- The number of fishing days is 26 days in a month.
- 1/3rd of boats belong to the three horse power categories of 60, 30 and 15 horse power.
- The additional fuel cost to alternative fishing grounds is 50% of the current cost.

The computation of additional fuel cost per month is shown in Table 4.

Table 4: Computation of Additional Fuel Cost/Month

Engine Capacity	Fuel Consumed Per Trip (litre)	Number of Boats	Fishing Day/Month	Additional Fuel	Additional Cost*
60 hp	60	124	26	50%	251,472
30 hp	30	124	26	50%	125,736
15 hp	15	125	26	50%	62,868
				Total	5,280,912

*Price of petrol = RM2.60/litre

The resulting increase in fuel cost per month is RM 251,472 (60 hp boat), RM 125,736 (30 hp boat) and RM 62,868 (15 hp boat). The total additional fuel cost per year is estimated at RM 5,280,912.

5.5 Recreational/Aesthetic Value

Another environmental service obtainable from the area is that it provides a place for water-based recreation. Tg Piai Resort is one stakeholder that relies on water-based recreational

activities as its main attraction. Because of the close proximity of the resort to a large scale industrial area following reclamation and operation of the proposed project, it will no longer be feasible for the resort to continue operation. Water sport activities which is the main feature of the resort are no longer safe to be carried out in the area.

The recreational service value that will be lost following project implementation can be estimated based on the current revenue generated by the resort. Based on a discussion with the resort operator in December 2013, the business is expected to lose an annual income of approximately RM3.0 million from room rentals and another RM2.5 million from the sale of food and beverage at the resort annually following project implementation.

Obviously, the recreational value is not equal to the total revenue of the resort since guests' willingness to pay (room rates) is only partially accounted for the purchase of recreational opportunity made possible by the stay. Further, there are also direct cost incurred for the provision of the hospitality service. Some indication on the magnitude of cost is provided by the Malaysia Tourism Policy Study (2000) where the direct cost of providing hospitality services is about 51% of revenue. In the absence of an authoritative study on the recreational value of such a site, this study assumes a that the recreational value to be 5% of gross revenue of RM5.5 million per year. As the number of guests is expected to grow over time, an annual growth rate of 2% is also assumed.

Another related environmental service provided by the area is (non-extractive) visual aesthetics enjoyed by visitors to Tg. Piai National Park. The visual impact of the project from the vantage point of Tg Piai National Park is due to the project footprint that is parallel to the entire east coast of Tg Piai. When viewed from this vantage point, visitors will see the increased activity generated by the project especially the during the reclamation and construction phases. After reclamation, the viewscape of the Straits of Johor, will be partly hindered and permanently altered since the reclaimed land will be directly visible.

In 2011, 65,000 people visit Tg. Piai National Park to be at the "southern-most tip" of the Asian continent, to enjoy the board-walk within a mangrove forest and to appreciate the unhindered natural view-scape of the straits. The entrance fee is currently set at RM5 for adult.

Previous studies for mangrove area tend to place the recreational value of mangrove forest (for example Ahmad (2009) for Matang Mangrove Forest) in the region of RM25 to RM50 per visit. Certainly, the aesthetic value of the mangrove forest and view-scape is only one out of several other recreational components obtainable from such site. For the purpose of this study, a value of RM2 is taken as the value of unhindered natural view-scape of the straits. In order to project the loss over the evaluation period of 50 years, the number of visitors is assumed to grow at an annual rate of 2%.

6. OVERALL ASSESSMENT

Tables 5, 6 and 7 the value of changes in environmental service flows for a 50-year valuation period. All items register losses in environmental service flows except for mangrove regeneration. Changes in service flows were discounted at 2%, 6% and 10% rate. The 10% rate is supposed to reflect the market rate of interest usually used for project evaluation. The lower rates of 2% and 6% are more suited for social welfare assessment.

At 2% discount rate, the present value of the net environmental loss amounts to RM316.7 million. The corresponding values for 6% and 10% rates are RM155.5 million and RM95.5 million respectively.

It is clear from results of the evaluation exercise that a significant amount of environmental service loss is to be expected following project implementation. If so desired by the authority, some of the losses could be offset by compensating environmental enhancements elsewhere, the monetary quantum of which may be based on the computed values.

Table 5: Estimates of the Discounted Loss in Environmental Services
(Discount Rate = 2%)

Yr	Loss of Mudflat (Reclamation)	Loss of Mudflat (Dredged Area)	Loss of Mangrove Area (Bridge)	Mangrove Regeneration (Gain)	Loss of Fishing Ground - Additional Fuel Cost	Aesthetics /Recreational Value	Net Loss
1	846,874	-	2,445	-82,693	5,177,365	397,059	6,341,049
2	1,660,538	-	2,397	-162,144	5,075,848	397,059	6,973,697
3	2,387,950	270,088	2,350	-238,447	4,976,321	397,059	7,795,321
4	3,086,197	529,584	2,304	-311,695	4,878,746	397,059	8,582,195
5	4,039,019	389,400	2,259	-381,979	4,783,085	397,059	9,228,842
6	4,953,288	254,510	2,214	-449,387	4,689,299	397,059	9,846,983
7	4,856,165	124,760	2,171	-514,005	4,597,352	397,059	9,463,501
8	4,760,946	-	2,128	-575,916	4,507,208	397,059	9,091,425
9	4,667,594	479,661	2,087	-635,202	4,418,831	397,059	9,330,030
10	4,576,073	352,692	2,046	-691,941	4,332,187	397,059	8,968,116
11	4,486,346	230,517	2,006	-746,211	4,247,242	397,059	8,616,960
12	4,398,378	112,999	1,966	-798,086	4,163,963	397,059	8,276,279
13	4,312,136	-	1,928	-847,641	4,082,317	397,059	7,945,798
14	4,227,584	434,443	1,890	-894,945	4,002,271	397,059	8,168,303
15	4,144,690	319,444	1,853	-940,068	3,923,795	397,059	7,846,773
16	4,063,422	208,787	1,817	-983,078	3,846,858	397,059	7,534,864
17	3,983,747	102,346	1,781	-1,024,039	3,771,430	397,059	7,232,323
18	3,905,634	-	1,746	-1,063,016	3,697,480	397,059	6,938,903
19	3,829,053	393,489	1,712	-1,100,072	3,624,980	397,059	7,146,221
20	3,753,974	289,330	1,678	-1,135,265	3,553,902	397,059	6,860,678
21	3,680,366	189,105	1,645	-1,113,005	3,484,218	397,059	6,639,388
22	3,608,202	92,698	1,613	-1,091,181	3,415,900	397,059	6,424,291
23	3,537,453	-	1,581	-1,069,785	3,348,922	397,059	6,215,230

24	3,468,091	356,395	1,550	-1,048,809	3,283,256	397,059	6,457,543
25	3,400,090	262,055	1,520	-1,028,244	3,218,879	397,059	6,251,358
26	3,333,421	171,278	1,490	-1,008,083	3,155,764	397,059	6,050,929
27	3,268,060	83,960	1,461	-988,316	3,093,886	397,059	5,856,109
28	3,203,980	-	1,432	-968,938	3,033,221	397,059	5,666,755
29	3,141,157	322,798	1,404	-949,939	2,973,747	397,059	5,886,226
30	3,079,566	237,351	1,377	-931,312	2,915,438	397,059	5,699,478
31	3,019,182	155,132	1,350	-913,051	2,858,272	397,059	5,517,943
32	2,959,983	76,045	1,323	-895,148	2,802,228	397,059	5,341,489
33	2,901,944	-	1,297	-877,597	2,747,282	397,059	5,169,985
34	2,845,043	292,368	1,272	-860,389	2,693,414	397,059	5,368,767
35	2,789,258	214,976	1,247	-843,518	2,640,602	397,059	5,199,623
36	2,734,566	140,507	1,222	-826,979	2,588,825	397,059	5,035,202
37	2,680,947	68,876	1,199	-810,764	2,538,064	397,059	4,875,381
38	2,628,380	-	1,175	-794,866	2,488,298	397,059	4,720,045
39	2,576,843	264,807	1,152	-779,281	2,439,508	397,059	4,900,088
40	2,526,317	194,711	1,129	-764,001	2,391,674	397,059	4,746,889
41	2,476,781	127,262	1,107	-749,020	2,344,779	397,059	4,597,968
42	2,428,217	62,383	1,086	-734,334	2,298,803	397,059	4,453,214
43	2,380,605	-	1,064	-719,935	2,253,728	397,059	4,312,521
44	2,333,926	239,844	1,043	-705,818	2,209,537	397,059	4,475,591
45	2,288,163	176,356	1,023	-691,979	2,166,213	397,059	4,336,834
46	2,243,297	115,265	1,003	-678,411	2,123,738	397,059	4,201,951
47	2,199,311	56,502	983	-665,109	2,082,097	397,059	4,070,843
48	2,156,187	-	964	-652,067	2,041,271	397,059	3,943,414
49	2,113,909	217,234	945	-639,282	2,001,246	397,059	4,091,111
50	2,072,460	159,731	926	-626,747	1,962,006	397,059	3,965,435
Total	**161,015,310**	**8,769,687**	**78,362**	**-39,001,734**	**165,945,297**	**19,852,941**	**316,659,864**

Table 6: Estimates of the Discounted Loss in Environmental Services
(Discount Rate = 6%)

Yr	Loss of Mudflat (Reclamation)	Loss of Mudflat (Dredged Area)	Loss of Mangrove Area (Bridge)	Mangrove Regeneration (Gain)	Loss of Fishing Ground - Additional Fuel Cost	Aesthetics /Recreational Value	Net Loss
1	814,917	-	2,353	-79,573	4,981,992	382,075	6,101,764
2	1,537,579	-	2,219	-150,137	4,699,993	367,658	6,457,311
3	2,127,689	240,651	2,094	-212,459	4,433,956	353,784	6,945,714
4	2,646,067	454,059	1,975	-267,243	4,182,977	340,433	7,358,268
5	3,332,325	321,268	1,863	-315,146	3,946,205	327,587	7,614,103
6	3,932,416	202,055	1,758	-356,769	3,722,835	315,225	7,817,520
7	3,709,826	95,309	1,658	-392,670	3,512,108	303,330	7,229,562
8	3,499,836	-	1,565	-423,364	3,313,310	291,883	6,683,230
9	3,301,732	339,299	1,476	-449,325	3,125,764	280,869	6,599,815
10	3,114,842	240,070	1,392	-470,990	2,948,834	270,270	6,104,418
11	2,938,530	150,988	1,314	-488,763	2,781,919	260,071	5,644,057
12	2,772,198	71,221	1,239	-503,016	2,624,451	250,257	5,216,351
13	2,615,281	-	1,169	-514,088	2,475,898	240,814	4,819,073
14	2,467,246	253,544	1,103	-522,296	2,335,752	231,726	4,767,076
15	2,327,591	179,394	1,041	-527,927	2,203,540	222,982	4,406,621
16	2,195,841	112,827	982	-531,247	2,078,811	214,567	4,071,780
17	2,071,548	53,220	926	-532,500	1,961,143	206,471	3,760,807
18	1,954,290	-	874	-531,909	1,850,135	198,679	3,472,069
19	1,843,670	189,463	824	-529,679	1,745,410	191,182	3,440,870
20	1,739,311	134,054	778	-525,997	1,646,613	183,967	3,178,727
21	1,640,860	84,311	734	-496,224	1,553,409	177,025	2,960,114
22	1,547,981	39,769	692	-468,135	1,465,480	170,345	2,756,132
23	1,460,359	-	653	-441,637	1,382,528	163,917	2,565,820

24	1,377,698	141,578	616	-416,639	1,304,272	157,731	2,565,256
25	1,299,715	100,173	581	-393,056	1,230,445	151,779	2,389,638
26	1,226,146	63,002	548	-370,807	1,160,797	146,052	2,225,738
27	1,156,741	29,718	517	-349,818	1,095,092	140,540	2,072,791
28	1,091,265	-	488	-330,017	1,033,106	135,237	1,930,079
29	1,029,496	105,795	460	-311,337	974,628	130,134	1,929,176
30	971,222	74,855	434	-293,714	919,460	125,223	1,797,481
31	916,248	47,079	410	-277,089	867,415	120,498	1,674,560
32	864,384	22,207	386	-261,404	818,316	115,951	1,559,840
33	815,457	-	365	-246,608	771,997	111,575	1,452,785
34	769,299	79,056	344	-232,649	728,299	107,365	1,451,714
35	725,754	55,936	324	-219,480	687,074	103,313	1,352,922
36	684,673	35,180	306	-207,057	648,183	99,415	1,260,700
37	645,918	16,594	289	-195,337	611,494	95,663	1,174,621
38	609,357	-	272	-184,280	576,881	92,053	1,094,283
39	574,865	59,075	257	-173,849	544,227	88,579	1,093,155
40	542,326	41,799	242	-164,008	513,422	85,237	1,019,017
41	511,628	26,288	229	-154,725	484,360	82,020	949,801
42	482,668	12,400	216	-145,967	456,944	78,925	885,186
43	455,347	-	204	-137,705	431,079	75,947	824,872
44	429,573	44,145	192	-129,910	406,678	73,081	823,758
45	405,257	31,234	181	-122,557	383,659	70,323	768,098
46	382,318	19,644	171	-115,619	361,942	67,669	716,125
47	360,677	9,266	161	-109,075	341,455	65,116	667,601
48	340,262	-	152	-102,901	322,127	62,659	622,299
49	321,002	32,987	144	-97,076	303,894	60,294	621,244
50	302,832	23,340	135	-91,581	286,692	58,019	579,437
Total	74,884,064	4,232,854	39,306	-15,565,358	83,236,999	8,645,516	155,473,381

Table 7: Estimates of the Discounted Loss in Environmental Services

(Discount Rate = 10%)

Yr	Loss of Mudflat (Reclamation)	Loss of Mudflat (Dredged Area)	Loss of Mangrove Area (Bridge)	Mangrove Regeneration (Gain)	Loss of Fishing Ground - Additional Fuel Cost	Aesthetics /Recreational Value	Net Loss
1	785,283	-	2,267	-76,679	4,800,829	368,182	5,879,882
2	1,427,788	-	2,061	-139,417	4,364,390	341,405	5,996,227
3	1,903,915	215,341	1,874	-190,114	3,967,627	316,576	6,215,219
4	2,281,674	391,530	1,703	-230,441	3,606,934	293,552	6,344,952
5	2,768,938	266,952	1,548	-261,865	3,279,031	272,203	6,326,808
6	3,148,753	161,789	1,408	-285,671	2,980,937	252,406	6,259,622
7	2,862,502	73,541	1,280	-302,984	2,709,943	234,049	5,578,331
8	2,602,275	-	1,163	-314,789	2,463,584	217,027	4,969,261
9	2,365,704	243,109	1,058	-321,943	2,239,622	201,244	4,728,794
10	2,150,640	165,756	961	-325,195	2,036,020	186,608	4,214,791
11	1,955,128	100,458	874	-325,195	1,850,927	173,036	3,755,229
12	1,777,389	45,663	795	-322,507	1,682,661	160,452	3,344,452
13	1,615,808	-	722	-317,621	1,529,692	148,783	2,977,384
14	1,468,916	150,952	657	-310,957	1,390,629	137,962	2,838,158
15	1,335,378	102,922	597	-302,881	1,264,208	127,928	2,528,153
16	1,213,980	62,377	543	-293,702	1,149,280	118,625	2,251,102
17	1,103,619	28,353	493	-283,690	1,044,800	109,997	2,003,573
18	1,003,290	-	449	-273,070	949,818	101,998	1,782,484
19	912,081	93,729	408	-262,037	863,471	94,580	1,702,232
20	829,165	63,906	371	-250,753	784,974	87,701	1,515,363
21	753,786	38,731	337	-227,958	713,613	81,323	1,359,832
22	685,260	17,605	306	-207,234	648,739	75,408	1,220,085
23	622,964	-	278	-188,395	589,763	69,924	1,094,534
24	566,331	58,198	253	-171,268	536,148	64,839	1,054,501

25	514,846	39,681	230	-155,698	487,407	60,123	946,589
26	468,042	24,049	209	-141,544	443,097	55,751	849,604
27	425,493	10,931	190	-128,676	402,816	51,696	762,450
28	386,812	-	173	-116,978	366,196	47,936	684,139
29	351,647	36,137	157	-106,344	332,906	44,450	658,952
30	319,679	24,639	143	-96,676	302,641	41,217	591,643
31	290,617	14,932	130	-87,888	275,129	38,220	531,140
32	264,198	6,787	118	-79,898	250,117	35,440	476,762
33	240,180	-	107	-72,634	227,379	32,863	427,894
34	218,345	22,438	98	-66,031	206,708	30,473	412,030
35	198,496	15,299	89	-60,028	187,917	28,256	370,027
36	180,450	9,272	81	-54,571	170,833	26,201	332,266
37	164,046	4,215	73	-49,610	155,303	24,296	298,322
38	149,133	-	67	-45,100	141,184	22,529	267,812
39	135,575	13,932	61	-41,000	128,350	20,890	257,808
40	123,250	9,499	55	-37,273	116,681	19,371	231,584
41	112,046	5,757	50	-33,884	106,074	17,962	208,005
42	101,860	2,617	46	-30,804	96,431	16,656	186,805
43	92,600	-	41	-28,004	87,664	15,445	167,746
44	84,181	8,651	38	-25,458	79,695	14,321	161,428
45	76,529	5,898	34	-23,144	72,450	13,280	145,047
46	69,571	3,575	31	-21,040	65,864	12,314	130,315
47	63,247	1,625	28	-19,127	59,876	11,418	117,067
48	57,497	-	26	-17,388	54,433	10,588	105,155
49	52,270	5,371	23	-15,807	49,484	9,818	101,160
50	47,518	3,662	21	-14,370	44,986	9,104	90,921
Total	**43,328,695**	**2,549,880**	**24,725**	**-7,755,343**	**52,359,263**	**4,946,425**	**95,453,645**