CHAPTER 05

MITIGATION MEASURES

5.1 Control of Impacts Related to Interaction of Harbor Structures with Waves and Currents

The impacts related to interaction of harbor structures with waves and currents could always be minimized by the selection of a proper harbor layout and the design of proper harbor structures. In the selection of the harbor layouts given in this project, designers have taken various measures to minimize several impacts.

Impacts related to wave reflection could be minimized by the selection of less-reflective structures. Toe protection aprons can be provided where necessary to minimize toe erosion arising from wave reflection. It is advisable to maintain the sandy shoreline at the eastern side of the basin in alternative layouts 1, 2 and 3 at its original state, which would enable dissipation of waves reflected from inner harbor structures.

5.2 Control of Impacts on Adjacent Beaches

The impacts of the proposed port on the neighboring beaches may not be very significant, at least for the alternative layouts 1, 2 and 3. However, it would be advisable to perform a current distribution and sediment transport study to identify the changes to the original current pattern and sediment movement followed by the construction of the proposed port structures.

The beach beyond the watering point should be monitored continuously after the construction of the port to identify seasonal and long-term changes associated with the development project. Monitoring should also be done at the shoreline at the western part of the Galle bay where yatchs are anchored.

5.3 Control of Sediment Transportation into the Harbor Basin and Approach Channels

The degree of siltation could not be estimated in the absence of a detailed sediment transport study within the harbor basin. Hence mitigatory measures for harbor siltation is not discussed in detail in the absence of such a study. However, it would be advisable to monitor the siltation in berthing areas and in the approach channel. Silt curtains can be provided to minimize siltation near berthing structures particularly during construction. Maintenance dredging operations within the basin and in approach channels would be adequate if harbor siltation is not excessive.

5.4 Control of Impacts Related to Dredging and Blasting

5.4.1 Construction Stage

Non-disruptive dredging techniques should be adopted to minimize disturbances to the sea bottom and to minimize particle suspension. Silt curtains can be provided near coral reefs and at archeological sites to cover them from heavy siltation. Coral patches should not be dredged or blasted if it is not absolutely necessary.

Special blasting techniques should be used to avoid any danger to the existing port structures and other historic buildings at the Galle Fort. Those structures and buildings should be carefully monitored continuously throughout the blasting process to identify any damage or instability following blasting.

5.4.2 Maintenance Stage

A trailing suction hopper dredger with a special suction head could be used for maintenance dredging to minimize dispersion of polluted sediment. In this type of dredgers, the suction head is designed such a way so as to minimize agitation of sediment.

It would be difficult to remove sediment deposits found near harbor structures by a trailing suction hopper dredger due to low accessibility. A grab dredger can be successfully used for such situations, with the exception when sediment contains contaminants.

5.5 Water Quality of Galle Bay

Oil recovery facilities should be provided at the port so that in the case of a spill, it should be recovered in no time. Particularly, during construction dredging is one of the key operations, which causes the suspended matters to stir up in the water column. Silt curtains in the areas of importance such as coral reef, places of archaeological interest etc. are to be employed to protect suspended matters being spread.

Proper sewage facilities must be provided so as not to contaminate the bay faecally. Cargo handling must be done with the utmost care to avoid accidental spills. If such an incidence takes place, immediately clean-up programme is to be launched. Proper solid waste yards are to be designed and their subsequent collection, transport and final disposal must be carefully carried out. Such yards must be kept free of animals so that dropping of garbage could be reduced markedly.

5.6 Sediment quality of Galle bay

It is necessary to monitor the sediment quality in regular intervals so that their degree of contamination could be evaluated. Areas of high contamination with heavy metal, organo-chlorides and pesticides must be dredged very carefully so as not to disturb the area. Such materiel should be disposed at a designated site with minimum spills.

5.7 Point Sources of Pollution and their Water Quality

No specific mitigation measures need to be provided, as no significant impacts are anticipated on the water quality of the point sources due to the project activities.

5.8 Water Quality of Recreational Areas

In the case of Alternatives 1,2 and 3, since no significant impacts are anticipated during the operational phase, no major mitigation measures are needed. During the construction phase, if the water quality in the old harbour area deteriorates below acceptable levels, the people will have to be warned to avoid contact sports during those periods.

5.9 Noise Pollution

During the construction phase, the noise level should be reduced by using equipment and vehicles that are well maintained, and restricting the operation of noise generating equipment to the daytime only. Proper traffic management practices and maintenance of access roads during transport of materials will help to reduce the traffic noise due to these vehicles. The responsibility of maintenance of access roads and roads on which heavy traffic is caused due to construction activities should be included in the contract agreement. If the predicted noise levels within the city and near schools, temples and other noise sensitive areas are excessive, noise barriers will need to be provided at these locations.

5.10 Air Pollution

Precautions should be taken to minimize the emanation of dust from the trucks delivering construction materials to the site, by wetting the surfaces, and using vehicles that meet the exhaust

standards. During operation stage, proper traffic management measures and enforcing pollution control measures for vehicles should be employed.

5.11 Construction material such as metal and sand, and their availability

Since the quarrying of rock and dredging of sand both require environmental clearance, mitigation measures would be incorporated into the permits issued for these activities.

5.12 Sewage, Drainage and Other Wastewater Systems

The existing sewage, drainage and other wastewater system would become inadequate in future, due to the high growth expected in the area due to the proposed project. Therefore, the infrastructure should be improved, taking into account the expected groth in the area. During the construction phase, facilities for proper disposal of wastewater produced in the workers' quarters, canteens etc. should be provided.

5.13 Solid Waste Disposal

Adequate facilities should be provided in the harbour for collection and disposal of waste from ships. (according to Marpol Convention, for which Sri Lanka is a signatory, bins the country to provide this service.) During the construction phase, special collection should be introduced to cater to the collection and disposal of solid waste from the construction site and workers' quarters. This should be included in the contract documents.

5.14 Hazardous Material and Ship Discharges

In order to mitigate the impacts on the marine environment by ship discharges, the port should provide facilities for reception and disposal of waste materials from ships. There should be reception facilities for:

* Oily wastes,
* Sewage and garbage.

Arrangements should be made to transport the waste materials collected in the reception facilities to a place outside the port for recycling, reuse, resource recovery or environmentally safe disposal. oily wastes,

Noxious liquid substances that are carried in bulk and harmful and hazardous substances carried in packages such as tanks and containers should be handled with care to avoid accidental spills. Contingency plans should be prepared for action in the case of accidental spills that could occur at the port, and all personnel should be trained on action to be taken in the event of such accidental situations at the port.

5.15 Flora of Rumassala Cliff

Selecting the road trace through a developed area can reduce the impacts on terrestrial flora and natural ecosystems. This will avoid the clearing of natural vegetation and reducing the biodiversity in the project area. When selecting lands for buildings it is important to allocate sites already disturbed due to various reasons. This will minimize the habitat destruction and change of terrestrial ecosystem. Choice of construction methods and equipment, silt curtain will reduce the impact on marine algae.

5.16 Coral Reef and Its Associated Fauna

Coral reefs are generally found on the leeward side of headlands or where there are rock outcrops that provide relatively calm sea conditions. This fact is evident when nearshore coral development along the western and southern coast is examined. Coral reefs have developed on the protected sides of headlands that provide shelter from the southwest monsoon. With the proposed development of breakwaters the degree of calmness in the sea will increase at Rumassala. The calmness resulting from the construction of breakwaters could be beneficial to coral growth, particularly the more fragile forms of corals such as branching and foliaceous species. However it will be very important to maintain good water circulation as corals can be severely affected by stagnant conditions. A reduction in circulation of water could increase the possibility of sediment deposition on the corals. Furthermore water circulation is essential to prevent the shallow areas from excessive warming which would be highly detrimental to corals. Table 5.1 gives the major impacts in the port area.

Table: 5.1 Significant Adverse Impacts

Activity	Issue	Possible Impacts	Action to mitigate impact
Rock blasting	Vibration and suspended sediment	Vibration could damage reef structure, Suspended particles may cause sediment deposition	Use vibration less techniques for blasting to reduce the impacts on reef.
Dredging	Increased loads of suspended particles due to dredging	Smothering of coral reef	Use of silt curtains around the dredging area
Construction of piers/breakwaters etc.	Increased loads of suspended particles Reduction of water flow	Smothering of coral reef	Use of silt curtains around the construction area
Movement of ships and other vessels	Increased suspended particles.	Smothering of coral reef	Management of traffic within the harbour and the Galle Bay.
Dumping of dredged material	Pollution caused by dumping of dredged material	Smothering of offshore reefs around the dumping area	Site for dumping dredged material should be carefully selected and the impact from dumping should be assessed.
Oil leaks and spillage from boats etc. (chronic)	Chronic oil pollution in the Bay	Shallow areas could be adversely affected by oil coated suspended particles	Waste oil management and maintenance of general cleaner harbour conditions
Oil pollution from accidental spill	Oil contamination within the Galle Bay	Sudden spill damage may be temporary but depends on the degree of the spill. If large, a spill could coat the entire reef in oil	Have booms and other necessary equipment stationed on site to contain oil spills
Antifouling paints and other chemicals	Toxic matter in the water such as heavy metals & Organo chlorides	Toxic to marine life and could adversely affect marine organisms	Remove sediments that are polluted with such chemicals periodically without much disturbances
Garbage	Solid and liquid waste in the water	Smothering of reef and general pollution of the sea	Proper disposal systems for solid and liquid waste

The use of sediment curtains around the area of dredging and filling activities would be the main measure to contain fine sediment from reaching the sensitive habitats of the coral reef. Other measure to save corals would be to relocate some corals to the adjacent reef/suitable habitats. Suitable habitats are found at Unawatuna and around the Galle Fort.

In connection with the above it will be necessary to prepare the receiving location, which is the Galle fort reef by cleaning and carrying out limited suction dredging among the existing coral patches. Ornamental fish collecting, coral collecting and souvenir hunting from the reef around the ramparts has to be stopped.

A large-scale coral transplanting project has been carried out in Singapore to save coral habitats during the development of Sentosa Island (Newman and Chuan, 1994). In this exercise many reef organisms have been relocated including corals, sponges and other live rocks (live organisms attached to rocks). It has been reported that 69% of the transplants have been successful but the percentage may not reflect the true percentage of survivors due to the initial losses of small colonies and poorly anchored colonies that had dislodged and was buried in the sand. The 2nd phase of this project has been more successful as the volunteers were requested to take specimens larger than 30 cm as it was found that small colonies do not survive well as transplants (Newman and Chuan, 1994).

Lindahl (1998) reported that reef rehabilitation carried out using branching *Acropora* spp increased by 51% after 23 months. However branching corals can be used only in relatively calm conditions such as in coral reef lagoons. For more exposed environments massive and other short branching species such as *Pocillopora verrucosa* and *P. eydouxi* will be more suitable.

5.16.1 Improvement of Degraded Reefs

Use of artificial reefs to improve the condition of highly degraded reefs have been attempted in the past. Clarke and Edwards in 1994 reported on a study carried out in the Maldives where a coral reef has lost its entire live coral cover. They had used artificial reef structures built with concrete blocks to determine the rate of recovery. Fish had colonized the artificial reef quite rapidly soon after it was deployed but a comparison of multivariate analysis between the artificial structures and undegraded reef flat sites had indicated a marked dissimilarity in fish communities. Clark and Edwards had also reported on the first colonizers of the artificial reef by algae, barnacles and later by benthic invertebrates. The first coral recruits have been observed after 6.5 months and after 11 months 3 coral genera, namely *Pocillopora*, *Acropora* and *Porites* have been observed. Branching coral species such as *Acropora* is not suitable for transplantation into high-energy areas. Species with massive growth forms or stubby branches are more suitable for high-energy environments.

Gomez et al., (1982) and Wong (1990) had reported corals colonizing tyre reefs in Malaysia. Clark and Edwards (1995) had pointed out that the tyre reefs used in Malaysia has been in deeper water where wave action does not affect the settlement of coral larvae.

5.17 Maritime Archaeology

5.17.1 Introduction

The mitigation measures proposed in this chapter refer to the impacts anticipated in the chapter on Anticipated Impacts. In recommending mitigation measures, no attempt is made to comment on Alternative 4 as it undoubtedly affects the important sites badly. In other words no mitigation measures, what so ever could be suggested for alternative 4.

The mitigation measures that are common to Maritime Archaeology are given in Table 5.2.

Table 5.2 Suggested mitigation measures for actions affecting archaeological resources

Actions affecting archaeological resources	Suggested mitigation measures
1. Dredging and stirring of seabed	1.1 Detailed study and modelling be undertaken at least for possible alternatives (ie. Alternative 1&2) before a final Plan is decided on to prevent damage occurring during construction. Based on this study, measures such as silt curtains are to be incorporated particularly in the areas where the sites of high archaeological values are situated at. In this regard, cutter section head dredger is preferred to hopper dredger.
2. Changes in water and current flow within the Bay, and their effects	2.1 A study to be made of the Admiralty charts current in 1966 and 1996, and a comparison made with the existing situation, particularly in the area abutting the Fort and the Marine Drive. This will show the effect of the building of the existing harbour and the boatyard on the coastline, and give an indication of the likely sediment movements that will be generated. Periodical cleaning up process is to be launched in order to prevent the sites from burying with sediments.
3. Adverse effects on cultural, tourist and recreational facilities in the Bay by the construction or expansion of Port facilities in the waters abutting the Fort	3.1 The Master Plan being prepared for Galle gives the Fort complex, the seaward face of the Ramparts, and as the historic harbour site in the lee of Black Fort high priority under "Culture, Tourist and Recreational Facilities". Particularly because of this, Alternative 4 has to be abandoned. All other Alternatives must aim at enhancing this value placed on this area. Recommended that the final Plan make provision for doing this.
4. Removal of bottom soil dredged up	4.1 Dredged material of the area where these exist a potential for archeological artifacts or material to be located will need to be examined prior to dumping, with archaeological personnel. If such material is found, immediately retoration must be planned together with the consultation of Dep. Of Archaeology.
5 Blasting of sea-bed	5.1 Give details of proposed blasting etc. by location, method to be employed and specialist opinion of effects to Director-General, Archaeology and obtain approval. 5.2 SLPA should set in place strict regulations for shipping, with the view of protecting the historical and archaeological value of the Fort and the Bay as a unified whole.

5.17.2 Mitigation relating to specified sites

Table 5.3 deals only with those sites which are considered likely to be affected, namely: Sites C, F, G, I, N, O, Q, S, W, X and Y. The other sites are dealt with elsewhere.

Table 5.3 Proposed mitigation measures specific to some sites

Site	Anticipated Impact	Mitigation Measures Recommended
C	Danger to underwater exploration (Alternatives 2 and 3 only)	Exact location of Channel by DGPS coordinates necessary to comment on this. Try to avoid this site if possible.
F	Complete destruction of site	As the site cannot be preserved under any of the Alternatives, a thorough investigation has to be carried out and the historic importance of the site perpetuated/preserved at a suitable location. The cannon can be relocated in safer waters near the Conservation Laboratory. All other artifacts recovered will have to be transferred to a Site Museum which will exhibit the material retrieved, the photographs and video footage and the historical research pertaining to this wreck
G	Proximity to, but outside Channel: but dangerous for underwater exploration	Site of moderate importance. SLPA and Archaeologist teams to coordinate to programme exploration and ship movements
I	Proximity to, but outside Channel: but dangerous for underwater exploration	Same as above
N	Complete destruction of site	Artifact to be retrieved and relocated in safe area
O	Complete destruction of site	No exploration contemplated. May be sacrificed
Q	Complete destruction of site	Examination of site prior to destruction
S	Complete destruction of site	Same as above
W	Proximity to, but outside Channel: but dangerous for underwater exploration	Same as Sites G and I (above)
X	Outside Channel and Basin, but all work likely to be rendered impossible	Programming of archaeological work in consultation with SLPA
Y	Proximity to, but outside Channel: but dangerous for underwater exploration	Same as Sites G, I and W (above)

In terms of Sections 43 A and B of the Antiquities Act, amended by the Antiquities (Amendment) Act No, 24 of 1998, the Director-General, Archaeology:

(i) has to approve or permit the encroachment upon the site;

(ii) can call for an EIA (Antiquarian, Historical and Archaeological) and object to or recommend the project to his Minister;

(iii) If he recommends it, he can recommend alterations to it, "estimate such additional costs as may be necessary for the taking of any measures to protect, preserve, excavate, document and publish and if necessary relocate any antiquities";

(iv) The project sponsors shall set apart maximum of one per cent of its total cost of the project for this purpose.

It is therefore recommended that, in mitigation for the destruction of the site and the intervention in the whole of the Galle Bay, the following measures be taken:

(i) full investigation of Site F together with the Dep. Of Archaeology;

(ii) relocation of the cannon in archaeologically accepted area;

(iii) Meet part of the cost of setting up of a Site Museum as some of the artifacts from site F are to be shifted.

It is also recommended that, as a measure that might win public support, the following be considered. Since in the sinking of the "Hercules" a large number of sailors died, this site was named "Hercules Kirkopf": meaning a Churchyard or Graveyard. Theoretically it is a tampering with human remains, though we have found none so far, and perhaps arrangements could be made with the Dutch Reformed Church to hold a religious service before the commencement of the construction. All this could lead to much tourist interest in Galle, with media coverage: it would be a fit recompense for the sacrifice of an important site in the interests of development.

5.18 Socio-economic Parameters

The adverse impact on loss of anchorage points and resources, to fishermen, can be mitigated by two ways. First, the fishermen may be allowed to continue beaching their crafts in the *Dewata* area (with or without fencing the shoreline) and to lay their beachseine in the *Dewata* coastal waters. The 18 traditional crafts may then continue to operate either in the new harbour area or, they may be allowed to pass through the approach channel and fish outside the harbour area, depending on resource availability. The two mechanised crafts will have to pass through the approach channel and fish in the deeper waters outside the harbour area. The beachseine is now

laid inside the inner boundary of the proposed harbour structures and the breakwaters as per Alternatives 1,2 and 4. Therefore, the fishermen operating this seine will not be denied of access to their traditional area of operation if any of the above three alternatives is implemented.

However, if this is not possible due to security reasons and the shoreline has to be fenced, then alternative locations will have to be provided to fishermen in this area. Due to the high degree of mobility of the mechanised crafts (which fish in deeper waters, outside the harbour area), these crafts can be beached in the *Mapalawella* or near Old Harbour Masters Office. Some of the traditional crafts can be moved to *Mapalawella*, perhaps not all, due to the limited beaching area. Some of these fishermen may be helped by way of providing them with credit facilities to mechanise their crafts and to operate from the landing point at Old Harbour Masters Office. The *Dewata* seine fishermen could be asked to lay their beachseine at *Mapalawella*, but which will have to be negotiated with the present seine fishermen at *Mapalawella*. At present, three seine nets are laid at this location, each taking its turn after the other to ensure equal access to resources. Negotiations will have to be carried out with the present seine owners at *Mapalawella*, with the involvement of the Ministry of Fisheries and Aquatic Resources Development and Sri Lanka Ports Authority, to include the *Dewata* –seine in their 'net sequence'. Such negotiations are necessary due to the existence of 'traditional barriers to entry' that prevent 'outsiders' from beaching their crafts in a particular landing point. Movement of area of operation from *Dewata* to *Mapalawella* may not cause serious problems in terms of 'loss of travel time to and from work place' or 'the burden of carrying fishing gear to and from crafts' because most of the fishermen operating at Dewata at present do not reside close to the landing point.

In the case of increased port activities it may be noted that traditional crafts from *Mapalawella* (next to the Navy Camp) operate in the old harbour area today, rather than fishing in deeper waters outside the harbour area. Moreover, three beachseines are operated from *Mapalawella*. This suggests the availability of shore seine type of fish varieties in and around old harbour areas. Therefore, one cannot expect a decline in fish catches along with the construction of port facilities such as breakwaters and revetments.

The impacts on coastal fisheries can be mitigated to a greater extent by the application of silt curtains. Moreover, the construction methods and equipment could be so selected to minimise the diffusion of turbidity and siltation. Disposal of dredging spoils into carefully selected sites will be of paramount importance in minimising the adverse impacts on marine life.

The above impacts can be mitigated by modifying the working-time zone. For example, small mechanised crafts leave for fishing around 3.00-4.00 pm and return at mid-night. The working-time zone can be adjusted in such a way that the movement of these crafts are not adversely affected. Construction activities will not affect the movement of day boats with inboard engines, because they leave for fishing early morning and return late in the evening. The movement of multi-day boats is variable and they may have to adjust their movement according to the working-time zone. It is best to work out the working-time zone, in consultation with the Fisheries Harbour Authorities in Galle.

A great majority of yachts arrive and anchor during the months of January, February and March. This fact will have to be taken into consideration in working out the construction schedule, so as to minimise the adverse impacts on the movement and anchorage of yachts. The present anchorage points of yachts can also be shifted towards the Old Harbour Master's Office (close to the rampart), away from the construction area. The yachtsmen should be made aware of the working-time schedules of the construction activities.

By choosing appropriate construction methods and equipment some of the impacts on recreation areas can be reduced. Use of silt curtains too will be of significant importance in mitigating adverse impacts on recreational sites (such as the *Unawatuna* beach). Care should be taken not to dispose dredging spoils close to the touristic and recreational areas. It is also important to refrain from carrying out dredging and blasting activities during the peak tourist season, which falls in the months of November, December and January.

Adjustment of the working-time zone and the construction schedule to suit the cargo handling and movement of vessels bringing in cargo, at the existing port is necessary.

5.19 Built-Environment

5.19.1 The hinterland

5.19.1.1 Construction Stage

As mitigation measure, it is recommended that sea transport should be used as far as possible for transportation of construction materials and plant to relieve the existing roads and railways from the additional burden. Construction material such as rock material must be carried into the site not through the Galle city but, via an alternative route.

5.19.1.2 Operation Stage

It is recommended to find alternative means (upgrading the railway system) of relieving the existing roads from the increased traffic during the operational stage. Railway option is much preferred as a long distance transport and for the local transport present road network must be greatly improved.

5.20 Galle Fort and the Landscape

5.20.1 The Galle Fort

If blasting is required during the construction a new technology must be used in order to minimize the vibration that could cause destruction to the Fort. Micro blasting is recommended over the macro-blasting and proper supervision should be provided to safe guard the structures of the Fort. If signs of collapse are felt, immediate rectifying actions must be taken with the consultation of Department of Archeology.

5.20.2 Landscape

The siting and design of the Port and its facilities should aim at improving the visual quality of the landscape, within engineering and site constraints. The following factors would contribute to the realization of the harmonious integration of the port with the existing landscape.

(i) The "profile" of the Port should seek similarity with the natural flowing forms.

(ii) The size of the individual elements in the design, the visual area they present, in particular their height, compaction and dispersion should not lead to the feeling of "congestion".

(iii) The sharpness of edges as perceived against background, particularly the skyline, should not be rough.

(iv) The placing of various elements of the design should be in relation to the foreground and background. Design should increase the absorption capacity of the landscape.

(v) The colour (hue, chrome and tone) & texture of various elements to be harmonious with the landscape.

(vi) Soft and hard landscaping should be used as a means of improving the harmony.

Most of the facilities in the Proposed Port are tall and the profile could be seen against the skyline, which creates a negative visual influence. This could be reduced to a grate extent by proper architectural designs with more thoughts to the aforesaid factors.

CHAPTER 06

MONITORING PLAN

6.1 Coastal Environment

This should be done at two levels.

i. Monitoring during construction to make sure all possible mitigatory measures are taken.

ii. Monitoring at the post-construction stage to identify the consequences of the project despite the mitigatory measures already taken,

Monitoring should be done on following potential areas of concern;

1. Toe erosion of harbor structures
2. Siltation at the harbor entrance and approach channel
3. Changes in shoreline beyond watering point
4. Changes in the shoreline at the eastern part of the bay in the basin
5. Changes in the shoreline near the yatch harbor at the western part of the bay
6. Displacement of armor blocks if any from coastal structures
7. Dumping grounds for change in bathymetry
8. Deterioration of coastal environment in neighboring areas
9. Salt water intrusion from river mouths open to the basin

6.2 Water quality of Galle bay

Elementary water quality parameters that have been measured in this study should be monitored at least once in six months. It should however, be noted that other than the regular monitoring programme, a contingency plan should be prepared on monitoring accidental spills, hazardous cargo and any other ad-hoc releases into the bay.

6.3 Sediment quality of Galle bay

Heavy metals, organo-chlorides and pesticides should be monitored in the sediments at least once in two years. Nevertheless, contingency plan must be prepared to monitor such parameters in the case of an accidental spill.

6.4 Point Sources of Pollution and their Water Quality

The monitoring of water quality within the Galle Bay area as proposed elsewhere in this report should be carried out. If the water quality in the Bay is deteriorating, the existing and any new point sources should be investigated.

6.5 Water Quality of Recreational Areas

Water quality in the old harbour area needs to be monitored for physical and chemical parameters including total suspended solids, turbidity, BOD and COD during the construction phase.

6.6 Noise Pollution

Monitoring of noise level at the point N6 to N9 is recommended, in order to check the increase in noise level due to the port expansion and related activities.

6.7 Air Pollution

Air quality should be monitored near the Port and in the city, for parameters shown in Table 3.11, in order to check any deterioration of the air quality in the vicinity of the project area.

6.8 Construction material such as metal and sand, and their availability

Monitoring of the quarrying activities would also need to be done as specified in the permits to make sure there is no over-exploitaion of resources.

6.9 Sewage, Drainage and Other Wastewater Systems

The adequacy of the infrastructure facilities should be monitored by regular surveys in the area.

6.10 Solid Waste Disposal

The solid waste collection and disposal should be monitored by regular surveys.

6.11 Hazardous Material and Ship Discharges

Monitoring of the water quality in the harbour area as recommended elsewhere in this report would indicate any pollution of the water due to spills.

6.12 Flora of Rumassala Cliff

No monitoring is required as the impacts are not significant.

6.13 Rumassala Coral Reef and its associated marine fauna

The monitoring programme should be carried out to include the three phases (i.e. pre-construction, during construction and operational). A study including the components in

Table 6.1 should be carried out prior to construction and thereafter a monitoring programme can be carried out as given in Table 6.1.

Table 6.1 Monitoring Program for coral reef at Rumassala

Activity	Construction	Operational
Photography of individual coral colonies over time to reveal sediment accumulation, smothering by invasive species, bleaching due to stress etc.	Once every 6 months	Annually
Monitor permanently fixed 1 sq.m. quadrats to measure coral recruitment and changes in community structure.	Once every 6 months	Once a year
Conduct belt surveys to determine fish species diversity and abundance	Once every 6 months	Once a year
Measure turbidity using a simple technique such as a Secchi Disk	Once a month	Once a month
Measure suspended particulate matter	Once a month	Once a month
Measure rates of sedimentation using sediment traps	Once a month	Once a month
Obtain water samples to measure changes in water quality	Once a month	Once a month

6.14 Maritime Archaeology

6.14.1 Introduction

A monitoring plan for a construction such as this project will, in reality, have to be worked out in consultation between the SLPA and the Archaeological Dept.

6.14.2 Monitoring plan during construction and operational phases

During the construction phase, a chosen archaeologist should be part of, or work with the construction team. He could report to the Ministerial monitoring committee on administrative matters and the Archaeological Dept. on technical matters. The site archaeologist should have access to all information and the ability to work on vessels involved in dredging and other activities and be given the opportunity to examine all material dredged from the bottom to assess their archaeological value. He should also be provided with the facility of examining the underwater sites from time to time to check on damage or degradation.

For the operational phase (i.e. after the port becomes operational) the Operators and the Archaeological Dept. should consider entering into a legally/administratively enforceable Agreement, and work out a programme of random and/or planned monitoring of the entire bay area, in relation to archaeological sites. Guidelines for this agreement will need be worked out before the operators take over the port.

In both the Antiquities Ordinance and the Treasure Trove Ordinance, which are very old pieces of legislation, and the much newer Cultural Property Act, it is very emphatically stated that all antiquities found in the territory of Sri Lanka is government property. There is very strong proof that persons of eminence as well as common thieves are pilfering antiquities from archaeological sites. Of importance is the fact that antiquities said to be from Site F had been sold in the USA by public auction. Therefore everything that is found on the Site during construction will have to be meticulously recorded and handed over to the Archaeological Dept. representatives.

The sites having high archaeological values needs to be demarcated. A possible method would be to place specially designed buoys, which will provide a visible barrier. This would be inexpensive and draw attention of ships entering the harbour to its historic importance. As these water are somewhat away from the existing channel, no navigational hazard will result from this.

6.15 Socio-economic parameters

A proper method of communication should be established with the fishermen organisations and the Harbour Master, so that information on the movement of ships could be disseminated to the seine owners and craft owners. Yet, proper and efficiently functioning fisheries organisation, such as a fisheries cooperative is not found in the *Dewata* fishing community. The District Fisheries Extension Officer of the Department of Fisheries and Aquatic Resources Development should be requested to initiate the formation of such an organisation among the fishermen in the *Dewata* region. The Harbour Master could then communicate with the relevant officials of this cooperative to inform them about the movement of vessels to and from the port. If credit facilities are to be granted to traditional fishermen in the area to mechanise their crafts (as indicated under methods of mitigation of impacts), such facilities could be extended to fishermen through this fisheries cooperative.

Such an organisational form will also facilitate in granting permission to fishermen to exploit the fish resources in the Dewata coastal waters.

Proper monitoring of the working-time zone is necessary. The working-time zone should be fairly flexible at the beginning and should be monitored well to allow for any changes forthcoming from disturbance to movement of fishing crafts.

6.15.1 Interfering with the movement and anchorage of yachts

Construction activities and sea traffic in respect of Alternative 4 will have moderate impacts on the movement and anchorage of yachts. If all yachts cease to arrive (about 155 per year), the annual loss of income would be significant. More than the income, it is the popularity of Galle port among yachtsmen in the world, which will be adversely affected, if yacht movements are greatly disturbed.

Working-time zone will have to be monitored during the months of January, February and March taking into consideration the movement of yachts.

Monitoring turbidity in *Unawatuna* and *Talpe* coastal waters will be required.

The Harbour Master should coordinate and monitor construction schedules of the port expansion project with cargo handling activities and vessel movement at the existing port.

6.16 Galle Fort and the Landscape

Vibrations in the Fort area must be monitored as and when necessary and be recorded for subsequent monitoring particularly during construction stage. It is advisable to draw the crack or cervices patterns that appear in structures and be monitored on a regular basis. The frequency of monitoring may change depending on the severity of the problem.

Vehicular movement particularly the truck loads of quarry metal must be monitored in order to get an idea of traffic congestion in the project area.

CHAPTER 07

CONCLUSION AND RECOMMENDATIONS

Various elements of the environment have been studies in detail. The impacts on some of the elements of environment are qualitatively assessed for all four alternatives and given in Table 7.1

Table 7.1 Degree of impact caused by all alternatives on environmental elements

Environmental Element	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Water quality of Galle Bay	L	L	L	L
Sediment quality of Galle Bay	L	L	L	L
Water quality of recreational activity area	L	L	L	L
Noise levels	L	L	L	L
Air quality	L	L	L	L
Availability of reclamation material (sea sand)	L	L	L	L
Sewage, drainage and other waste water systems	L	L	L	L
Solid waste disposal	L	L	L	L
Hazardous ship cargo during discharges	L	L	L	L
Flora of Rummassala	L	L	L	L
Coral reef and its associated fauna	M	M	M	L
Marine Archeology	L	L	L	H
Fishing Ground	L	M	M	L
Fishing craft movement	M	M	M	L
Tourism	L	L	L	L
Transportation of Quarry Products	M	M	M	M
Galle Fort	L	L	L	H
Overall evaluation	Good	Medium	Medium	Bad

Note: L - Low; M - Medium ; H - High

The study carried out in relation to environment issues suggested that alternative 1 is the most suitable and preferable alternative. It is recommended to adopt alternative 1 compared to other alternatives. (Fig. 7.1).

Since the present study conforms only to EIA guidelines given by JICA, rearrangement of this study to suit EIA process in accordance with CEA regulations should be done by SLPA in

consultation with Coast Conservation Department. In this context, this report could be made use as a supplementary document so that the repetition of experiments, tests and other surveys etc. could be avoided.

As the study has highlighted three major environmental issues (Table 7.1) mainly , Coral and its associated fauna, fish craft movement in the Dewata area and transport of quarry material, further investigation on these issues is highly recommended.

Finally, detail design of alternative 1 is recommended for the implementation of the project.

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ANNEX

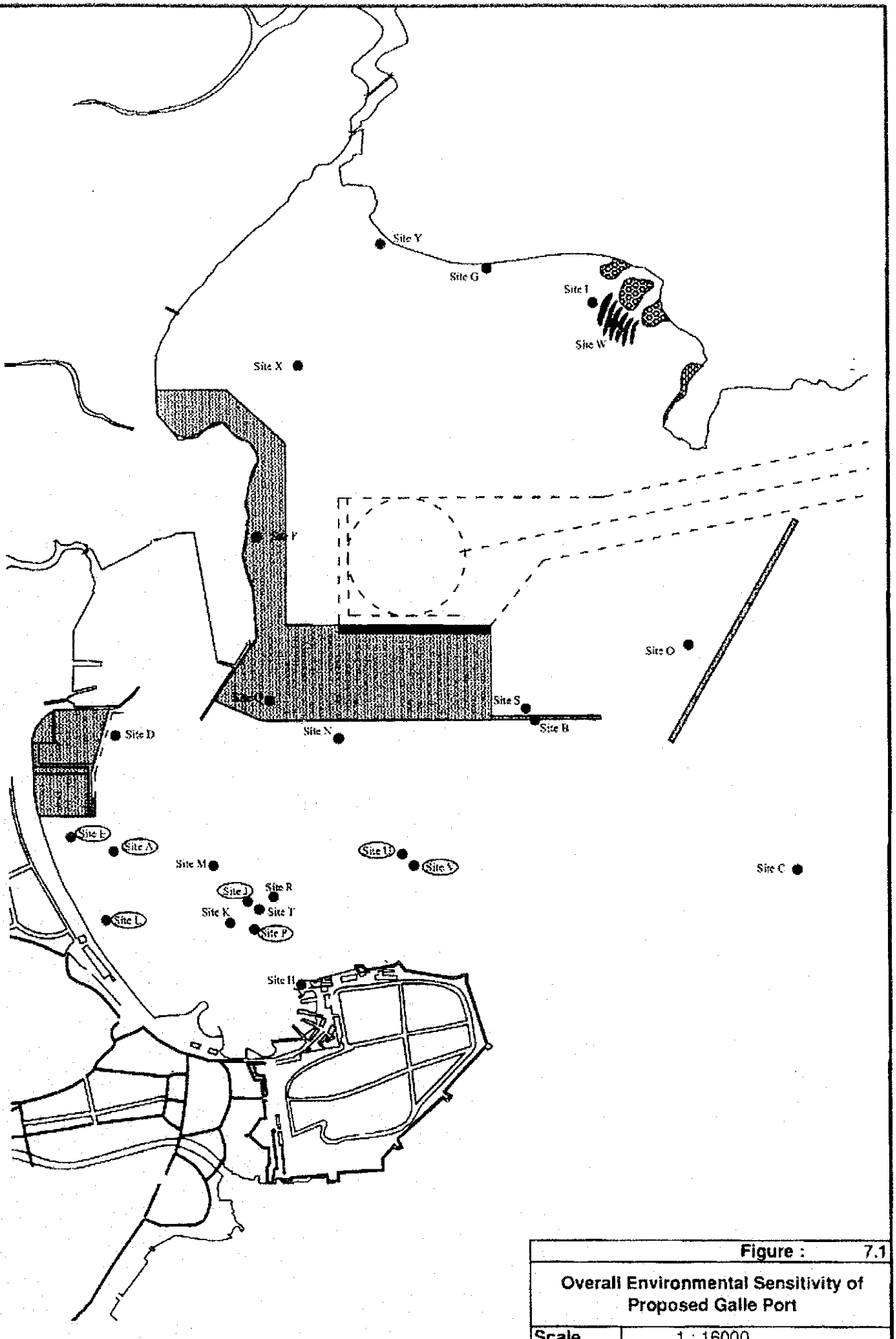
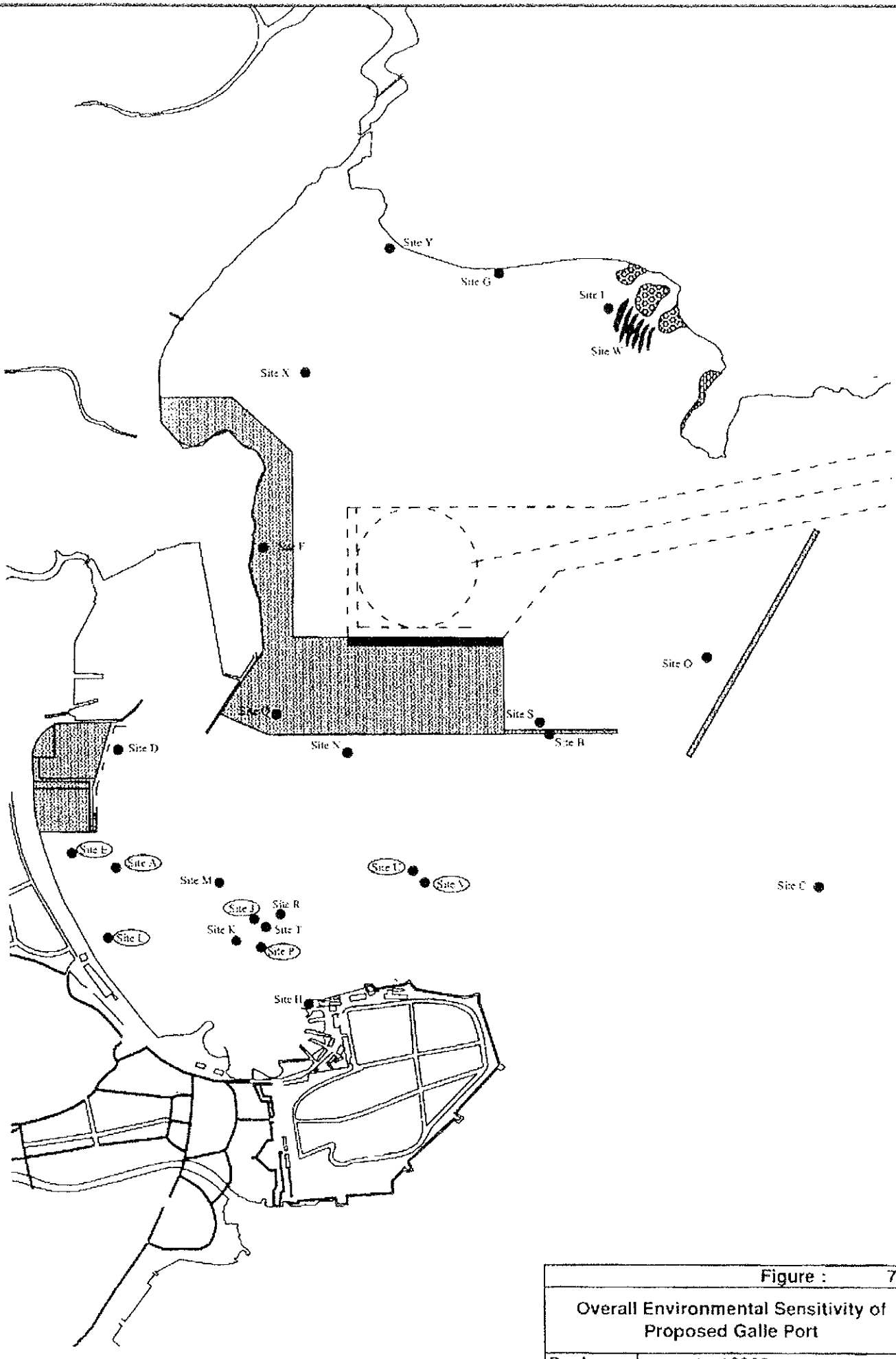


Figure :	7.1
Overall Environmental Sensitivity of Proposed Galle Port	
Scale	1 : 16000



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