6 IMPACT ASSESSMENT AND MITIGATION MEASURES

6.1 Methodology

This Chapter provides the prediction and assessment of the impacts of the works on the environment as well as the proposed mitigation measures that have been considered in the design of the works or that should be considered during the construction and operation phases.

Impacts can either be positive or adverse. It is important to consider the duration of the impact and at what phase of the project it occurs, whether short term (construction phase) or long term (operational phase), direct or indirect. Adverse impacts should be adequately assessed and mitigated, if not eliminated, so that the residual is not significant from an environmental point of view.

The aim of impact prediction and assessment is to ensure that potential environmental risks are foreseen and avoided at an early stage in the planning cycle so as to pre-empt issues.

The EIA mechanism has been applied to the proposed project in the following order of priority:

1. **Avoid** adverse environmental impacts
2. **Minimize** risks and control adverse environmental impacts
3. **Mitigate** adverse environmental impacts.

Project impacts are normally analysed using a range of methods, from simple qualitative analysis to detailed quantitative survey or modelling.

The types of impact analysis methods and tools used and the breadth and depth of analysis must be commensurate with the type, scale, location and significance of each impact posed by the project, in line with good international industry practice.

The factors given in Table 6-1 were considered in assessing the predicted impacts.

The next step is to rate both impact and probability on a scale of 1 (low) to 5 (high) for each identified risk.

Tables 6-2, 6-3 and 6-4 provide the relevant explanation in this connection.

Table 6-1 Factors to be Considered for Impact Estimation

Factors	
Type and location	Is the Project in a high-risk sector or does it include high-risk components? Is it located in sensitive areas (e.g. in densely populated areas, near critical habitat, near educational institutions, homes, hospitals, protected areas, etc.)
Magnitude or intensity	Could an impact result in destruction or serious impairment of a social or environmental feature or system, or deterioration of the economic, social or cultural well-being of a large number of people? Manageability: will relatively uncomplicated, accepted measures suffice to avoid or mitigate the potential impacts, or is detailed study required to understand if the impacts can be managed and which management measures are needed?
Duration	Will the adverse impacts be short-term (e.g. exist only during construction), medium term (e.g. five years) or long-term?
Reversibility	Is an impact reversible or irreversible?
Public Participation	Absence of public participation is an inherent risk for the success and sustainability of any project. Have project-affected communities been consulted in project planning and design? Will they have a substantive role to play in the Project going forward?

Table 6-2 Rating of Impact

Score	Rating	Social and Environmental Impacts
5	Critical	I. Significant adverse impacts on human populations and/or environment; II. Adverse impacts high in magnitude and/or spatial extent (e.g. large geographic area, large number of people, trans-boundary impacts, cumulative impacts) and duration (e.g. long-term, permanent and/or irreversible); III. Areas impacted include areas of high value and sensitivity (e.g. valuable ecosystems, critical habitats); IV. Adverse impacts to rights, lands, resources and territories of indigenous peoples; involve significant displacement or resettlement; V. Generates significant quantities of greenhouse gas emissions; VI. Impacts may give rise to significant social conflict.
4	Severe	I. Adverse impacts on people and/or environment of medium to large magnitude, spatial extent and duration more limited than critical (e.g. predictable, mostly temporary, reversible); II. The potential risk impacts of projects that may affect the human rights, lands, natural resources, territories, and traditional livelihood.
3	Moderate	I. Impacts of low magnitude, limited in scale (site-specific) and duration (temporary); II. Impact can be avoided, managed and/or mitigated with relatively uncomplicated accepted measures.
2	Minor	I. Very limited impacts in terms of magnitude (e.g. small affected area, very low number of people affected) and duration (short); II. may be easily avoided, managed and mitigated.
1	Negligible	I. Negligible or no adverse impacts on communities, individuals, and/or environment.

Table 6-3 Rating the Probability of a Risk

Score	Rating
5	Expected
4	Highly Likely
3	Moderately Likely
2	Not Likely
1	Slight

The combination of impact and probability is then used to determine the overall significance of the risk (Low, Moderate or High) using Table 6-4 as a guideline.

Table 6-4 Determining Significance of Predicted Impacts

(Adapted from IAIA Risk Assessment Framework)

Probability/ Likelihood level	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
		Negligible	Minor	Moderate	Severe	Critical
		Consequence Level				
Impact Category		High		Moderate		Low

The impact assessment, identification and mitigation measures for construction and operation/utilisation phases of the project are given in Sections 6.2 and 6.3 respectively.

6.2 Construction Phase

6.2.1 General

During the construction phase, impacts on the following environmental aspects will be of significance:

- Geology & Geomorphology
- Water Quality
- Biodiversity
- Aesthetics
- Air Quality
- Traffic
- Socio-economic
- Noise
- Health and Safety.

6.2.2 Geology and Geomorphology

As no natural geomorphologic feature of interest has been identified on site, the impact on geomorphology is not considered significant.

About 20 m of the lagoon will be reclaimed. The seabed within this strip comprises silty sand and sandy silt with scattered boulders. The reclamation will make available a strip of flat land along the coast that can be used for leisure/recreational activities and landscaping hence compensating for the loss in the lagoon area.

Mitigation Measures

No further mitigation measures are envisaged than those that have already been considered at planning and design phases and integrated in the construction project.

6.2.3 Water Quality

The water quality test as well as ecological survey report suggests that the lagoon water at the site is not of good quality. The concentration of heavy metal chromium was noted to be at an elevated level, beyond norms.

The works will not represent a source of pollution in itself but however might indirectly introduce contaminants in terms of the materials being used for fill. A reduction in the quality of the nearshore water will be expected in terms of suspended solids due to wash out of sediment from the fill material. The adverse impact is likely to be localised and temporary, occurring only during the construction period. Moreover, any adverse impact in water quality is not expected to create any additional impact on ecology. The adverse impact is expected to be short term, high in occurrence and low in consequence and hence, moderate in significance.

During the construction stage, the following activities may also present a risk to water quality:

- Wastewater generated by site activities being discharged to sea
- Solid waste generated on site
- Domestic wastewater produced on site
- Fuel spillage from machinery to be used on site.

Any adverse impact on water quality due to the above activities is expected to be in the short term only. Water quality problems frequently arise in enclosed or semi-enclosed water bodies, particularly if flushing rates are low such as ports, harbours and marina areas with restricted tidal access, which is not the case of Grand Baie Le Capitaine site.

Hence impact on the water quality will be *moderately likely* in occurrence, but *moderate to low* in consequence, hence *moderate* in significance.

Mitigation Measures

The construction activities will have to be planned in such a way so as to minimize sediments from fill material to be carried away into the lagoon with tidal movements. The stretch of the lagoon within the fill area at the site may be fenced with a silt trap so as to limit the spread of sediments away from the working area. This measure will provide a better control over sediment propagation and limit the impact to a change in sediment level in the lagoon nearshore.

Furthermore, the material to be used for fill should not be contaminated and should not contain any polluting material or chemicals that can be released in the natural environment of the receiving end.

Fill material to be used at this site, which will comprise mainly rocks for the revetment and crushed stones for the fill behind the revetment wall, should ideally be procured from stone crushing plants and washed so as to minimise the risk of contamination of the lagoon water by organic materials or other contaminants. Should rocks for the revetment be sourced from open fields, care should be taken not to carry spoil and soil from the fields to the site of work. The rock material should ideally be stockpiled outside the site so that only selected rocks suitable for the works are brought to the site free from contaminants that could eventually pollute the lagoon. Further protection against contamination of sea water at the site from sediments could be achieved by providing a silt trap around the working area.

Appropriate sanitary facilities should be provided by the contractor for the workers. Wastewater generated at site should be collected and carted away to a wastewater treatment plant or disposed of in a manner that is approved by the Wastewater Management Authority and/or the Local Council. The mode of disposal of domestic wastewater will depend on the contractor's site establishment and will have to be detailed in its Environmental Monitoring Plan. Possible methods of wastewater disposal include:

- Collection and carting away to a disposal point as approved by the WMA
- Septic tank and leaching fields/absorption pit (depending on location of the site establishment with respect to the High-Water Mark of the sea or any other existing water bodies).

The approval of the WMA will have to be sought by the contractor prior to the setting-up of these facilities.

The contractor should provide an emergency preparedness plan for approval by the Engineer in case of spill of fuel or other fluids from equipment/machinery used or accidents that may lead to fuel spillage of fluids from equipment/machinery on land or in the water body.

Maintenance of vehicle should not be carried out on site but in a proper workshop located beyond the 30 m limit from the High Water Mark of the sea. Refuelling of the off-road equipment should be carefully planned such that no fuel is spilled on the ground or into waterways.

Should fuel be stored on site, this must be done in an area enclosed by bunded walls with proper drainage facilities.

6.2.4 Biodiversity

As stated in the ecological survey report, the site can be classified as being stressed, of low sensitivity and unlikely to be significantly impacted upon by man-made activities. It further states that any future infrastructure works should not have any significant impacts or cause further degradation to the area. Though no particular care would be required to protect the biodiversity and ecosystem present at the site, due attention must be given to ensure that no hydrocarbons, chemicals or other products are allowed to get into the sea during the construction period. Three juvenile *coqueluches* and four *badamiers* will have to be felled.

Mitigation Measures

The impacted trees, which are located close to the water's edge will, undoubtedly, be directly affected by the construction works. Though they are not under any conservation threat, they should be preserved wherever possible.

Trees to be removed will have to be replaced by appropriate native species as part of the landscaping works under the project.

The authorisation of the Forestry Service should be obtained prior to the felling of the trees impacted by the proposed works.

6.2.5 Air Quality

The main impact of the works on ambient air quality will be associated with the transport, storage, handling and distribution of material on site.

Sources of supply of materials are expected to be from stone crushing plants and from the fields. Whilst materials from the crushing plants are generally washed at source, those from the fields usually contain soil and other particles that could become airborne during handling on site.

The main sources of emission to air will mostly be fugitive dust during the placement of fill materials and the emission from the exhausts of vehicles carrying materials to site and the earthmoving equipment to be deployed on site.

The fugitive dust emissions have the potential to cause nuisance to the nearest receptor, which is the village, in terms of soiling of surfaces. Particulate matter namely PM10, as well as the emissions from engines have the potential to have an adverse effect on human health.

The works will be carried out in a highly popular area, hence the impact, though short term, will have a temporary adverse impact which is *highly likely* in occurrence and *moderate* in consequence and hence *moderate* in significance.

Mitigation Measures

As far as practicable, materials to be brought on site should be free from particles that could eventually become airborne at the site. During the construction period, water will have to be sprayed over the dust-generating materials to minimize its emission to air.

The placement of a dust trap/fence will also contribute significantly in attenuating air pollution by dust particles.

The contractor should also ensure that all plant and equipment to be deployed for the works are operated and maintained in accordance with the original manufacturers' specifications and manuals and in such a manner as to minimise the emissions of hydrocarbons, particulates and vehicle exhaust pollution. However, no maintenance of vehicles should be done at site.

6.2.6 Traffic

The existing traffic along the coast road at the site can be classified as medium to high during peak hours. A substantial amount of fill and rock materials will be required

for the proposed works. Preliminary estimates show volumes in the order of 3,000 m^3 of these materials will be required. This represents some 375 trips to the site over the construction period of 8 months. Materials will be transported to site by medium to heavy lorries, which will add up to the existing traffic that transits through the coast road at the site.

Though insignificant, traffic will increase during construction period, especially the number of heavy vehicles carrying fill, rock and other materials to site. The Mon Choisy-Cap Malheureux Road B13 is a two-way road with no parking facilities to accommodate construction vehicles at the site. This may cause blockages and queuing along the road during the construction period. Moreover, the road structure may also be damaged by these vehicles, if excessively loaded.

An adverse impact, *highly likely* in occurrence and *moderate to severe* in consequence hence *moderate to high* in significance is expected during the short term especially during the peak hours.

Mitigation Measures

The selection of quarry areas for fill material should take into consideration their proximity to the site but should not be at the expense of the quality of the fill material. The contractor must plan the frequency of the delivery trucks to the site in such a way that the number of trucks at the site at any given moment does not result in significant disruption of traffic along the coast road. In this respect, the contractor will have to seek and obtain the required clearances from the relevant authorities in accordance with its methodology to carry out the works prior to the start of activities on site.

Care should also be taken not to exceed the prescribed axle loadings by the trucks that will transport materials to the site to prevent damage to the road structure.

Heavy vehicles should ideally circulate during off-peak hours.

6.2.7 Socio-economic

The construction works is not expected to impact on the commercial activities around the site if properly planned.

According to information obtained from the relevant authorities, there are no major fisheries activities at this site. The existing fish landing station of Grand Baie is located some 400 m to the north of the site. Activities at the fish landing station will therefore not be impacted by the works.

The users of the existing jetty, if any, will however be temporarily impacted adversely.

It is also to be noted that the site will be secured during the construction phase and as such access to the sea from the site will not be available.

The construction project is expected to generate employment for the short term and hence will have a moderately significant impact.

6.2.8 Noise

Noise issue will only arise during the construction period due to the equipment and vehicular activities. The adverse impact will only be short term, *highly likely* in occurrence and *moderate* in consequence, hence *moderate* in significance.

Mitigation Measures

Construction activities will normally be restricted from 07.00 hours to 17.00 hours. Hence no disturbance will be caused at night-time. Contractors will have to ensure that earthmoving equipment on site and vehicles used for the transportation of materials to site will have to conform to statutory noise levels.

Worker, who may be exposed to high level of noise for long period of time, must be provided with appropriate personal protective equipment as per requirement of Occupational Health and Safety Act of Mauritius.

6.2.9 Health and Safety

The works on site may present a risk to worker or users of the area and coast road, more specifically pedestrians. Accidents due to site works may have impacts that are critical in consequence and hence *high* in significance.

Mitigation Measures

All precautions must be taken as per the Occupational Safety and Health Act of Mauritius as well as other precautionary measures required by the TRMSU and other authorities. Appropriate traffic management schemes should be developed during the construction phase to ensure safety of road users, including pedestrians that transit at the site.

Appropriate personal protective equipment must also be provided to workers on site.

Furthermore, the Contractor will have to comply with all requirements of the Occupational Safety and Health Act and other legislations with respect to health and safety on site.

6.3 Operation/Utilisation Phase

6.3.1 General

Rock-armoured revetment usually has significant impacts on the existing littoral regime, which is a primary function of the project.

The most common problems that arise from the effects of this type of works on the existing regime are typically accretion up-drift and erosion down-drift with variations caused by local changes in wave exposure, refraction, diffraction, etc. Similarly, coastal works such as rock revetment will have some impact on local geomorphology.

The effects on the geomorphological environment are of considerable interest to the designer and have already been investigated as part of the engineering studies (hydrodynamic modelling) as detailed in Section 6.3.2.

Impacts of shoreline works on the landscape may be of particular significance where protection measures are design to project above beach levels. Moreover, the exposure of shoreline works allows few opportunities for effective screening or camouflage.

Effects of climate change, which also impact on the littoral regime, have already been taken into account in the planning and design of the works.

6.3.2 Geomorphology and Hydrodynamic Impacts

The expected hydrodynamic impacts on the site shoreline and adjacent areas have been reviewed for the preliminary options, and compared in terms of the following aspects:

- Wave reflection
- Down drift erosion
- Overtopping and run-up.

Wave Reflection

Waves can be reflected into the bay area for the operational design condition (as shown in Figure 6-1. Due to the small size of the reflected waves and the dissipation of the reflected waves before reaching the beaches in Grand Baie the impact is not expected to be significant during operational conditions. The impact of reflection is not expected to increase due to the construction of a revetment, if anything it should improve the dissipation of wave energy due to the increased roughness of the revetment slope as compared to the existing boulders, cobbles and small retaining wall on the upper section of the profile.

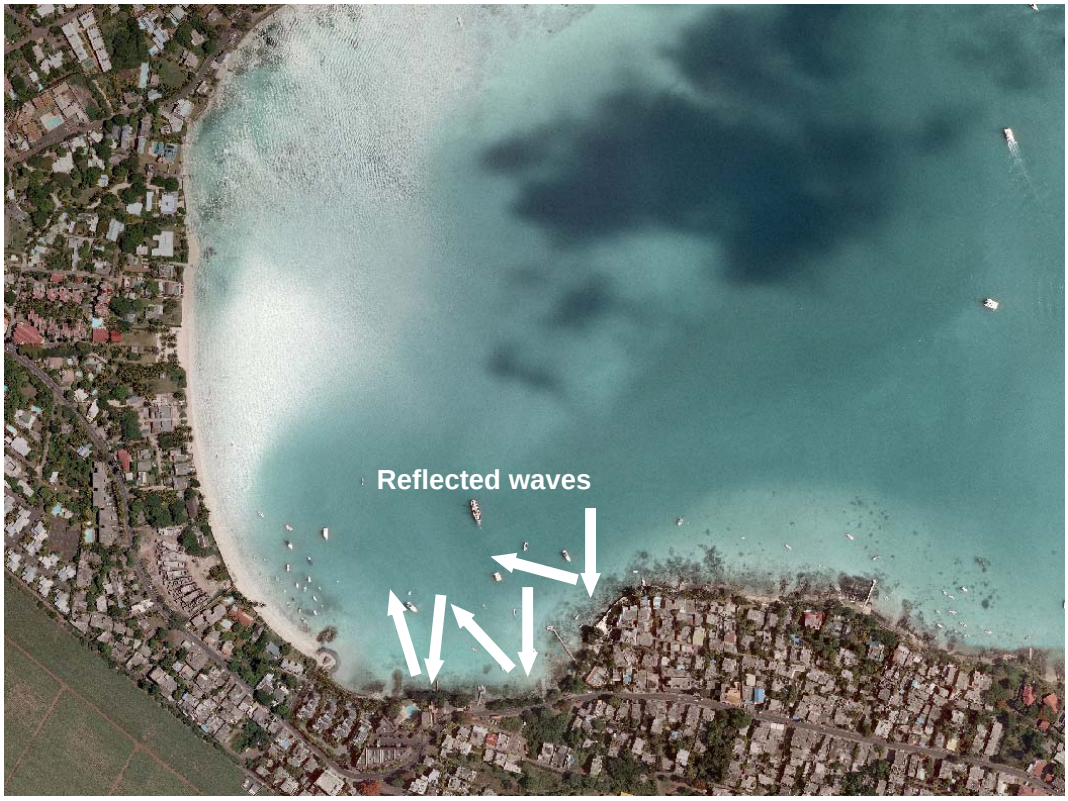

Figure 6-1 Potential Wave reflection

The revetment rock protection will stretch to a vertical level of +2.5 m MSL, with the crest wall above that level to +2.85m MSL. In the existing state the beach is largely intertidal, with some scattered boulders below the water level. The existing seawall

stretches from approximately +0.5m MSL to +1.5m MSL. This existing retaining wall is expected to cause more reflection of waves than the new revetment, therefore, implementation of a revetment in this area is expected to improve conditions from a wave reflection perspective.

Coastal Morphology

Due to the lack of sediment supply and any historical morphological changes during the period for which aerial imagery is available, it can be assumed that there will be no change to the site morphologically. The revetment is not expected to cause downdrift erosion of adjacent coastlines or beaches.

Overtopping and Flooding

The intention is to protect the site with a revetment stretching from the abutment towards the existing retaining wall to the east. The proposed revetment crest height is +2.5m MSL, with a crest wall up to +2.85m MSL. The proposed raised crest level should provide much improved coastal protection than the existing structures. The crest berm and walkway are expected to provide an additional horizontal buffer to protect the road against flooding. This will be integrated with a collector drain discharged through two outfalls.

The overtopping is still expected to be excessive for a 100-year cyclone, especially so with the addition of Sea Level Rise (SLR). However, in this case the Still Water Level (SWL) is not expected to exceed the crest height of the revetment. Acceptable overtopping is predicted during 1-year and 10-year events to protect hinterland infrastructure from erosion and minimize damage.

6.3.3 Landscaping and Aesthetics

The extension of the land towards the sea will provide a recreational/leisure area for the inhabitants, the public and tourists, which will impact positively on the area.

Landscaping works will comprise mainly greening to enhance the aesthetics of the waterfront and a walkway. These works will lead to a *positive* impact in the area in the long term and is classified as *highly significant*.

6.3.4 Socio-economic Impact

In addition to coastal protection, the project will provide an additional space with proper walkways for the community and public at large. The proposed scheme also provides for access to the existing jetty from the walkway through a new stairway. Access from the walkway to the coastline to the west of the site will be restituted through another staircase.

The project is therefore expected to be beneficial to the community leading to a *significantly positive* impact.

6.3.5 Significance of Impacts during Operation Phase

Notwithstanding the minor adverse residual impacts on the geomorphology at the site in the short term, the project will have a long term highly beneficial impact as far as aesthetics, recreational value and coastal protection are concerned.

6.4 Maintenance as a Mitigation Measure

Rock revetments, though more costly than other types of protection measures such as gravel nourishment, require minimal maintenance. However, the revetment should be inspected on a regular basis to ensure rocks are not removed from the coastal protection structure.

Routine maintenance will include cleaning to remove floatsams and jetsams trapped between the rocks. Provision of bins along the crest of the revetment will also assist in preventing littering into the rock revetment. The pervious concrete surfacing of the walkway should also be cleaned by water jetting at least once a year to prevent clogging by dust and soil particles hence resulting in a reduction of its permeability.

Other mitigating measures (for softscaping aspects) that would result from maintenance are:

Watering	: Ideally daily in summer and twice weekly in winter
Fertilizing	: Use of compost instead of chemicals to prevent pollution
Mowing	: For levelling/cutting down the grassed area for aesthetics and tidiness
Weeding	: Planted areas to be maintained free of weeds and undesirable grasses to enhance aesthetics and to prevent damage to the plants.