Environmental Impact Assessment

PROPOSED DREDGING WORKS AT WEST HARBOUR, PORT ANTONIO, JAMAICA.

Submitted to

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EXECUTIVE SUMMARY

1. Purpose of Study

The Port Authority of Jamaica (PAJ) intends to increase the capacity of the deep-water harbour at West Harbour, Port Antonio, so as to allow for safer manoevouring of ships and to accommodate slightly longer cruise ships (228m length) at the Ken Wright pier. To do so it proposes to carry out the minimal amount of capital dredging required along the entrance channel and within the bay to improve navigational safety.

2. Proposed Project

The proposed dredging works are shown at Figure 1.

2.1. Channel

The dredging project intends to excavate the approach channel to give a bottom width of 92m (302ft), and minimum depth of 10m (33 ft). Most of the dredging will be done along the northern side of the channel near its mouth (Area H1), some along the southern side of the channel (Area H2), and a little on the north side at the point where the channel opens into the basin (Area S1).

2.2 Ken Wright Pier

A small amount of capital dredging will be carried out in the middle of the basin (Area S2), near the Ken Wright Pier, in order to safely accommodate the sterns of longer cruise ships.

2.3 Volumes and Types of Sediments to be Dredged

It has been estimated that a total of 50,000 cu.m. of dredged material will be generated by the proposed works, made up of the arisings from capital (about 35,000 cu.m.) and maintenance dredging (about 15,000 cu.m.).

2.3.1 Areas H1 & H2

The substrate to be dredged at Area H1 at the mouth of the approach channel is part of a submarine limestone ledge/plateau occurring at depths between 7 - 9m. This will require use of a cutter suction dredge for its removal and the dredged material will predominantly be made up of coarse cuttings.

2.3.2 Area S1

The materials to be dredged will be comprised of fine sediments, perhaps overlying some coarse material that may have slumped from the channel slope.

2.3.3 Area S2

The removal of sediments at Area S2 constitutes capital dredging since this is an area that has not previously been disturbed. The sediments to be dredged from this area are dark muds.

Figure 1. PAJ Port Antonio Dredging – Plan of proposed dredging works.

2.3.4 Sediment contamination

Owing to the absence of any industrial operations in the vicinity of Port Antonio, it is very unlikely that dredging at West Harbour would involve removal or dispersal of sediments contaminated by heavy metals.

2.4. Dredging equipment and methodology

2.4.1 Hydraulic cutter suction dredge

An HSCD is the most suitable type of equipment for dealing with the firm stony materials such as that which will be encountered in carrying out the proposed capital dredging of the stony ledge at the mouth of the channel.

2.4.2 Trailing suction hopper dredge

TSHDs are very frequently used to carry out dredging of loose materials and it is proposed to use such a vessel for the capital dredging of the muds at Areas S1 and S2 as well as for any other maintenance type dredging at West Harbour**.** The dredged material is placed in the hold or hopper on the vessel which then sails to the underwater disposal site and deposits the sediments by opening the bottom-opening gates of the hold.

2.5 Disposal of Dredged Materials

2.5.1 Disposal of fine sediments

It is proposed to dispose of the fine sediments dredged by the THSD at the 1000m contour line approximately 3km (1.8m) due north of Port Antonio (approximate coordinates: 76^{o} 27' W, 18^{o} 14' N). It is expected that the strong westerly flowing current (see Section 3.1.7.1 below) would effectively disperse the sediments with very little likelihood of them being washed ashore in any appreciable or unacceptable quantities. About 5 trips to the site by THSD would be required.

2.5.2 Disposal of coarse materials

There are two options for the disposal of the coarse material arising from capital dredging at the entrance channel. The preferred is to use a diffuser cone fitted to the HSCD to spread the relatively heavy material in a thin layer (<1m) over the sea floor at the entrance to East Harbour in depths of approximately 30m – 40m (see window insert at Figure 2.1). This material would not be re-suspended by wave action, including that during normal storm activity due to the depth. There are no known coral reef systems in this area that would be directly affected by sedimentation and the sediments would be expected to settle rapidly given their high specific gravity.

The second option considered for disposal of the coarse materials is for the HSCD to deposit the material on the seafloor near the channel mouth to be afterwards sucked up by THSD for disposal at the deep-sea site. However, the consulting engineers have advised that the relatively small amount of material involved would make it difficult for the THSD to locate, much less remove the material, given the uneven nature of the sea floor.

2.6. Duration of dredging works

The amount of dredging to be carried at West Harbour is considered to be a very minor operation. In terms of the capacity of the large dredging vessels currently available in Jamaica it

should not take the two dredges, working around the clock, more than two to three days to accomplish the task. Completion of the dredging works would be signaled by conduct of a post-dredging hydrographic survey to confirm conformance to the dredging design.

3. Summary of Potential Impacts

Those potential impacts relevant to the proposed project are:

Positive

1. Improved capacity of entrance channel and harbour to accept larger vessels.
2. Improved navigational safety in entrance channel.
3. Improved ship mooring space at Ken Wright Pier.
4. Increased foreign exchange earnings and economic activity related to increased cruise ship visits and tourism services.

Negative

1. Loss of < 2,600 sq.m. of coral community (Site H1) and benthic biota (Site H2) at entrance to channel.
2. Sedimentation and turbidity over coral and seagrass communities along approach channel and at Navy Island/Nose Point due to suspension and dispersal of fine sediments.
3. Medium term loss of biota at ~35,000m^2 disposal site for coarse dredged material at entrance to East Harbour.
4. Short-term impacts on pelagic environment due to suspended sediments and turbidity arising from deep-sea disposal of fine dredged material.
5. Hindered ship traffic due to dredging operations.

4. Impact Mitigation

The impact mitigation measures should entail:

1. Good dredging practice to minimise sediment suspension and dispersal at the dredging sites.
2. Deployment of a silt barrier across the eastern side of the Navy Island/Nose Point shallow reef community. The silt screen should extend southwards for 300m from a convenient point at the SW end of the Navy Island shoreline, approximately along the 6m contour.
3. Independent environmental monitoring of the project to ensure use of silt screens, disposal of dredged material only at approved sites, and compliance with turbidity standard over reef area. (Monitoring should include aerial overflight of first deep sea disposal trip confirm acceptable sediment dispersion at disposal area).
4. In consultation with the manager of Boundbrook Wharf, schedule dredging operations so as to avoid or minimise disruption of regular banana shipping.
5. Advise local residents and yacht persons, prior to commencement, of the intended dredging operations, associated noises, and duration of nuisances.

5. Conclusions and Recommendations

This EIA has been carried out on the basis that it is necessary to carry out capital and some maintenance dredging at West Harbour to increase the capacity of the approach channel to accommodate larger cruise ship vessels and to extend the berth space at Ken Wright Pier.

5.1 Conclusions

1. The substrate to be removed along the sides of the approach channel into West Harbour (Areas H1 and H2) is predominantly hard limestone material with some overlay of fine sediments.

2. Removal of the above substrate will result in the irreversible loss of small coral reef communities established on the rocky ledges.

3. The substrates to be removed within West Harbour at Areas S1 and S2 are comprised of soft grey muds not containing or supporting any significant biota.

4. The total amount of dredged material to be removed by the proposed dredging works is estimated at 50,000 cu.m., approximately made up of coarse rock cuttings (35,000 cu.m.) and of fine sediments (15,000 cu.m.).

5. Given the absence of any major industrial and on-going boatyard activity in the vicinity of Port Antonio it is unlikely that the dredged material will contain any significant levels of contaminants.

6. The remaining potential impacts of the proposed dredging works that have been identified are:
   a. suspension of fine sediments in the water column during dredging excavation that could result in deleterious turbidity and sedimentation over the shallow reef system between Navy Island and Nose Point;
   b. suspension of fine sediments in the water column during disposal of the fine sediments at the proposed deep sea disposal site; and
   c. smothering of any sessile biota on the sea floor by coarse dredged materials at the proposed disposal site at the entrance to East Harbour.

7. Given the very short duration of dredging works (2 – 3 days) and the levels of turbidity normally experienced in West Harbour after heavy rainfall events it is unlikely that the effects of suspended sediments and turbidity due to the proposed dredging project would cause intolerable impacts on the biota.

8. Satisfactory mitigation of these impacts identified at #6 above can be achieved by:
   a. properly controlled dredging operations and restriction to designated dredging sites to minimise sediment suspension;
   b. deployment of silt screens along the eastern face of the Navy Island/Nose Point shallows to prevent movement of any suspended sediments over the reef; and
   c. disposal of the fine sediments at deep water site where prevailing currents will disperse materials away from inshore habitats.

9. Fishing areas currently used by fishermen from the three fishing beaches around Port Antonio will not be adversely affected by dredging. The works will not be carried out in traditional fishing grounds, they will be of short duration, and any dispersal of suspended sediments will be contained within West Harbour.

10. It is possible to carry out the proposed dredging works at West Harbour without unacceptable adverse environmental effects.

11. There are no known plans for further dredging at West Harbour within the foreseeable future. It is also not likely that maintenance dredging will be required in the near future but note should be taken of the current levels of sediment deposition at the mouth of the Annotto River.

5.2 Recommendations

1. An investigation of proposed inshore disposal site for coarse materials is to be carried out to determine the nature of the benthic biota in that area and its suitability for dredged material disposal. The findings of the survey will be presented to NEPA by 17 June 2002. If the site is not suitable, then the coarse materials from the channel will be piled at its mouth and removed by the THSD for deep-sea disposal.
2. Implementation of the dredging works should conform to the mitigation methods and procedures outlined above at Section 7.1.
3. Hold consultations with PAJ, the consulting engineers, the dredging contractors and NEPA to detail best technology for monitoring programme, discuss/agree on compliance standards.
4. Consideration should be given of the present opportunity to remove at least some of the sediments at the mouth of the Annotto River. The river is a constant source of sediment input to the bay and the river delta is fairly rapidly encroaching into the West Harbour basin.

1. INTRODUCTION

1.1 Harbour Dredging and Environmental Impact Assessment

The Port Authority of Jamaica (PAJ) intends to increase the capacity of the deep-water harbour at West Harbour, Port Antonio, so as to allow for safer manoevouring of ships and to accommodate slightly longer cruise ships (228m length) at the Ken Wright pier. To do so it proposes to carry out the minimal amount of capital dredging required along the entrance channel and within the bay to improve navigational safety. Dredging would seek to achieve depths of up to 10m in the channel and 8.7m in the basin.

Dredging can be defined as the process of removal of submerged material from the seabed or from other water bodies by use of various types of excavation machinery. In the trade, dredging projects are categorized under three broad headings:

1. *Capital dredging* has the following features; relocation of large quantities of materials, compact and undisturbed soil, low contaminant content (if any), significant layer thickness, and non-repetitive dredging activity.
2. *Maintenance dredging* is the term used to describe the type of dredging that has to be carried out periodically in order to maintain sufficient depth for safe navigation in waterways used by floating craft. Maintenance dredging is therefore usually concerned with removal of loose sediments that have accumulated relatively recently.
3. *Remedial dredging* applies to the removal of contaminated material and is usually linked to the further treatment, reuse or relocation of such materials. This type of dredging does not apply to the present project.

Port and harbour development is on the prescribed list of development activities for which a development permit from the National Environment & Planning Agency (NEPA) is required. Given the potentially significant adverse environmental impacts associated with dredging, NEPA has requested the preparation and submission of an Environmental Impact Assessment (EIA) report to inform the permit application review process.

1.2 Project Rationale

Worldwide, cruise shipping is currently experiencing a period of substantial growth and the Caribbean has emerged as the world's most popular cruising area. Within this context, due to its inherent natural beauty and strategic geographic location, Jamaica is a favoured destination. However, Port Antonio, the cradle of tourism and cruise shipping in Jamaica, cannot accommodate the large mega-liners now entering the market owing to its physiographic constraints. On the other hand, it is excellently placed to exploit the smaller cruise ships and 'boutique' vessels that carry a comparatively smaller number of passengers but those placed at the higher end of the market. The existing Ken Wright Pier accommodates such cruise ships but the number of visits has declined dramatically over recent years.

Apart from cruise ships, Port Antonio is the major banana shipment port for Jamaica and fruit are exported on a regular basis by dedicated vessels from the nearby Boundbrook Wharf. In addition, the PAJ is presently completing a major port and waterfront development project at West Harbour. This includes the construction of new yacht marina capable of accommodating mega-yachts and an associated boatyard facility, and refurbishment of the existing cruise ship pier and the Port Antonio Marina. It is anticipated that West Harbour will become a major

destination for yachts sailing the Caribbean and that maritime activities in the port will increase commensurately.

For these reasons the PAJ wishes to improve the capacity of West Harbour to safely accommodate the expected increase in ship and small vessel activity and to allow for the safer manoevering of slightly larger cruise ships. At the present time, a suction cutter dredge and a hopper dredge are working in Jamaica at Kingston Harbour and will become available to undertake ancillary dredging works on the island for a limited period of time after June 2002. The PAJ is seeking to have the limited amount of dredging that is required for port improvement at West Harbour to be done at this time.

1.3 Execution of the EIA

This EIA was carried out by Environmental Solutions Ltd. The multidisciplinary team engaged to carry out the assessment included local expertise in environmental impact assessment, coastal engineering, oceanography, marine and coastal ecology, environmental chemistry, and socio-economics. The team members were:

- ◊ Mr. Peter Reeson, M.Sc. - EIA Specialist and Team Leader
- ◊ Mr. Cowell Lyn, M.Sc. - Coastal Engineer
- ◊ Mr. David Narinesingh, M.Sc. – Oceanographer and Ecologist
- ◊ Mr. George Campbell, M.Sc. – Socio-economist
- ◊ Mrs. Sharonmae Shirley – Environmental Chemist

1.4 Study Area

The area encompassed by this study is shown at Figure 1.1. It primarily focuses on that coastal marine area that could potentially be directly affected by the dispersal of suspended sediments generated by the proposed dredging works. This includes West Harbour and the ship channel between Titchfield Hill and Navy Island, as well as Bryan's Bay to the west.

The study also considers the implications of dredging on activities currently taking place within and on lands immediately surrounding West Harbour. Particular attention was paid to the activities of fishers operating from the three fishing beaches in Port Antonio (see Section 3.3.3) and to the schedule of banana boat shipping in the bay (see Section 3.3.6.4).

Note was also taken of the fact that Port Antonio is situated within the boundaries of the proposed Port Antonio Marine Park (see Section 3.2.3).

1.5 Terms of Reference

The TOR for the EIA of the proposed dredging works is provided at Appendix 1. They were adapted from World Bank and NEPA environmental assessment guidelines and make reference to NEPA *Guidelines for the Planning and Executing of Coastal and Estuarine Dredging Works and Disposal of the Dredged Materials.* The TOR also address specific NEPA requirements for this EIA as given in letters to PAJ dated 21 February 2002 and 8 April 2002 and were approved by NEPA in letter dated 10 June 2002.

Figure 1.1 PAJ West Harbour Dredging EIA - Study area and site location map.

It is to be noted that this EIA is solely concerned with the proposed dredging works in West Harbour. It is the intention of the PAJ to carry out a separate EIA, if required, of any plans for improvements of the Ken Wright Pier when these have been completed.

1.6 West Harbour port facilities

Port Antonio has two bays, East and West Harbours. Whereas East Harbour is the more spacious and directly accessible, it is very open at the mouth to the extent that heavy incident waves and swells from the north are persistently able to penetrate into the bay, especially during the months of December to March. This makes the bay unsuitable for use as a deepwater harbour. No doubt the much better-sheltered conditions inside West Harbour were the most compelling factor that caused the late nineteenth century entrepreneurs, who started the Jamaica banana export trade, to locate their shipping dock inside West Harbour, rather than at East Harbour.

In this context it bears mentioning that during the early stages of the modern Caribbean cruise shipping in the late 1960's, a cruise ship pier and onshore terminal facilities were built near Folly Point, just at the entrance of East Harbour. However, the cruise ship operators of the day felt that sea conditions at that location were persistently too rough for berthing their vessels, and they never utilized the facilities. Within a few years after construction, seasonal 'northers' and hurricanes completely destroyed the pier trestle and the landing platform. Presently, two badly deteriorated breasting dolphins are the only elements of the rejected berthing facilities still visible at the site (Plate 1.1).

1.6.1 Ship piers

There are three functional ship docks at West Harbour; the Ken Wright Cruise Ship Pier, Boundbrook Wharf and the smaller Marine Police/JDF Coast Guard pier. The latest PAJ handbook gives the capability ratings for the two larger docks, as provided below.

i. *Ken Wright Cruise Ship Pier*
Built in 1976 and located on the western side of the Titchfield Peninsula (Plate 1.2), it accommodates vessels of up to 167m, (550 ft.) length with maximum draughts of 7.9m (26ft.). The terminal has just been renovated and a small recreational beach developed on adjacent land as part of the PAJ West Harbour Development Project (Plate 1.3).

ii. *Boundbrook Wharf*[1]
Located at the southern side of the bay, opposite to Navy Island (Plate 1.4), it is rated for safe accommodation of vessels up to 167m (550 ft.) in length with maximum draughts of 7.9m (26ft.). It was most recently up-graded in 1992 to improve the efficiency of load-out of agricultural products from the region, but also in the hope of attracting more cruise ship calls to the port.

iii. *Marine Police/JDF Coast Guard Pier*
Situated in front of the new Marine Police/JDF Coast Guard station at the eastern side of the bay, this is a new steel-piled dock with concrete superstructure designed to accommodate vessels of the size currently used by the coast guard (Plate 1.5).

[1] T*he present location of Boundbrook Wharf is believed to have been the site of the very earliest dock built at Port Antonio (late nineteenth century) for ocean-going vessels.*

1.6.2 Marinas

There are now two marinas at West Harbour, the second one having just been constructed as part of the PAJ's West Harbour Development Project.

i. *Port Antonio Marina*
Located immediately west of the mouth of the Annotto River (Plate 1.6), the marina hosts the annual Port Antonio Blue Marlin Tournament. The old wooden pier has recently been replaced by a steel-piled pier with a concrete superstructure. Several local deep-sea fishing charter boats moor at the facility, which also caters to visiting yachts, particularly outside of the hurricane season. Associated with the marina is the wooden *Joe Keiffer Dock* (Plate 1.7).

ii. *Port Antonio Yacht Club and Marina*
Located on the western and lee side of Titchfield Hill and adjacent to the Ken Wright Pier, this is a new state-of-the-art facility (Plates 1.8 & 1.9) constructed by the PAJ and intended to attract the mega-yacht market to Jamaica. The steel-piled pier with concrete superstructure can accommodate up to 30+ yachts of varying sizes.

1.6.3 Boatyard

Situated immediately west of the Boundbrook Wharf, this is also a new facility built to complement the new marina. Presently under construction, it will have a travel lift and a ramp for bringing boats onshore for maintenance and outfitting purposes (Plate 1.10). It will also have refueling depot.

1.7 Methodology

1.7.1 Sediment and marine benthic survey

The sediments at eight stations (GS1 - GS8) was sampled using a 0.25 m^2 Van Veen grab on June 4, 2002. These stations are shown in Figure 1.2. The sediment was collected within zip-lock plastic bags and a simple qualitative examination of the eight samples was subsequently conducted to determine the presence of above-substrate and within-substrate marine flora and fauna. Sediment colour, smell, and particle size were described.

Sediment depth was determined by physical probing of the substrate at each station using SCUBA.

Seagrass communities and coral reefs at the entrance of the approach channel and within West Harbour were assessed by a combination of boat patrolling, exploratory grab sampling and underwater visual observations.

1.7.2 Water currents

Drogue tracking was conducted in West Harbour on June 4, 2002. Three drogues, with sails set at 2m below water surface, were deployed and their movement tracked with a GPS instrument. The drogue tracks are shown at Figure 3.5.

Figure 1.2 PAJ Port Antonio Dredging - Locations of sediment and water quality sampling stations.

1.7.3 Water quality

The water quality data presented at Section 3.1.9 is summarised from the more recent data collected during the on-going PAJ Marina Monitoring Project being conducted by ESL. Six stations within the bay at West Harbour (see Figure 1.2) are regularly sampled. The parameters measured are: salinity, pH, temperature, total suspended solids (TSS), turbidity (Secchi disc), dissolved oxygen (DO), biological oxygen demand (BOD_5), nitrates, phosphates, total and faecal coliform bacteria.

Samples were collected at a depth of 0.5m. from a small boat. All samples were collected in pre-cleaned 2 litre polyethylene sample bottles and placed on ice. Bacterial samples are collected at the water surface in sterilized 100ml glass bottles.

Salinity, temperature, and dissolved oxygen were measured *in situ* at all sampling stations using a YSI Model 57 Salinity/Conductivity/Temperature (SCT) meter and YSI Model 33 Oxygen meter respectively. Measurements were taken at the surface (0.5m depth) of the water column.

Environmental Solutions Limited Laboratory performed or supervised the analysis of all parameters. Laboratory analyses used certified methodology, primarily from the text *'Standard Methods for Examining Water and Wastewater'*.

1.7.4 Community interviews

Fishing activities are those most likely to be directly affected by the proposed dredging works. Interviews were conducted with members of the fishing communities associated with the three fishing beaches located at Port Antonio in order to ascertain their perceptions of the impacts related to dredging. The beaches were at East Harbour, West Harbour (Upper Bryan's Bay/Keiffers Dock), and Lower Brya'ns Bay. The interviews were guided by a questionnaire comprising 16 questions.

2. PROPOSED DREDGING PROJECT

Available records show that the channel into West Harbour was last dredged in 1938. This was reportedly done using a bucket dredge. The *Notice to Mariners No.1 (1938),* shown at Appendix 2, indicates that at that time the channel was dredged to a minimum depth of 30 feet (9.1m) with a bottom width of 280 feet (85m). At the completion of dredging, the bearing of the centerline of the channel was given as 248^0 31' (see portion of 1938 British Admiralty Chart # 458 reproduced in Appendix 3). The 2001 British Admiralty Chart # 458 gives the bearing of the centerline of the West Harbour approach channel as 248^0 47', which for all intents and purposes, may be regarded as being the same as the bearing of the 1938 centerline.

2.1 Dredging Plan

The original project brief provided by PAJ for the EIA is shown at Appendix 3. These initial design considerations have since been refined by the consulting engineers and the proposed dredging works are shown at Figure 2.1.

Figure 2.1 PAJ Port Antonio Dredging – Plan of proposed dredging works.

2.1.1 Channel

The proposed dredging project intends to excavate the approach channel to give a bottom width of 92m (302ft), and minimum depth of 10m (33 ft). The recent hydrographic chart prepared in September 2001 by the Survey Department shows that very little dredging will have to be done inside the channel, in order to satisfy that objective. Most of the dredging will be done along the northern side of the channel near its mouth (Area H1), some along the southern side of the channel (Area H2), and a little on the north side at the point where the channel opens into the basin (Area S1).

2.1.2 Swinging basin

The diameter of the ship turning area has been increased from 300m (984 ft) to 350m (1230 ft) without any dredging being required.

2.1.3 Ken Wright Pier

A small amount of capital dredging will be carried out in the middle of the basin (Area S2), near the Ken Wright Pier, in order to safely accommodate the sterns of longer cruise ships.

2.2 Volumes and Types of Sediments to be Dredged

It has been estimated that a total of 50,000 cu.m. of dredged material will be generated by the proposed works, made up of the arisings from capital (about 35,000 cu.m.) and maintenance dredging (about 15,000 cu.m.). There are no borehole data available to definitively characterise the substrates to be dredged in West Harbour.

2.2.1 Areas H1 & H2

The substrate to be dredged at Area H1 at the mouth of the approach channel is part of a submarine limestone ledge/plateau (see Section 3.2.2.1) occurring at depths between 7 - 9m. This will require use of a cutter suction dredge for its removal and the dredged material will predominantly be made up of coarse cuttings.

2.2.2 Area S1

The grab sample of the substrate at this site revealed that the materials to be dredged will be comprised of fine sediments, perhaps overlying some coarse material that may have slumped from the channel slope.

2.2.3 Area S2

The removal of sediments at Area S2 constitutes capital dredging since this is an area that has not previously been disturbed. Based on the inspection of the two sediment grab samples taken during the present field study and on those collected in 2001 during the EIA study for the new marina development it can confidently be assumed that the sediments to be dredged at Area S2 will be dark muds. The experience gained during the recent reclamation of the West Harbour shoreline and the reports of local fishers lends credence to this.

2.2.4 Sediment contamination

Although dredging and spoil disposal has the potential to reintroduce and redistribute toxic chemicals deposited in the sediments into the water column, owing to the absence of any industrial operations in the vicinity of Port Antonio, it was decided at the outset of the EIA study not to carry out chemical determinations for potential contaminants in the harbour sediments. It is very unlikely that dredging at West Harbour would involve removal or dispersal of any sediments contaminated by heavy metals.

2.4 Dredging equipment and methodology

2.4.1 Hydraulic cutter suction dredge

An HSCD (Figure 2.2) is the most suitable type of equipment for dealing with the firm stony materials such as that which will be encountered in carrying out the proposed capital dredging of the stony ledge at the mouth of the channel. Hydraulic dredgers use centrifugal pumps to provide the digging and lifting force to "suck up" excavated seabed material in slurry form. HCSDs have "cutter heads", fitted with tough metal teeth, that rotate and bore into the seabed material, thereby enhancing the effectiveness of the suction force. HCSDs remain stationary while excavating, supported on legs called "spuds" which anchor them in position. The cutter head does its digging supported at the tip of the dredge's "ladder", at the end of the suction pipeline. The ladder is swung from side to side in small arcs while digging, leaving a characteristic scalloped pattern to the edges of the dug out areas.

2.4.2 Trailing suction hopper dredge

TSHDs (Figure 2.3) are very frequently used to carry out dredging of loose materials and it is proposed to use such a vessel for the capital dredging of the muds at Areas S1 and S2 as well as for any other maintenance type dredging at West Harbour**.** TSHDs are self-propelled ships that can have either one or two tubular "drag-arms" extending from the side(s) of the vessel down into the water, with the tips of the tubes kept close to the sea floor of the area to be dredged. By hydraulic suction, the sediments are sucked up from the bottom of the sea floor through the drag arms and placed in the hold or hopper on the vessel. The TSHD slowly traverses the area to be dredged, trailing its drag-arm and sucking up loose sediments until the hold of the ship is filled to capacity. The vessel then sails to the disposal site and deposits the sediments by opening the bottom-opening gates of the hold.

2.4.3 Environmental factors related to dredge type

Table 2.1 lists the relevant environmental considerations related to the types of dredge vessel currently available in Jamaica to implement the proposed dredging at West Harbour.

2.4.4 Specifications of available dredging vessels

The specifications of the two dredging vessels currently available in Jamaica are given in Table 2.2. In terms of their dimensions and power capacities both of these vessels are capable of satisfactorily carrying out the scope of dredging works for West Harbour.

2.5 Disposal of Dredged Materials

2.5.1 Disposal of fine sediments

It is proposed to dispose of the fine sediments dredged by the THSD at the 1000m contour line approximately 3km (1.8m) due north of Port Antonio (approximate coordinates: 76^{o} 27' W, 18^{o} 14' N). It is expected that the strong westerly flowing current (see Section 3.1.7.1 below) would effectively disperse the sediments with very little likelihood of them being washed ashore in any appreciable or unacceptable quantities. About 5 trips to the site by THSD would be required.

2.5.2 Disposal of coarse materials

There are two options for the disposal of the coarse material arising from capital dredging at the entrance channel. The preferred is to use a diffuser cone fitted to the HSCD to spread the relatively heavy material in a thin layer (<1m) over the sea floor at the entrance to East Harbour in depths of approximately 30m – 40m (see window insert at Figure 2.1). This material would not be re-suspended by wave action, including that during normal storm activity due to the depth. There are no known coral reef systems in this area that would be directly affected by

Figure 2.2 Drawing of a hydraulic cutter suction dredge.

Figure 2.3 Drawing of a trailing suction hopper dredge.

Table 2.1 Comparison of environmental factors related to type of dredge vessel (based on Smits (1998))

Environmental Effects Criteria	Cutter Suction Dredge	Trailing Suction Hopper Dredge
Accuracy of excavated profile	Good (about 25 cm).	Low (0.5 – 1 m vertically, 3 – 10 m horizontally).
Increase of suspended sediments	Variable (depends on ladder swing speed & cutter head rotation speed).	Low at draghead. Can be high at dredge site if loading continues with overflow of excess water. Pronounced in case of fine sediments.
Mixing of different soil layers	Depth of sediment should be greater than size of cutter head.	Accurate control achievable.
Creation of loose (mobile) spill layers	Tendency to leave thick spill layer in soft sediments.	Little residual spill layer at draghead. Larger spill layer if large quantities of overflow allowed.
Dilution	Variable amount of water added depending on sediment type.	Significant amounts of water added during suction process.
Noise generation	High (100 – 115 dB in immediate vicinity, 50 – 70 dB at few hundred meters).	High (100 – 110 dB in immediate vicinity. 50 – 70 dB at few hundred meters).
Normal output rate	50 – 5,000 m^3/hr.	200 – 10,000 m^3/hr

Table 2.2 Specifications of dredging vessels.

	'Leonardo da Vinci'	'Cristoforo Colombo'
Length overall	121.49m	115.5m
Breadth	22.4m	22.2m
Draught	5.18m	4.5m
Loaded draught	N/A	8.32m
Hopper capacity	N/A	5,750 / 7,000 m^3
Dredging depth	30m	35.5m
Suction pipe diameter	900mm	1,000mm
Discharge pipe diameter	900mm	900mm
Cutter power	6,000 HP	N/A
Propulsion	2 x 6,600 HP	2 x 5,425 HP
Total installed diesel power	27,524 HP	14,750 HP
Complement	41 persons	37 persons
Year built	1986	1994

sedimentation and the sediments would be expected to settle rapidly given their high specific gravity.

The second option considered for disposal of the coarse materials is for the HSCD to deposit the material on the seafloor near the channel mouth to be afterwards sucked up by THSD for disposal at the deep-sea site. However, the consulting engineers have advised that the relatively small amount of material involved would make it difficult for the THSD to locate, much less remove the material, given the uneven nature of the sea floor.

2.6 Duration of dredging works

The amount of dredging to be carried at West Harbour is considered to be a very minor operation. In terms of the capacity of the large dredging vessels currently available in Jamaica it should not take the two dredges, working around the clock, more than two to three days to accomplish the task.

Completion of the dredging works would be signaled by conduct of a post-dredging hydrographic survey to confirm conformance to the dredging design.

3. PROJECT SETTING

3.1 Physical Environment

3.1.1 Geomorphology and Bathymetry

West Harbour is well protected, enclosed as it is by Navy Island, the Titchfield Peninsula, and the fringing reef between Nose Point and Navy Island (see Figure 1.1).

The western approach to the harbour is, for the most part, blocked by a 200 m - 500 m wide fringing reef, which has a reef crest approximately 0.2 m beneath water level. A single manmade (?) channel (i.e. Hog Channel), approximately 75 m wide, 300 m long and 7 m deep, divides this fringing reef in the northwest. Local fishermen (in 25 ft. canoes) are the only users of this approach to West Harbour.

The eastern entrance to West Harbour is located to the northeast, between Navy Island and the Titchfield Peninsula. Cruise ships, cargo vessels and yachts use this eastern approach to enter the harbour. The middle of the channel at the centre line varies between 11m - 15m in depth.

With the exception of waters close to the shoreline, water depths in the middle and most of the harbour are typically between 7 m and 12 m.

3.1.2 Marine Substrates

The majority of the sediment samples collected during the June 4, 2002 marine survey (see Figure 1.2) suggest that the bottom sediments in West Harbour are comprised of a muddy layer more than 1m thick. The collected sediments were all light to dark brown in colour, odourless and did not contain any obvious above- or within-substrate marine flora or fauna.

The exception to these observations was the sample collected at Station GS1, located at the entrance of the channel to West Harbour. This sample contained terrigenous sands, coralline/shell fragments and *Halimeda sp.* chips, which generally had diameters between 1mm and 10mm. About half of the GS1 sample contained the same brown muddy sediments found at

the other sampling stations. Physical probing at GS1 revealed that the sediment layer there was less than 15cm deep with a hard underlying substrate.

3.1.3 Climate

The parish of Portland has the highest levels of rainfall in Jamaica. The annual average rainfall over the Rio Grande catchment is 5,074mm, while in the town of Port Antonio, the average is 3,082mm. Most precipitation occurs on the steep northern slopes of the Blue Mountains, but the lower slopes and coastal plain have almost daily showers. Rainfall generally occurs in short heavy bursts, followed by clear bright skies (Louis Berger International, Inc., 1996).

Thirty-year mean climatic data for Port Antonio (1951 to 1980) show that rainfall occurs throughout the year with distinct seasonal variations and three peak periods in January (224 mm), June (339 mm) and November (359 mm). Mean monthly maximum and minimum temperatures, recorded over the same time period, indicate a maximum temperature of 31^{o}C in June, July and August and a minimum temperature of 19^{o}C in February. Relative humidity ranges from 75% to 88% in Port Antonio, with the highest readings being obtained in the afternoons (Louis Berger International, Inc., 1996).

3.1.4 Wind

SWIL (1996) report that wind conditions for the Caribbean Islands are dominated by trade winds which blow across the southern part of the North Atlantic Ocean (south of the Azores high pressure area). These winds approach with great constancy, primarily from the northeast and southeast directions. Some seasonal changes occur within this pattern, as a result of the relative position of the sun and the earth s surface. In general, these seasonal changes in the annual wind regime may be described as follows:

a. December to February: Winds are primarily from the NE to ENE.
b. March to May: Winds are mainly from the East.
c. June to August: Winds are primarily from the E to ESE.
d. September to November: Winds are mainly from the E to SE.

Wind speeds are also influenced by the location of the Inter-tropical Convergence Zone, or ITCZ. The ITCZ is formed as a result of the convergence of north-east and south-east winds in a belt around the equator. This belt migrates north and south of the equator, in tandem with the sun s motion. Since the ITCZ is characterised by wind uplift (as a result of convergence), surface wind speeds tend to be low in the vicinity of this feature. The ITCZ is closest to the Caribbean Islands between June and November. These months, therefore, have the lowest average wind speeds, compared with the rest of the year (SWIL, 1996).

Specific to Port Antonio, winds velocities tend to be uni-directional and are generally, during the day, predominantly from the E and ESE at speeds between 10 m/s and 20 m/s. During the night, the winds are weaker and are predominantly from the SSW at speeds between 3 m/s and 10 m/s. Mean wind speed in Port Antonio is typically 9 m/s (17 knots) with maximum winds speeds as high as 30 m/s (58 knots) (SWIL, 1996).

3.1.5 Waves

Given the extremely well protected nature of West Harbour, the prevailing wave and swell wave climate does not result in waves greater than 0.25 - 0.5m in West Harbour on a regular basis (ESL, 2001). This is supported by information gathered from interviews with local fishermen during a survey carried out in February 2001. Observations made during the marine survey at that time revealed that 1 - 1.5m waves breaking on the windward side of the Nose Point/Navy

Island fringing reef were dampened and reduced to wavelets less than 0.3m in height behind the reef crest (ESL, 2001).

However, swells and waves generated by severe tropical storms have been reported to have caused severe coastal damage in both West and East Harbours in the past. Waves several feet high were observed during Hurricane Allen in 1980 (ESL, 2001).

3.1.6 Tides

During the Louis Berger International, Inc. (1995) Port Antonio Sanitation Study, tidal elevation data at the Port Antonio Ken Wright cruise ship pier was collected over the period August 1995 to August 1996 (SWIL, 1996). They reported that tides within West Harbour were semi-diurnal with a tidal range of 0.5 m.

3.1.7 Currents

3.1.7.1 Offshore Deep-water Currents

Apart from a very general and brief description of north coast currents within the Admiralty Pilot (1971), no long-term measured current velocity information exists for deep-water currents offshore of the northeastern coastline of Jamaica. That document states that "the currents along the N coast of Jamaica set W at ½ to 1½ knots (0.257 m/s to 0.514 m/s), depending upon the force of the wind. Occasionally this set is reversed by weak currents that occur most frequently during the moon's second quarter" (Admiralty Pilot, 1971).

Deep water currents, offshore of Port Antonio beyond the 1000 m depth contour, are believed to be similar (in speed and direction) to the westward (0.257 m/s to 0.514 m/s) ocean currents described by the Admiralty Pilot (1971).

3.1.7.2 Inshore Coastal Currents

No long-term measured (e.g. current meter) data exists for West Harbour and the little that is known about the current patterns in the harbour are extrapolations based on offshore Caribbean oceanic circulation and offshore numerical model simulations conducted by SWIL in 1995 and 1996 (SWIL, 1996).

Simulations and results of the SWIL (1996) two-dimensional finite element numerical model were based upon current meter data from a single SensorData SD6000 current meter; moored approximately 1km northwest of Navy Island (between 95-09-27 and 95-10-11). This moored current meter reported an average current speed of 6 cm/s towards the SSE (144^{o}), representative of prevailing shallow water coastal current velocities immediately offshore of Port Antonio.

Figures 3.3 & 3.4 show typical rising tide and falling tide flow predictions from the SWIL (1996) two-dimensional model runs. The model's horizontal resolution of West Harbour was coarse and circulation patterns and features within West Harbour were moderately or poorly resolved. Nevertheless, the figures represent possible general circulation patterns within the harbour. These predictions, however, should be applied cautiously and probably need further field verification and re-runs using a higher resolution mesh.

The predictions suggest a residual northeastward flow pattern, particularly within the harbour entrance channel, on both the rising and falling tidal stages and this pattern is confirmed by

Figure 3.3 Predicted surface current flows on a rising tide (Taken from SWIL, 1996).

Figure 3.4 Predicted surface current flows on a falling tide (Taken from SWIL, 1996).

some fishermen. However, the experience and observations of yachtsmen regarding surface water circulation within West Harbour suggest that the residual flow direction on both the rising and falling limbs of the tide is actually in the opposite direction; i.e. southwestward into the harbour (between Navy Island and the Titchfield Peninsula), westward across the north side of the basin, and hence through Hog Channel to rejoin the main offshore flow north and northwest of Navy Island. This apparent contradiction between observed/local knowledge of circulation within West Harbour and the SWIL (1996) model is believed to be primarily due to the fact the model does not adequately resolve the real-world morphology and bathymetry of Hog Channel and the latter's constraint on flows in a southeasterly direction.

SWIL's ADCP and drogue tracking results probably give a better indication of the general overall current speed and direction within West Harbour than does their two-dimensional model. ADCP and drogue tracking results (SWIL, 1996) suggest that during a rising tide condition, average current speeds within West Harbour are 0.05 - 0.08m/s in a 250^{o} (WSW) direction. During a falling tide, the results suggest similar average current speeds of 0.05 - 0.08m/s, within the harbour, this time in a 70^{o} (ENE) direction.

The results of the drogue tracking exercise, conducted on June 4, 2002 for the present EIA, are comparable with the reported findings of SWIL's ADCP/drogue studies. Figure 3.5 shows the measured drogue tracks overlaid on the UK Hydrographic Office (1995) Admiralty Chart # 458.

The June 2002 drogue study suggests that a fast 0.232m/s southwestward current flows into West Harbour between Navy Island and the Titchfield Peninsula. The outward flow is northwestward through Hog Channel at an average speed of 0.087m/s where it rejoins the main inshore flow northwest of Navy Island. These findings support the description of residual circulation within West Harbour suggested by local yachtsmen. Their observations and the June 2002 drogue tracking exercise also appear to agree on the fact that circulation within the southeastern corner of West Harbour is negligible and probably characterised by a weak clockwise eddy with "dead-zones" at its center. Average current speeds measured in this area during the 2002 study were less than 0.010 m/s.

3.1.8 Surface drainage

The Annotto River and thirteen drains empty into West Harbour. These are contaminated with sewage and carry large amounts of solid waste, including sediments, from the surrounding watersheds and urban areas. During periods of heavy rainfall visibly high levels of turbidity are caused in the inner basin of the bay as a result of these discharges.

3.1.9 Marine water quality

The maximum and minimum values of the data generated by the water quality monitoring exercises conducted in Port Antonio on 20/09/01, 8/11/01, 6/12/01, 24/01/02, and 18/04/02 are presented in Table 3.1. Although other parameters were also routinely measured, only the data for the seven critical pollution indicators are tabulated and discussed for the purposes of this document. In general, the results show that, with the exception of faecal coliform bacteria, the levels of the other five parameters did not vary considerably over the period.

Figure 3.5 Tracks of surface drogues set on 4 June 2002.

Table 3.1 West Harbour water quality data – maximum and minimum values for measurements taken between September 2001 and April 2002.

PARAMETER	STATIONS						NEPA STANDARD
	PM 1	PM 2	PM 3	PM 4	PM 5	PM 6	
BOD (mg/l)	0 - 9	0 - 2	1 - 10	2 - 7	0 - 2	1	0.57 – 1.16
Faecal coliform*	<3 - 21	<3 - 4	<3 - 2400	<3 - 460	<3 - 4	4	<2 - 13
TSS (mg/l)	1.33 – 1.73	1.20 – 1.63	0.93 – 2.10	1.70 – 2.30	0.73 – 1.60	1.90 – 2.00	10
Nitrate (mg/l)	0.12 – 0.43	0.27 – 0.41	0.06 – 0.55	0.14 – 0.38	0.04 – 0.43	0.20 – 0.01	0.001 – 0.081
Phosphate (mg/l)	0 – 0.14	0 – 0.01	0.01 – 0.03	0 – 0.14	0 – 0.01	0 – 0.01	0.001 – 0.055
DO (mg/l)	6.13 – 9.96	5.55 – 6.58	3.30 – 7.28	4.30 – 6.28	4.81 – 7.60	6.13 – 6.79	4.5 – 6.8

* MPN/100ml

- ***Biochemical oxygen demand***

BOD levels ranged from 0 to 10, and were on average between 1 and 2.6 mg/l for stations PM1, PM2, PM5 and PM6. Stations PM3 and PM4 averaged 4.6 and 3.2 mg/l respectively, values greater than the recommended water quality standard. These two stations were the only stations where BOD levels regularly exceeded 3 mg/l on individual trips. The data indicate that the waters at Station PM3, in particular, and to some extent at Station PM4, are continuously stressed.

- ***Faecal coliform bacteria***

Faecal coliform levels behaved similarly as BOD over the period. Coliform levels at stations PM1, PM2, PM5 and PM6 were within the recommended standard. Stations PM3 and PM4 consistently showed significantly high levels. The data confirms that Station PM3 and PM4, which receive direct discharge from drains originating in the town, are being impacted significantly.

- ***Total suspended solids***

Levels of total suspended solids (TSS) were fairly constant between 1.5 and 1.9 mg/l and fall below the NEPA's proposed standard of 10mg/l for waters near coral reefs. However, it should be noted that the levels of turbidity in the inner basin at West Harbour are high after heavy rainfall periods due to drainage outflows. It is unlikely that any turbidity caused by the proposed dredging operations over a two to three day period would have an adverse impact exceeding the naturally occurring conditions at West Harbour.

- ***Nitrate and phosphate***

Nutrient levels were also fairly constant over the period. Nitrate levels ranged from 0.24 to 0.3 mg/l (3.7 to 4.6 uM). Phosphate levels on the other hand ranged from 0 to 0.06 mg/l (0 – 2 uM). Nutrient levels consistently exceed national standards and highlight the poor quality of inshore waters at Port Antonio.

- ***Dissolved oxygen***

Dissolved oxygen data indicate that the waters are well oxygenated. This is an improvement on the readings taken during the fieldwork for the EIA (January 2001), when oxygen levels at Station PM3 and PM4 were low.

3.2 Biological Environment

3.2.1 Terrestrial ecology

A detailed description of the terrestrial flora and fauna around West Harbour may be found in the EIA report prepared by ESL for the Port Antonio Yacht Club and Marina in April 2001. A description is not relevant to the purposes of this EIA since land-based sites for dredged material disposal are not being considered for this project. Suffice it to note that the terrestrial environment surrounding West Harbour is highly urbanised and modified.

Remnant stands of fringing mangroves occur west of the new boatyard, at the mouth of the Annotto River, and at the southwestern section of Navy Island.

3.2.2 Marine Ecology

Figure 3.6 shows the extent and distribution of seagrass beds and coral reefs within and around West Harbour. Generally, the seagrass bed communities tended to be restricted to the shallower regions of the harbour in water depths less than 3 - 4 m. The primary seagrass species comprising these beds was *Thalassia testudinum*. (*Syringodium filiforme* and *Halodule beaudettei* were not observed during the marine survey.) Solitary individuals of Starlet, Rose and Brain Coral were occasionally noted within these *T. testudinum* beds.

There is a wide fringing reef was to the northwest of West Harbour between Nose Point and Navy Island. Hog Channel (man-made ?), approximately 75m wide x 300m long x 7m deep, divides reef.

3.2.2.1 Marine communities at entrance to West Harbour

A shallow coral reef is located along the southeastern shoreline of Navy Island. Corals also occurs on the hard rock slope and on a 10,650 m² rocky ledge found along the north side of the approach channel (see Figure 3.6). The rock ledge/plateau is 7m - 9m deep and is located at GPS coordinates:—UTM **Zone 18** 346708E 2011447N (WGS84). Tables 3.2 & 3.3, respectively, list the coral/sponge and fish species observed during the SCUBA survey of the above reef.

Water clarity was excellent. The fish species were quite diverse and abundant, consisting mainly of adults, and the observed coral species were very healthy and in good condition. Yellow Pencil Coral (*Madracis mirabilis*) was by far the dominant coral, with Massive Starlet Coral (*Siderastrea siderea*) and Lettuce Coral (*Agaricia agaricites*) occuring frequently. Two species of sponge, Scattered Pore Rope Sponge (*Aplysina fulva*) and Pink Vase Sponge (*Niphates digitalis*) usually associated with deep water, high water clarity, wall reefs were also observed. Elkhorn coral (*Acropora palmata*) and Staghorn coral (*Acropora cervicornis*) were conspicuously absent.

The entire channel slope is covered with both living and dead coral between depths of 2 - 7m. This slope face is unlikely to be directly impacted by the proposed dredging operations, which are primarily concerned with deepening the existing approach channel rather than widening it.

Figure 3.6 West Harbour – distribution of marine communities.

Table 3.2 List of the stony coral and sponge species observed on the reef at the entrance of the West Harbour approach channel.

FAMILY/CLASS	SCIENTIFIC NAME	COMMON NAME	HABITAT & BEHAVIOR	DAFOR
Stony Coral				
Agariciidae	*Agaricia agaricites*	Lettuce Coral	**Size:** Colony usually 4 in. - 3 ft. **Depth:** Usually 3 - 240 ft Inhabit most marine environments from mangroves and back ref areas to outer reefs and walls.	F
Pocilloporidae	*Madracis mirabilis*	Yellow Pencil Coral	**Size:** Colony usually 5 in. - 4 ft. **Depth:** Usually 3 - 190 ft Generally inhabit deeper, clear water, outer reefs. Occasionally in shallower water with some sedimentation and water movement.	D
Siderastreidae	*Siderastrea siderea*	Massive Starlet Coral	**Size:** Colony usually 1 ft. - 6 ft. **Depth:** Usually 2 - 220 ft Tend to inhabit shallow to moderate reefs between 25-45 ft. Prefer clear water. Usually deeper than similar Lesser Starlet Coral.	F
Sponges				
Demospongiae	*Aplysina fulva*	Scattered Pore Rope Sponge	**Size:** 4 - 8 ft. **Depth:** Usually 10 - 130 ft Inhabit deep sloping reefs and walls. Common in the Caribbean.	O, F
Demospongiae	*Niphates digitalis*	Pink Vase Sponge	**Size:** 4 - 12 in. **Depth:** Usually 25 - 75 ft Inhabit coral reefs. Occasional in the Caribbean.	R

Table 3.3 List of the fish species observed on the reef at the entrance of the West Harbour approach channel.

FAMILY	SCIENTIFIC NAME	COMMON NAME	HABITAT & BEHAVIOR	ABUND-ANCE
Acanthuridae	Acanthurus bahianus	Ocean Surgeonfish	**Size:** 6 - 12 in ., max. 15 in. **Depth:** Usually 15 - 80 ft Inhabit reefs. May swim in loose aggregations that can include Blue Tangs and look-alike Doctorfish.	F
Chaetodontidae	*Chaetodon capistratus*	Foureye Butterflyfish	**Size:** 3 - 4 in ., max. 6 in. **Depth:** Usually 10 - 60 ft Flit about reef tops; often in pairs. Common to occasional in the Caribbean.	F
Pomacentridae	*Abudefduf saxatilis*	Sergeant Major	**Size:** 4 - 6 in ., max. 7 in. **Depth:** 1 - 40 ft Swim in all habitats, most often in midwater. Usually in loose aggregations.	F
Scaridae	*Sparisoma viride*	Stoplight Parrotfish	**Size:** 1 - 1½ ft ., max. 2 ft. **Depth:** Usually 15 - 80 ft Swim about reefs stopping to scrape algae from rocks and corals	F

ABUNDANCE CODE:

S	-	Single	-	One (1) sighting
F	-	Few	-	Two (2) to ten (10) sightings
M	-	Many	-	Eleven (11) to one hundred (100) sightings
A	-	Abundant	-	Over one hundred (100) sightings

A raised rocky plateau (approx. 10,650 m²) occurs at the base of the channel slope at depths of 7 - 9m. It is comprised of a 10 - 20m wide sand channel and a raised 5 - 10m wide strip of coral reef, approximately 1m high. The sand channel and the coral reef strip both run parallel to the channel slope in an ENE and WSW direction. The coral reef strip only covers about 25 % of the rocky plateau and thus has an area of roughly 2,600 m². The reef is comprised of both living and dead individuals/colonies, these being species that are commonly found around Jamaica, on the Nose Point/Navy Island fringing reef and on the deep wall reef ecosystems offshore of Port Antonio, Dragon Bay and Orange Bay. The corals observed on the rocky plateau (see Table 3.2) were mainly restricted (spatially) to the latter 5 - 10m wide, 2600 m² strip of coral reef. The entire 2600 m² coral reef strip (living and dead corals) and the associated sand channel would be removed by the proposed dredging exercise.

Beyond the plateau water depths increase (over a horizontal distance of approximately 5m) towards the center of the ship channel where depths range between 14m and 16m. With the exception of sparse growths of seagrasses (*Halophila decipiens*), the light brown muddy sediments at the bottom of the ship channel are devoid of above-substrate marine flora and fauna.

Along the southern section of the West Harbour entrance channel (i.e. the northern side of the Titchfield Peninsula at GPS coordinates:-UTM **Zone 18** 346542E 2011278N (WGS84)), seagrass beds (*Thalassia testudinum*) are the dominant marine community. Seagrass leaf blade lengths were typically in the order of 15cm and the blades were covered with calcareous epibiota. These healthy seagrass beds will not be directly impacted by the proposed PAJ dredging works as they are restricted to the top of the channel slope in water less than 2m deep. Although, individual *Siderastrea sp.* coral heads (and a large number of *Diadema antillarum* urchins) are associated with the *T. testudinum* beds, no established coral reef communities were observed in this section of the approach channel.

3.2.2.2 Nose Point/Navy Island fringing reef

The Nose Point/Navy Island fringing reef is the closest defined coral reef ecosystem to the proposed dredging area. The following description is extracted from a recent EIA study done for the new marina development (ESL, 2001). A survey carried out on 4 June 2002 confirmed that the morphology and species composition of the reef have not changed significantly over the one year time period since the first survey and the following account is therefore still relevant and current.

This shallow protective fringing reef (with a back reef lagoon) is located northwest of West Harbour. This fringing reef is approximately 1.5 km long and has a reef crest approximately 15 - 20m in width. The reef extends from Nose Point (in the west) to Navy Island (in the east) and is closely associated with the latter.

Algal, coral, fish and invertebrate species, observed on the fore reef and in the back reef lagoon, are listed respectively in Tables 3.4, 3.5, 3.6 & 3.7.

Table 3.4 Marine algal species observed on the Nose Point/Navy Island fringing reef.

Classification		
Green Algae (Chlorophyta)	Brown Algae (Phaeophyta)	Red Algae (Rhodophyta)
Halimeda opuntia	*Dictyota cervicornis* *Sargassum polyceratium* *Padina sanctae-crucis*	*Centroceras clavulatum** *Ceramium sp.** *Hypnea musciformis* *Jania adherens* *Amphiroa rigida* *Porolithon pachydermum***

* high nutrient indicator species.
** reef building, red encrusting algal species.

Table 3.5 Stony and soft coral species observed on the fore reef and back reef at Nose Point and Navy Island.

FAMILY	SCIENTIFIC NAME	COMMON NAME	HABITAT & BEHAVIOR	DAFOR*
Stony Corals				
Acroporidae	*Acropora palmata*	Elkhorn Coral	**Size:** Colony usually 3 ft. - 12 ft. **Depth:** 1 - 55 ft. Most common between 1-35 ft. Prefer shallow areas where wave action causes constant water movement. Branches orient parallel to surge direction. One of the primary corals of shallow water fringing reef	F
Agariciidae	*Agaricia agaricites*	Lettuce Coral	**Size:** Colony usually 4 in. - 3 ft. **Depth:** Usually 3 - 240 ft Inhabit most marine environments from mangroves and back ref areas to outer reefs and walls.	A, F
Faviidae	*Diploria clivosa*	Knobby Brain Coral	**Size:** Colony usually 6 in. - 4ft. **Depth:** Most common between 3 - 20 ft. Inhabit many shallow environments, including both seaward and lagoon sides of reefs, turtle grass beds and even mangrove roots.	A, F
Faviidae	*Manicina areolata*	Rose Coral	**Size:** Colony usually 2 in. - 6 in. **Depth:** Usually 2 - 200 ft. Inhabit areas of coral rubble, sand and turtle grass beds.	F
Faviidae	*Solenastrea hyades*	Knobby Star Coral	**Size:** Colony usually 3 in. - 2ft. **Depth:** Usually 2 - 60 ft. Inhabit a wide range of underwater environments from areas of high sedimentation, including back reefs, lagoons and turtle grass beds, to deep outer reefs.	A, O
Poritidae	*Porites porites*	Finger Coral	**Size:** Colony usually 1 ft. - 4 ft. **Depth:** Usually 3 - 160 ft Inhabit most reef environments and depths.	F
Siderastreidae	*Siderastrea radians*	Lesser Starlet Coral	**Size:** Colony usually 4 in. - 12 in. **Depth:** Usually 0 - 90 ft (rarely below 30	A

			ft) Inhabit flat rocky/sandy substrates, most common from low tide line to 20 ft. Can tolerate surge sandy & silty conditions.	
Siderastreidae	*Siderastrea siderea*	Massive Starlet Coral	**Size:** Colony usually 1 ft. - 6 ft. **Depth:** Usually 2 - 220 ft Tend to inhabit shallow to moderate reefs between 25-45 ft. Prefer clear water. Usually deeper than similar Lesser Starlet Coral.	F
Fire Corals - Hydrocorals				
Milleporina	*Millepora alcicornis*	Branching Fire Coral	**Size:** Colony usually 1 in. - 18 in. **Depth:** Usually 3 - 130 ft Inhabit all marine environments.	A
Milleporina	*Millepora complanata*	Blade Fire Coral	**Size:** Colony usually 1 in. - 18 in. **Depth:** Usually 0 - 45 ft Inhabit shallow water reef tops. Usually in areas with some water movement; most common in areas with constant surge.	A

* Abundance and distribution within the Caribbean

Table 3.6 List of the fish species observed on the fore reef and back reef at Nose Point and Navy Island.

FAMILY	SCIENTIFIC NAME	COMMON NAME	HABITAT & BEHAVIOR	DAFOR*
Acanthuridae	Acanthurus bahianus	Ocean Surgeonfish	**Size:** 6 - 12 in ., max. 15 in. **Depth:** Usually 15 - 80 ft Inhabit reefs. May swim in loose aggregations that can include Blue Tangs and look-alike Doctorfish.	A
Acanthuridae	Acanthurus coeruleus	Blue Tang	**Size:** 5 - 10 in ., max. 15 in. **Depth:** Usually 10 - 60 ft Can be solitary, but more often in large aggregations foraging about shallow reef tops, grazing on algae. Schools can include Surgeonfish and Doctorfish.	A
Haemulidae	*Haemulon flavolineatum*	French Grunt	**Size:** 6 - 10 in ., max. 1 ft. **Depth:** Usually 12 - 60 ft Prefer coral reefs. Drift in small to large schools. Often in the shade of formations.	F
Haemulidae	*Haemulon striatum*	Striped Grunt	**Size:** 6 - 9 in ., max. 11 in. **Depth:** Usually 40 - 100 ft Usually inhabits deep reefs becoming more abundant with depth. Juveniles may be found in shallower areas.	O
Holocentridae	*Holocentrus rufus*	Longspine Squirrelfish	**Size:**5 - 10 in ., max. 12½ in. **Depth:** Usually 4 - 100 ft During the day, drift inconspicuously in shaded areas near bottom.	O
Labridae	*Thalassoma bifasciatum*	Bluehead Wrasse	**Size:** 4 - 5 in ., max. 6 in. **Depth:** Usually 6 - 80 ft Usually inhabits most reefs environments. May act as cleaners, removing parasites and debris from larger fish. Often swims in schools.	F

Mullidae	*Pseudupeneus maculatus*	Spotted Goatfish	**Size:** 5 - 8 in ., max. 11 in. **Depth:** Usually 5 - 60 ft Use barbs to dig in sand and around areas of rubble for food. Often congregate in small groups of four to six. When not searching for food, often rest on bottom and match colour to blend with background.	F
Pomacentridae	*Stegastes fuscus*	Dusky Damsel	**Size:** 3 - 5 in ., max. 6 in. **Depth:** 5 - 40 ft Inhabit rocky areas. Territorial; pugnaciously chasing away intruders	A, F
Pomacentridae	*Stegastes planifrons*	Threespot Damsel	**Size:** 3 - 4 in ., max. 5 in. **Depth:** 0 - 130 ft Inhabit reef tops in areas of algae growth. Territorial; pugnaciously guard relatively large areas, and rapidly dart about, nipping and chasing away intruders	A, F
Scaridae	*Sparisoma viride*	Stoplight Parrotfish	**Size:** 1 - 1½ ft ., max. 2 ft. **Depth:** Usually 15 - 80 ft Swim about reefs stopping to scrape algae from rocks and corals	F

* Abundance and distribution within the Caribbean

Table 3.7 List of the invertebrate species on the fore reef and back reef at Nose Point and Navy Island.

SCIENTIFIC NAME	COMMON NAME	HABITAT & BEHAVIOR	DAFOR*
Anemones			
Condylactis gigantea	Giant Anemone	**Size:** 6 -12 in. across tentacles & body **Depth:** 15 - 100 ft Inhabit reef and lagoonal areas	F
Echinoderms - Echinoidea			
Diadema antillarum	Long-spined Urchin	**Size:** (Body) 2 - 3 in ., (Spines) 4 - 8 in. **Depth:** 0 - 130 ft Found in all habitats. Hide during day in sheltered locations. Feed in the open on algae at night.	F
Echinometra lucunter	Rock-boring Urchin	**Size:** (Body) 1¼ - 3 in ., (Spines) ¾ - 1¼ in. **Depth:** 0 - 15 ft Most common in shallow rocky and tidal areas. Bore holes in substrate, which they occupy during day. Feed on algae in the open (near their holes) at night	F, O
Echinometra viridis	Reef Urchin	**Size:** (Body) 1¼ - 2 in ., (Spines) 1 - 1½ in. **Depth:** Usually 15 - 45 ft Inhabit shallower reefs Hide during the day in sheltered locations. Feed in open on algae at night.	O, R
Tripneustes ventricosus	West Indian Sea Egg	**Size:** (Body) 4 - 5 in ., (Spines) ¼ - ¾ in. **Depth:** 0 - 30 ft Inhabits sea grass beds, occasionally on shallow reef	O, R

KEY:

D - Dominant- Numbers dominate the site
A - Abundant- Many individuals observed

F	-	Frequent	-	Individuals observed frequently
O	-	Occasional	-	Individuals observed a few times
R	-	Rare	-	Individuals observed once or twice

* Abundance and distribution within the Caribbean

Elkhorn coral (*Acropora palmata*) and Blade Fire Coral (*Millepora complanata*) were the dominant coral species in the fore reef environment; whilst Finger Coral (*Porites porites*), Starlet Coral (*Siderastrea radians* and *Siderastrea siderea*) and Lettuce Coral (*Agaricia agaricites*) dominated living coral species within the back reef lagoon.

The back reef lagoon is approximately 200m to 500m wide, 0.25 to 1.5m deep and protected from high wave energy by the reef crest of the fringing reef. It supports and provides protection for the fish species listed within Table 3.6.

T. testudinum dominated seagrass cover within the lagoon and was the only seagrass species observed during the marine survey. Bare coralline sand, dead coral colonies and coral rubble accounted for 80 - 90 % of ground cover immediately behind the reef crest. *T. testudinum* beds dominated ground cover approximately 200m inshore of the latter and were home to several individuals of West Indian Sea Egg (*Tripneustes ventricosus*). The Long-spined Urchin (*Diadema antillarum*) was the dominant sea urchin species closer to the reef crest.

Within the back reef seagrass meadows were a few individuals of the stony coral *Siderastrea radians* and *Siderastrea siderea*. No hydrocorals (e.g. the fire coral, *Millepora*) or octocorals (e.g. sea fans) were observed in this community.

Two algal high-nutrient indicator species (i.e. *Centroceras clavulatum* and *Ceramium sp.*) were observed within the back reef lagoon.

3.2.2.3 Mud-bottom basin community

Sediments along the eastern shoreline of West Harbour basin were comprised primarily of terrigenous material brought down over time by the rivers and gullies discharging into the harbour. The sediments were dark brown in colour and silty in texture. This substrate does not support any above-substrate marine flora or fauna (e.g. seagrass beds, algal mat communities, etc.) but contained tiny red bloodworms (unidentified; 1–2 cm long). Thus, the soft, unconsolidated fine sediments appear not to support any significant biota and this is probably due to constant deposition of fine sediments and organic material from nearby drains which smothers the benthos and creates semi-anoxic conditions.

The sediments along the shoreline of the southeastern corner of West Harbour were also terrigenous. They were anoxic, black in colour and comprised of the same silty material as described above. This material similarly has its source from the rivers and drains that discharge into West Harbour. It does not support any above-substrate marine flora or fauna. Blood worms (a total of 10 individuals) and a single *Macoma tenta*, a bivalve characteristic of soft bottom sediments, were the only infaunal species collected in the 6 grab samples taken. It appears that these sediments also have a low species diversity, indicative of stressful conditions.

3.2.3 Protected areas – proposed Port Antonio Marine Park

The Portland Environment Protection Association (PEPA) has been working on the conservation of the Portland environment since its inception in 1988. A Management Plan for the proposed Port Antonio Marine Park was prepared and submitted to the Natural Resources Conservation Authority (NRCA) in 1997. Due to a lack of funding the NRCA has not yet been able to have the Port Antonio Marine Park declared officially as a protected area, although it is listed as one of

the priority sites in the *Policy for Jamaica's System of Protected Areas* (NRCA, 1997). The boundaries of the proposed marine park extend from North East Point (east of Boston Bay) to ? Bluff (west of Snow Hill). The park contains approximately 30 km of coastline and extends out to the 200m contour.

3.3 Socio-economic Environment

3.3.1 Demography

According to the 1991 census the parish of Portland had a population of 75,500, of which about 17% (13,118) resided in Port Antonio. In 1995, it was estimated that Port Antonio had a population of 14,820 with an annual growth rate of 1.1%. Portland has a young population of which approximately 35% was under the age of 15 years. The population has aged somewhat though, as in 1970 the median age was 16.7 years and 17.5 years for males and females respectively, while for 1991, the corresponding figures were 21.8 and 23.2 years. An average of 650 visitors per night add to the population numbers (Louis Berger, 1996 – Chap. 8; Sect. 8.2.3).

3.3.2 Land use

The coastal area is used for commerce, fishing, recreation, housing, tourism, administration and transport, and includes a commercial wharf, a cruise ship pier, two marinas, a few small docks, a fishing beach, a bathing beach, a squatter settlement, and a Marine Police/JDF Coast Guard station. The Titchfield peninsula is largely residential, but also has a major secondary school, a military training post, and several guesthouses. The coastal plain is largely urban, with all the associated urban land uses - residential, commercial, administrative, industrial, and recreational. West Street and West Palm Avenue are dominated by commerce and small industry, while Boundbrook district is largely residential. The settlement pattern is largely linear. Some informal farming and livestock rearing is also done on empty plots and in kitchen gardens.

Apart from the hospital, health clinic, and the Bonnie View Hotel, much of the land overlooking West Harbour is residential, used for some small-scale agriculture and under mixed, mainly secondary, forest cover. Communities include Stony Hill, Lighthouse, Spring Bank, Janga Gully, and Waterworks.

Navy Island is covered mainly by ruinate vegetation, with a central facility and villas (presently closed) along the southern side. It should be noted that the water supply to Navy Island runs through a submarine pipe laid in shallow water between a point on the mainland just west of the new boatyard and the island. The pipeline will not be threatened by the proposed dredging project. Overhead cables carrying electricity to Navy Island also run along the same alignment.

Except for areas of linear settlement along the roads, most of the upper reaches of the mainland watershed are covered in woodland. For this reason, the visual backdrop to West Harbour, especially as seen from the bay, is lush, verdant and 'tropical' looking. There is little available information on the current extent of squatting on the hills facing West Harbour but certainly Port Antonio does not yet exhibit the degraded visual appearance now becoming characteristic of Montego Bay. However, the protection of this green, wooded hill-scape, through appropriate land use control, is critical to maintaining the attractiveness of Port Antonio generally, and West Harbour specifically, as a unique marina/resort destination. Fortunately, the high rainfall characteristic of Portland encourages the rapid and lush growth of vegetation.

The areas directly affected by the dredging project are the sides of the entrance channel into West Harbour, the ship turning basin within West Harbour and the deep-sea site recommended

for the dumping of dredged materials. Intrusion onto the shoreline is not contemplated. The coastline of West Bay is neither depositional nor erosional, except at the mouth of the Annotto River where the mangrove stand is building seawards.

The coastal plain is flat and of very low elevation, less than one metre above sea level over much of the land contiguous with the bay. The surface is poorly drained and the water table is very high. Most of the area was probably covered by mangroves before the first settlements took place.

Dredging operations should be carried out cognizant of activities associated with the following shorefront sites (listed from east to west):

1. Ken Wright Pier and adjacent public bathing beach
2. Port Antonio Yacht Club and Marina
3. Marine Police/JDF Coast Guard Pier
4. Port Antonio Marina and Joe Keifer dock
5. Bryan's Bay fishing beach
6. Boundbrook Wharf
7. Fishing beach at
8. Fishing beaches at Bryan's Bay,

3.3.3 Port Antonio fishing beaches

Fishing as an economic activity in Port Antonio is discussed later in Section 3.3.6.1. The nature of the project required that the various fishing communities be consulted with respect to their perceptions regarding the impacts of dredging on their activities. The results of these consultations are presented below.

There are three main fishing beaches in Port Antonio collectively accounting for a small boat fishing fleet of about 60 active boats and approximately 120 fishers. Several non-fishers also find accommodation on the fishing beaches. The three beaches share common fishing grounds, methods of fishing, types and size of catch and number of days spent fishing. As a series of semi-structured interviews on these beaches revealed, the responses to the proposed dredging project were the same at each beach with almost no exceptions.

The majority of fishers used pots, set bottom lines or engaged in trolling. The main fishing grounds included inshore waters along the coast and one or more of the four off-shore banks; Henry Holmes, Grappler and Formigas off the northeast coast and Albatross off of the southeast coast. Table 3.8 summarizes the main locations and types of fish caught at each location. This is common to all three fishing beaches.

The types of fishing practiced include fish pots, bottom lining, trolling, seine nets, spear fishing, and line fishing from shore, with the first two being the most practiced. Fishers go to sea whenever the weather permits. The type of fishing depends to some extent on their ability to finance their trips. For example trips to the nearer banks require an initial outlay of a couple of thousand dollars and proportionately more to the farther banks. Typically, inshore pot fishers fish up to 7 days a week, those engaged in inshore bottom and trolling may fish 3 or 4 days each week, and those working the banks report one or two trips per week. Similarly average catch sizes per trip, assuming good weather, range from 40 lbs for pot fishing to 200 lbs for divers using SCUBA gear. The catch does not vary between beaches but with the method of fishing and all the beaches engage in each type of fishing. The possible exception is Upper Bryan's Bay where no SCUBA-diving fishers were identified.

Table 3.8 Main locations and types of fish from each location.

Type of Fish	West Harbour	East Harbour	Henry Holmes Bank	Grappler Bank	Fomigas Bank	Albatross Bank
Black Snapper			X	X	X	X
Silk Snapper			X	X	X	X
Pot Snapper	X	X				
Black Satin			X	X	X	X
Parrot	X	X				
Bonito			X	X	X	X
Marlin			X	X	X	X
King			X	X	X	X
Barracuda			X	X	X	X
Bonito			X	X	X	X
Tuna			X	X	X	X
Dolphin			X	X	X	X
Kongo Tony	X	X				
Doctor Fish	X	X				
Sail Fish			X	X	X	X

It is only during conditions of rough weather and poor seas at open sea that the fishers will instead set pots in either West or East Harbour.

3.3.3.1 Keifer/(Upper) Bryan's Bay fishing beach

Sheltered in the small embayment between the Port Antonio Marina and the Boundbrook Wharf, the beach is referred to by fisherfolk as Bryan's Bay Fishing Beach but it is also widely identified with the neigbouring Joe Keifer Dock. If pressed, the beach will also be distinguished from its namesake beach to the west by prefacing it with the term "Upper".

This fishing beach (Plate 3.1) is used by about 20 fishermen and berths 10 fishing canoes. However the beach-based population is about 60 persons housed in 'ranches' or semi-permanent structures in which they sleep and house their gear. Although, from observation, the predominant gender is male, it is evident that several households exist and women and young children were in attendance. The fishing beach is a licensed beach and has its own gasoline depot.

Approximately 15 persons on this beach were interviewed to probe their perception of project benefits and any perceived negative impacts of the project. Five individual interviews were conducted on one occasion and a group discussion comprising 10 persons was held on another. The majority stated their occupation as fishers but a small number of females who gave the impression of being spouses also participated. To a remarkable extent (not usually found in non- community based projects not offering a direct benefit) the response to both the current dredging project and the on-going marina project was consistently affirmative. To the direct question " Do you approve this project?" asked after the dredging work to be undertaken was explained, the unequivocal answer in every instance was "Yes". This unanimity was to be repeated at each of the other two beaches sampled.

When probed (assisted) as to their main concerns regarding the dredging operations, two main concerns emerged; turbidity (colloquially referred to as "jugsey") and disposal of dredged material. These two concerns outranked damage to reefs (seen as a negligible impact given the reefs to be affected), loss of pots (since these are seldom set within the harbour and could be set elsewhere during dredging), and loss of marine life. The concern with 'jugsey' and the

disposal of dredged materials were linked in an interesting way. Due to the prevalence of pot stealing very few fishers use surface markers. This means that the recovery of the pots is dependent on very good water visibility. In clear water they are able to see pots down to about 25 fathoms with a face glass. Unless the dredged material is carried away from inshore areas, sediment drift will reduce visibility and the fish caught may suffocate before recovery becomes possible.

In response to being asked to suggest the best disposal area for the dredged materials the responses varied widely. However, a consensus seemed to coalesce around a distance of 15 miles offshore, a figure very much out of alignment with the responses from the other two beaches which favoured 4 to 5 miles.

Responding to their perception of some of the benefits to be derived from the dredging, the responses were common to nearly all fishers interviewed. The project is seen as complimenting the improvements in West Harbour, which in turn means economic development and improved markets for their fish. The inflow of larger boats and yachts will mean more hotels, restaurants, employment and the consumption of fish. Interestingly, and unlike their Kingston counterparts, fishers on this beach claim to suffer from too few vendors, forcing them to do their own vending.

The fishers took the opportunity at this meeting to impress on the consultants their desire to participate positively in the wider marina project. They felt that their beach could be an important attraction to visitors and they accepted that they had a responsibility to be pro-active in cleaning up their environs towards this objective. Entrepreneurial activity was already being planned in relation to the provision of a beach restaurant offering local dishes and music. Their main concern was their inability to attract the attention of anyone in "authority" in relation to the harbour developments and who in turn could assist them in realizing the perceived opportunity.

One individual, who by virtue of having worked for a while on the current Port of Kingston dredging project warned that a certain complement of indigenous skills was always needed on dredging projects, mainly in relation to the operation of small auxiliary boats and tugs and that local skills would not allow the current Kingston crews to be brought down to Port Antonio where available skills were idle.

3.3.3.2 East Harbour fishing beach

The southern rim of East Harbour supports an active strip of entrepreneurial activity centered mainly on small restaurants, bars and clubs. Associated with this is the East Harbour fishing beach (Plate 3.2), which is the largest of the three such beaches in Port Antonio. A count of fishing boats by the consultants, including those at sea, put their number at 24 and the fishers did a census that placed their numbers as 64. An earlier attempt at forming a fishing cooperative broke down, but some fishers have associated themselves with the North East Cooperative Society Ltd whose main membership is drawn from Boston, Long Bay and Manchioneal, all towns to the east.

Due to threatening weather interviewing took place shortly after dawn and was limited to a group discussion with 6 fishers. However because of their obvious seniority and experience, confidence was put in the responses given by them. The fishers expressed approval for the dredging project and the developments in West Harbour in general. They voiced the wish that their own harbour be deepened. When asked to choose from 9 possible negative impacts that could attend the dredging exercise, they were unanimous in their concern for where the dredged material would be deposited. Here more realistic expectations prevailed than at Keiffer's beach

and it was felt that 2 miles out would be a sufficient distance north of the drop off to avoid the inward drift of deposited material.
No negative impacts were expected from the operation of the dredge, whether on pots or nets. It was felt that prudence would dictate that they kept their equipment clear of the operating area.

The main benefits perceived for themselves were tied in with the development of West Harbour as distinct from the project per se. The stimulation of visitor arrivals and the consequent increase in prosperity for Port Antonio would result in increased demand for fish and also offer other employment opportunities.

The type of fishing engaged in has already been discussed and is in keeping with the other beaches. However the beach is somewhat distinct in that a fraternity of fishers specializing in deep diving exists to the eastern end of the beach and number some 25.

The consultants were struck by the potential for promoting this length of shoreline as a unique 'strip' of entertainment activity for visitors. It offers this potential to a degree unparalleled by most other harbours around the Island. This fact was appreciated by the fishers present. However like their counterparts at Kieffer's Beach some organizational 'coming together' will be necessary to convert this potential into a realizable opportunity.

3.3.3.3 (Lower) Bryans Bay Fishing Beach.

This is perhaps the smallest of the three fishing beaches comprising about 12 boats and about 36 fisherfolk, including those licensed as fishers and others. Individual interviews were held with 5 fishermen four of whom owned 'ranches' on the beach (Plate 3.3).

Without exception the respondents were favourably disposed to the proposed dredging project although one respondent opined that it would bring no tangible benefits to himself. Three of the respondents expressed concern about where the dredged materials would be deposited, one identified loss of pots and trolling lines as his principal concern and the fifth mainly feared oil spill contamination. The perception of project benefits were similar to those expressed on the other beaches, namely the expectation of larger vessels visiting resulting in economic spin-offs and increased trade for the fishers. One respondent thought that the cleaning up of West Bay and in particular its improved circulation, which would be a corollary to its development, would encourage fish to come in to breed in the fringing mangroves and return fish life to West Harbour over time.

Four of the five respondents thought that depositing the dredged materials 3 - 4 miles offshore would be sufficient to prevent it from returning to shore. However one person felt that 15 miles was his minimum comfort level.

The respondents felt that it was highly unlikely that they would be affected in any way by the project, more so as it appeared to them to be of short duration.

3.3.3.4 Shanshy Beach Complex

While not a fishing beach, this facility shares its frontage with the Lower Bryan's Bay fishing beach and is therefore included here for convenience (Plate 3.4). It is located along the coastline in an area mapped as Ships Rock. The complex which comprises a series of adjoining buildings built into the hillside and slightly elevated above the beach, advertises a range of hospitality related activities such as restrooms, pool games, other indoor games and packaged tours.

The property seems to be facing much reduced circumstances as it was closed on the Friday afternoon visited by the consultants. The manager confirmed that business was very slow and welcomed the marina project as offering some hope for the economic prospects of the town. She was also positive about the project but expressed concern about any damage to the reefs whether as a result of the actual cutting operations or the disposal of dredged material. Given the reduced scale her current operations she felt that the project would be completed before it had much opportunity of impacting her negatively.

3.3.3.5 Muscle Beach & Fitness Center.

This is a private beach property cum gym located a few chains west of the Jamaica Public Service Co. Ltd. power station. The owner, once active in its civic life, was very supportive of the new marina project. He felt that it augers well for the town and echoed the optimism that Portlanders express when commenting on that project. He sees a very positive benefit from the dredging project in that a major problem for him has been the deposition of sediment on his beach whenever the Annotto River is in spate. As a consequence the bathing area on his beach is only ankle deep and he has been contemplating building a groyne on its eastern side to arrest this problem. He will now await the completion of the dredging to determine its impact on solving his problem. He foresees no problems for his beach during the dredging operation since it seems likely to be over with before he is fully up and running with his project.

3.3.4 Education and Training

There are a wide range of educational facilities in Port Antonio, several primary schools, all-age schools, two secondary schools, including the Titchfield High School on the peninsula, and several post-secondary institutions, offering a range of vocational and technical skills. The only tertiary institution, the College of Agriculture, Science and Education (CASE) is located at nearby Passley Gardens.

Although educational statistics show that most of the working population of Portland is unskilled (approx 62% have only a primary school education), many people quickly acquire 'on-the-job' training and skills. The 'man in the street' in Port Antonio appears to be fairly well educated, with a keen understanding of environmental issues, and of the overall plans for the development of West Harbour.

3.3.5 Employment

It is estimated that in 1991, of a work force of 10,851, most of them males, 74% were employed. Much of the labour force is self-employed. 2000 persons were directly employed in agriculture, and of these, 1339 were employed by the banana industry. Tourism directly employed 700 persons, and indirectly provided employment for another 1000 persons, while construction and industry employed 340 and 346 persons respectively. The remaining 5300 workers are engaged mainly in service industries, merchandizing and other commercial activities. Many families rely heavily on remittances from family and friends overseas; the presence of many money transfer services in the town attest to this.

The direct employment content of the proposed dredging project is negligible.

3.3.6 Economic Activities

3.3.6.1 Fishing

Fishing is important to the economy of Port Antonio although its importance has not been quantified. The general description of this sector have already been dealt with above, here comments will be limited to its economic contribution. There is a ready market for fish, which is sold mainly in Port Antonio, but also in Buff Bay and Kingston. Supply does not meet the

demand. This industry, especially the inshore fishery, is suffering from over fishing and declining yields. The fishermen attribute this to an increase in the number of fishermen; more people are turning to fishing as the cost of living is rising and employment opportunities are more limited. The increasing costs of equipment and fuel required for deep-sea fishing is reported to be a severe limiting factor. This project will not of itself alter the contribution of this sector, however in the wider context of the development of West Harbour, the industry would benefit from both direct and indirect spin-offs associated with increased tourism and trade.

3.3.6.2 Tourism

In 1871, after sugar began its decline, Lorenzo Baker started exports of bananas to Boston and this ushered in an era of prosperity. American tourists soon followed the shippers and businessmen, traveling on the banana boats and staying at the Titchfield Hotel. The town prospered. The banana industry suffered heavily, though, and Panama disease and the effects of a hurricane in 1903 caused a decline from which the industry never fully recovered; this was compounded by disruption of shipping during World War II. Tourism, under the patronage of celebrities like Errol Flynn, still flourished into the 1950's and 60's, but today the glamorous resort is now more of a backwater to the more heavily marketed Ocho Rios and Montego Bay. Thus the economic health and the standard of living have recently been in decline. This is reflected in the high unemployment and especially, the poor quality of basic infrastructure.

Although it still hosts the high-end tourist when compared to the other tourist resorts, Port Antonio is not as attractive to the mainstream tourist. It is, however, also very popular to the back-packer at the low end of the market. Most tourists don't visit Port Antonio for the limited attractions of the town itself, but more for its proximity to the natural wonders of Portland parish, where sightseeing, hiking and rafting on the Rio Grande are offered. The marlin tournament in October also attracts some boating tourists.

3.3.6.3 Commerce

Port Antonio is the hub of commercial activity for much of the parish of Portland. It's sphere of influence extends for more than 50 kilometers and includes the towns and settlements of St Margaret's Bay, Hope Bay, Orange Bay and Buff Bay to the west, Drapers, Fairy Hill, Boston Bay, Priestman's River, Manchioneal and Hectors River to the east, and Fellowship, Mooretown and Millbank to the south. Much of the commercial activity in the parish is concentrated on the coastline, with two large bakeries, hardware and furniture shops, a meat, produce and craft market, branches of major banks and several retail stores and dining places. West Harbour is also a major shipping port.

It is under the umbrella development of West Harbour that the proposed dredging project will be contributory to the anticipated economic benefits refered to throughout.

3.3.6.4 Shipping

Shipping and port facilities constitute a major land use West Harbour and therefore shipping schedules need to be considered with respect to potential short-term dislocation from dredging works. West Harbour receives 8 - 10 ship calls per month (two banana vessels per week) and a number of visiting yachts. The shipping schedule for July and August 2002 (the period within which dredging is planned to take place) is shown at Table 3.9.

3.3.7 Local environmental organisations

The Portland Environmental Protection Association (PEPA), established in 1988, is the pre-eminent regional environmental NGO. It is a very active organization comprised of about 60 community associations and about 75 individual members. Its programme of activities includes

environmental advocacy, resource user group support, community group support and environmental education.

Table 3.9 Schedule of vessels docking at Boundbrook Wharf - July-August 2002.

Vessel	Gross Tonnes	Length (m)	Arrival dates	
			July	August
The Pilgrim	7743	131.25	5	2
Prince of Waves	7329	134.0	12	9
Prince of Seas	6363	120.31	19	16
The Music	5103	131.25	26	23

A meeting was held at the Port Antonio Marina with Mr. Harvey Webb, Executive Director, PEPA, to discuss the dredging project. Reflecting his organizations official stance, there was general support for the need to dredge West Harbour with some reservation expressed about potential impacts on marine benthic communities west of the basin while at the same time acknowledging the validity of some trade off. The possibility for removal of the sediment bar at the mouth of the Annotto River met with a favourable response. His major concern was with where the dredged materials would be dumped and the effective monitoring of this activity. PEPA will continue to take an active interest in this issue.

3.3.8 Natural and technological hazard vulnerability

Storm surge as a result of hurricanes, and storm waves from 'northers' are the major natural hazards affecting the study area.

'Northers' are annual phenomena associated with northern air mass/cyclonic systems. Wind generated waves under these circumstances exert considerable wave energy on the shoreline. Considerable erosion from undercutting was evident along the northern tip of the Titchfiels Peninsula (Plate ??).

Dredging activities could be affected if they are carried out during the hurricane season and a tropical storm or hurricane passes over or in close proximity to Port Antonio. 'Northers' tend to be most active from December through March and therefore any dredging carried out during that period could be affected.

Port Antonio is also seismically active and records high levels of earthquake activity. There are no records of tsunamis for the area.

Technological hazards associated with the study area include oil spills, fires, accidents, and polluted discharges from vessels.

4. ENVIRONMENTAL POLICY, LEGISLATION AND REGULATORY FRAMEWORK

The environmental laws and regulations of Jamaica and the international conventions to which it is a signatory that are relevant to the proposed PAJ dredging project at West Harbour are listed and annotated below.

4.1 Acts and associated Orders & Regulations

Natural Resources Conservation Authority Act (1991)
This is the main environmental legislation that relates to the proposed dredging of West Harbour. This Act establishes the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development through the protection and management for the country's natural resources and the control of pollution.

Sections 9 and 10 of the NRCA Act stipulate that an Environmental Impact Assessment (EIA) is required for new projects and existing projects undergoing expansion that are listed under its list of prescribed categories of development activities.

The Act also incorporates the earlier Beach Control Act, Wildlife Protection Act and Watersheds Act.

◊ Beach Control Law (1955) and Beach Control Act (1978) (subsequently re-authorized under the NRCA Act and currently under review)
The regulations of 1978 relate to hotels, commercial and public recreational beaches, regulated beach activities, care of beaches and rights of license. The Beach Control Act extends only to the foreshore; while it provides for the designation of protected areas, it does not address the basis for such designation, nor does it deal with the management of coastal resources landward or seaward of the foreshore. The Beach Control Law requires that an application be made for the modification of any beach/coastline and sets out requirements for the posting of public notices.

◊ Wild Life Protection Act (1945)
Prohibits removal, sale or possession of protected animals, use of dynamite, poisons or other noxious material to kill or injure fish, prohibits discharge of trade effluent or industrial waste into harbours, lagoons, estuaries and streams. It authorizes the establishment of Game Sanctuaries and Reserves. Protected under the Wildlife Protection Act are six species of sea turtles.

The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996)
The island of Jamaica and the Territorial Sea of Jamaica has been declared as a Prescribed Area. No person can undertake any enterprise, construction or development of a prescribed description of category except under and in accordance with a permit.

The Natural Resources Conservation (Permits and Licenses) Regulations (1996)
These regulations give effect to the provisions of the Prescribed Areas Order. Port and harbour developments are included on the prescribed list.

NEPA Environmental Review and Permitting Process

The environmental Permit and License System (P&L), introduced in 1997, is a mechanism to ensure that all developments in Jamaica meet required standards in order to minimize negative environmental impacts. The P&L System is administered by the National Environmental and Planning Agency (NEPA), formerly the Natural Resources Conservation Authority (NRCA), through the Permit and License Secretariat. Permits are required by persons undertaking new developments, which fall within a prescribed category. Under the NRCA Act of 1991, the NRCA is authorized to issue, suspend and revoke permits and licences if facilities are not in compliance with the environmental standards and conditions of

approval stipulated. An applicant for a Permit or License must complete an application form as well as a Project Information Form (PIF) for submission to the NRCA.

Water Quality NRCA Act (1990)
The NRCA has primary responsibility for control of pollution in Jamaica's environment, including pollution of water. National standards exist for industrial and sewage discharge into rivers and streams.

Fishing Industry (Fish Sanctuaries) Order (1979)
The Fishing Industry Act of 1975 is related to the regulation of the fishing industry and serves to conserve and manage the fisheries resources by addressing such issues as licensing. Under the 1979 Order fish sanctuaries may be declared by the Minister, in which no fishing is allowed.

Town and Country Planning Act (1958)
Established the Town and Country Planning Authority with responsibility for Development Orders to control both rural and urban land development, ensure proper sanitary conveniences, co-ordinate building of roads and other public services. Planning approvals for the project will have to be obtained from the Town Planning Authority.

Marine Board Act (1985)
The Marine Board which is comprised mainly of Port Authority offices, is empowered to regulate and control Jamaica's harbours and their shipping channels. The Act prohibits the discharge of rubbish, stones, ballast, mud, or oil into any harbour or shipping channel.

Harbours Act (1976)
The Harbours Act authorizes the Port Authority of Jamaica to declare, establish or alter the boundaries of harbours. The PAJ has ultimate management responsibility for all harbours in the island.

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Maritime Authority of Jamaica Act (1998)
The Maritime Authority of Jamaica was primarily set up for Jamaica to comply with the International Maritime Organisation London Convention / London Protocol and is responsible for, *inter alia*, issuance and review of dredging permits, setting of monitoring conditions and designation of approved disposal sites.

Quarries Control Act (1983)
This Act repeals the Quarries Act of 1958 and makes provisions for quarry zones and licenses, quarry tax, enforcement and safety. The proposed PAJ project should ensure that any earth materials used for the construction of bunds for the dredged material retention basins are only obtained from licenced quarries.

National Heritage Trust Act (1985)
Provides for protection of areas, structures and objects of cultural significance to Jamaica by declaration of any structure as a national monument where preservation is of public interest due to historic, architectural, traditional, artistic, aesthetic, scientific or archaeological importance. This includes the floor of the sea within the territorial waters or the Exclusive Economic Zone.

There are no known historical or archaeological sites that would be affected by the proposed dredging works.

The Office of Disaster Preparedness and Emergency Management Act (1998)
This Act established the Office of Disaster Preparedness and Emergency Management (ODPEM) to develop and implement policy and programmes to achieve and maintain an appropriate state of national and sectoral preparedness for coping with emergency situations. The proposed project should ensure that it collaborates with this agency in the preparation of the appropriate emergency response plans in relation to potential oil spills and dredged material transport pipe breakage/leaks.

4.2 Policies and Regulations

National Policy for the Conservation of Seagrasses (1996)
This policy guides the issuing of licenses, or permits for activities such as dredging, disposal of dredge spoil, beach development and effluent disposal, which directly or indirectly affect seagrass communities. Seagrass meadows occur in the bay beyond the Montego Freeport harbour.

Policy for Jamaica's System of Protected Areas (1997)
The System of Protected Areas is an expression Jamaica's commitment to protect the environment and its resources through the protection of parks and protected areas. The policy lists six goals, which include, economic development, environmental conservation, sustainable use of resources, recreation and public education, public participation and financial sustainability. The proposed dredging project is located within the boundaries of the proposed Port Antonio Marine Park.

Mangrove and Coastal Wetlands Protection - Draft Policy and Regulations (April 1996)
A review of the issues affecting wetlands in Jamaica as well as Government's role and responsibility. Five main goals are outlined which include guidelines for wetlands development, cessation of destructive activities, maintenance of natural diversity, maintenance of wetland function and values and integration of wetland functions in planning and development. The proposed PAJ project should undertake to protect the mangroves in the Bogue Lagoon.

Coral Reef Protection and Preservation Policy and Regulation (Draft) (1996)
This document reviews the ecological and socio-economic functions of coral reefs, issues affecting coral reefs and Government's role and responsibility. Five main goals are outlined which include reduction of pollutants, reduction of over-harvesting of reef fish, reduction of physical damage from recreational activities, improving the response capability to oil spills, and control of coastal zone developments. The proposed PAJ project must endeavour to ensure that its dredging activities do not threaten or harm the coral reefs around Montego Bay.

4.3 International Conventions

The conventions listed below apply to the project in so far as Jamaica is a signatory to them and because they relate to the operations of the dredging vessels.
London Convention (Prevention of Marine Pollution by Dumping of Wastes and other Matter) (1972) and Protocol (1996)
Established to protect and preserve the marine environment (sea and sea-bed) from all sources of pollution, and to take effective measures to prevent, reduce, and eliminate marine pollution

caused by dumping or incineration at sea. The project should meet the provisions of the Convention and associated Protocol, to which Jamaica is a signatory.

The project should meet the provisions of the Convention and the associated 1996 Protocol, to which Jamaica is a signatory.

MARPOL Convention (Prevention of Pollution from Ships)(1973) and Protocol (1978)
This international agreement covers vessel-source pollution by oil (Annex I), chemicals (Annex II), harmful substances in packaged form (Annex III), sewage (Annex IV), garbage (Annex V) and air pollution (Annex VI). Annexes I and II are conpulsory. The annexes of relevance to this project are Annex I, Annex IV and Annex V.

The Annex I, which applies, *inter alia*, to ships over 400Gross Tonnes (GT), regulates the rate of discharges of oil, establishes prohibited zones within which no discharges may take place, and introduces equipment requirements and procedures to minimise the amount of oil discharged. It also specifies measures to prevent oil being spilled as a result of accident or collision, grounding, etc.

Annex IV applies to ships over 200GT carrying more than 10 persons. The discharge of sewage is prohibited within 4 nautical miles of the nearest land unless the vessel has an approved sewage plan and facilities for comminuting and disinfecting the sewage before discharge.

Annex V applies to all types of ships (including yachts and fishing vessels) and offshore platforms. It prohibits the disposal of synthetic fishing nets (*silt screens?*), ropes and plastic bags. The Protocol makes provision for the declaration of Special Areas and the Caribbean Sea has been so declared. However, zero tolerance discharge standards cannot be enforced until adequate port reception facilities are put in place. Jamaica does not yet have such facilities.

Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region) (1983)
Adopted in March 1983 in Cartagena, Colombia, the Convention is the only legally binding environmental treaty for the Wider Caribbean. The Convention came into force in October 1996 as a legal instrument for the implementation of the Caribbean Action Plan and represents a commitment by the participating governments to protect, develop and manage their common waters individually and jointly.

Ratified by twenty countries, the Cartagena Convention is a framework agreement, which sets out the political and legal foundations for actions to be developed. The operational Protocols, which direct these actions, are designed to address special issues and to initiate concrete actions. The Convention is currently supported by three Protocols. These are:

- ◊ *The Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region* (The Oil Spills Protocol), which was adopted and entered into force at the same time as the Cartagena Convention.;
- ◊ *The Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region* (The SPAW Protocol), which was adopted in two stages, the text in January, 1990 and its Annexes in June, 1991. The Protocol entered into force in 2000.
- ◊ *The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region* (LBS Protocol), which was adopted in October, 1999. Four of the Contracting Parties have already signed the Protocol and the remaining sixteen are expected to sign.

5. POTENTIAL ENVIRONMENTAL IMPACTS

The proposed dredging project will entail capital dredging of hard substrate on the north (Area H1) and south side (Area H2) of the approach channel into West Harbour so as to establish design depths and widths of 10m and 92m respectively. A HCSD will be employed for this work. The project will also entail some capital dredging of muddy sediments at the mid-eastern side of the harbour basin (Area S2) to safely accommodate larger cruise ships at the Ken Wright Pier. A THSD will be used for this work as well as for any maintenance dredging required, including the removal of soft sediments at Area S1.

This section of the report identifies the potential environmental impacts and possible issues that could arise from implementation of these works using both the cutter suction dredge and a trailing head hopper dredge. Their inclusion does not mean that they would necessarily occur or that they could not be successfully mitigated.

5.1 Dredging

5.1.1 Excavation

5.1.1.1 Loss of coral community

Dredging of the deep rocky ledge along the north side of the approach channel at Site H1 will result in the short-term irreversible loss of the existing coral communities living on the affected area. It should be borne in mind that at least 50 % of the 2,600m² reef area is presently comprised of dead individuals. The potentially negative impacts on the associated fish species are thought to be less severe given that that there are adequate reef and sea grass bed ecosystems within less than a 1 km radius of the site to which they may retreat. Over time, recruits of the same coral species are likely to recolonise the fresh rock face of the now deepened plateau and a similar new reef ecosystem would become established. Thus, the immediate negative impact of deepening the approach channel would be reversed over the long-term period (say 10 to 30 years).

The reef community and sea grasses living on the slope above 7m should not be directly affected. The predominantly fast 0.232 m/s southwestward current in the channel, which maintains excellent water clarity in this section of the channel, is expected to promote rapid sediment transport of turbid waters away from the immediate area and into the channel. This will tend to reduce the time period over which undisturbed coral and sea grass species would have to endure deteriorated water clarity.

5.1.1.2 Sediment dispersal

The rotary action of the cutter head in the case of a cutter suction dredge, and the dragging of the suction pipe along the bottom in the case of a hopper dredge, will disturb the substrate and place sediments into suspension. These suspended sediments may then smother nearby bottom-living flora and fauna as and when they settle. The effect will be greatest in those areas with fine sediments, which are more easily placed into suspension, i.e. Areas H2, S1, & S2. The suspension of sediments would be minimised to the extent that the powerful suction pumps on the dredgers are able to suck up these materials out of the water column.

The potential impacts of sediment dispersal are considered to be of moderately high significance at the entrance to the approach channel where the suspended sediments may get caught up in the westerly currents flowing through the channel. These currents could carry suspended sediments over corals living down stream along the sides of the channel. It should be noted that the coral communities in the channel are in relatively good condition (see Section

3.2.2) and, therefore, the direct impacts of sedimentation, although limited in duration could be moderate to severe on those communities close to the dredging site. It is very unlikely that the coarse sediments brought into suspension in the channel would be carried across to the northern side of West Harbour to adversely impact the reef between Navy Island and Nose Point as these would be expected to settle fairly rapidly. Furthermore, the dredging activities in the channel should not exceed one day, thus limiting the amount of material placed in suspension.

Dredging of the soft mud in the middle part of the basin (Area S2) is likely to create high levels of suspended sediments since this type of material has a low specific gravity and is easily placed into suspension. There is very little biota living in these muds that would be affected by sediment settlement. The transport of these suspended materials is not likely to be extensive, however, due to the very weak currents in this enclosed part of the bay (see Section 3.1.7.2 above). This is borne out by observations made during the recent coastal works carried out for the new marina development project. It is also not likely that these suspended sediments would be carried over the Navy Island/Nose Point reef and shallow water communities in any deleterious quantities due to the above reason as well as to the fact that dredging activities here would not last for more than a day.

5.1.1.3 Water turbidity

The suspension of fine sediments in the water column creates turbidity, which scatters and attenuates light levels and potentially affects the growth of plants and corals indirectly by reducing the availability of light and consequently the photosynthetic process in plants and coral symbionts.

High levels of localised turbidity can be expected during dredging of the mud at Area S2. Due to the weak water currents in this part of the bay, the turbidity is not expected to move very far. There is no sensitive biota in the vicinity of Area S2 to be adversely affected by light attenuation.

It should also be noted that the turbidity regularly occurring in the harbour after prolonged rainfall (as was experienced on several occasions recently), would potentially have a much more deleterious effect than that caused by the proposed short-duration dredging works.

5.1.1.4 Shipping hindrance

In terms of the possibility of impeding shipping, a HCSD remains stationary during excavation, being fixed in position by spuds at each dredging location. It cannot therefore quickly move away while operating in the channel to allow free passage to visiting ships. On the other hand, a TSHD excavates by dragging the suction head over the sea floor and is easily able to move away from the path of ships, and is thus least likely to interfere with normal shipping routines at West Harbour. Given the fact that only two vessels visit Port Antonio each week (see Section 3.3.6.4) this potential impact is not considered as being significant.

5.1.2 Hopper dredge spillage and leakage

5.1.2.1 Deliberate spillages

It is a practice in some dredging operations to maximise the amount of solid material in the hopper hold by allowing the slurry water mixed with the dredged material to overflow from the vessel. In the case where fine sediments are being dredged, this results in high turbidity of the water surrounding the vessel, which could then be transported by surface water currents over sensitive habitats.

A second means of deliberate spillage occurs when the bottom gates of the hopper hold are opened slightly so as to release sediments while the vessel is on route to the disposal site. Where appropriate controls and disposal site records are not in place, this practice can shorten the turn-around period for the trip with obvious financial benefits. The resulting impacts of turbidity and sedimentation would be most severe in the vicinity of the inshore fringing reefs when the hopper vessel is moving out to sea. It should be noted that the dredging contractors engaged by PAJ for the proposed dredging works at Port Antonio are required to keep careful logs of dredged material disposal trips and that, therefore, this potential impact is not expected to occur.

5.1.2.2 Accidental spillages

The amount of material leaking from the bottom gates of a hopper dredge (or hopper barge) would normally be insignificant. However, if a hard object or rock becomes lodged between the gates, then material will steadily spill out of the ship's hold into the water column. As applies above, the resulting impacts of turbidity and sedimentation would be most severe in the vicinity of inshoe fringing reefs when the THSD vessel was moving out to sea.

5.1.3 Noise

Given the proximity of the 24/7 dredging operation to residential areas, marinas and yachts, the noise generated by the dredging vessels may cause a level of auditory discomfort, especially at night, which is difficult to evaluate in the absence of any noise measurements for dredging operations. However, given the very short-term nature of the dredging works, it is not expected that these sounds would be intolerable. Recent piling activities carried out in Port Antonio did not generate any public outcry. Furthermore, the dredging vessels being employed to carry out the dredging works are very modern vessels fitted out with noise abatement equipment.

5.1.4 Visual/seascape impacts

To some individuals, the presence of the dredging vessels possibly could appear as a visual intrusion on the normal seascape at West Harbour. However, given the normal nature of shipping activity in this area, and the short-term nature of the proposed dredging operation, this potential impact is not considered to be intolerable or significant.

5.1.5 Impairment of fishing activities

Apart from incidental recreational-type hand fishing done from the shoreline, no commercial fishing activities normally take place in the West Harbour, except perhaps, during periods of bad weather. In that case, dredging operations could have an impact on local fishery activities through the generation of turbidity and dispersed sediments which prevent fishermen being able to see and find their fish pots, clog gill nets, and cause suffocation of fish caught in traps. However, all the fishermen interviewed have indicated their support for the dredging project (see Section 3.3.3) and the brevity of the proposed dredging operations would militate against such events.

5.1.6 Modification of wave and current pattern inside harbour

The minor modifications (1m or less) of the bathymetry of the channel and West Harbour are not likely to significantly change the existing pattern of currents and waves in the bay.

5.2 Spoil disposal

5.2.1 Deep-sea disposal

The disposal of fine dredged materials at sea by the THSD will cause turbidity in the water column and, perhaps, settlement of the material over deep-water benthic communities. That is

not likely to be significant since the sediments are fine grained and will therefore become quickly and widely dispersed. The potential severity of the impact would be dependent on the location of the disposal site relative to valuable shallow water ecosystems (e.g. coral reefs, mangroves, recreational bathing waters). The proposed disposal site is located in deep water at the 1000m contour (see window insert at Figure 2.1) where prevailing currents will not bring the settling material back inshore. The above is not to suggest that the deep-water benthos does not contain valuable biological resources but these are, presumably, not as vulnerable to diffused sedimentation as would be shallow water coastal ecosystems.

This option precludes any re-use of the dumped materials but avoids the potential impacts associated with on-land disposal and de-watering. In any case, the muddy sediments do not have much application for re-use. As pointed out above in Section 5.1.2, leakage of materials to be dumped while the hopper vessel is in transit through inshore waters, could have an adverse short-term impact on inshore biological resources.

5.2.2 Inshore sea disposal

There has not been the opportunity to investigate the sea floor at the proposed disposal site for coarse materials at the mouth of East Harbour (see window insert at Figure 2.1). It is likely that this area is comprised of open sand, perhaps with sparse growths of sea grasses and sponges. The proposal to spread the sediments in a layer approximately 1m thick (see Section 2.5.2) will smother any existing biota on the sea floor in the area (approx. 35,000m^2) to be covered. On the other hand the material would provide suitable substrate for eventual re-colonisation and re-establishment of the biota.

5.3 Summary of Potential Impacts

Table 5.1 below summarises the potential impacts related to cutter suction dredging and suction hopper dredging operations at West Harbour respectively. In some cases measures can be taken to avoid or reduce the severity of the impact, and the appropriate mitigation measures are identified below in Section 6. In other cases the impacts cannot be avoided or successfully mitigated if the project is implemented and these represent irreversible impacts.

Those potential impacts relevant to the proposed project are:

Positive

1. Improved capacity of entrance channel and harbour to accept larger vessels.
2. Improved navigational safety in entrance channel.
3. Improved ship mooring space at Ken Wright Pier.
4. Increased foreign exchange earnings and economic activity related to increased cruise ship visits and tourism services.

Negative

5. Loss of < 2,600 sq.m. of coral community (Site H1) and benthic biota (Site H2) at entrance to channel.
6. Sedimentation and turbidity over coral and seagrass communities along approach channel and at Navy Island/Nose Point due to suspension and dispersal of fine sediments.
7. Medium term loss of biota at ~35,000m^2 disposal site for coarse dredged material at entrance to East Harbour.

Table 5.1 West Harbour Dredging - Summary of Potential Adverse Environmental Impacts

ACTIVITY	POTENTIAL NEGATIVE IMPACTS	DIRECTION		Impact Significance	Mitigation Possible	DURATION		LOCATION		MAGNITUDE		EXTENT	
		Positive	Negative			Long	Short	Direct	Indirect	Large	Small	Wide	Local
Dredging													
1. Excavation and suction pumping													
1.1 Substrate removal	Loss of coral community at Site H1		3	**High**	**No**	3		3		3			3
	Loss of benthic biota at Site H2		3	**Mod**	**No**	3		3		3			3
	Modification of current & wave pattern		3	**Low**	**No**	3		3			3		3
1.2 Sediment disturbance and overfilling of hopper dredge	Settlement of suspended solids on reef		3	**Mod**	**Yes**		3		3		3		3
	Attenuation of light in water column		3	**Low**	**Yes**				3				3
	Dispersion of contaminated sediments		3	**Low**	**Yes**		3		3		3		3
	Degradation of pelagic habitat		3	**Low**	**Yes**		3		3		3		3
	Damage to fishing gear		3	**Low**	**Yes**		3		3		3		3
1.3 Presence/location of dredges	Increased ambient noise level		3	**Low**	**Yes**		3	3			3		3
	Impaired visual aesthetics/seascape		3	**Low**	**No**		3	3			3		3
	Hindrance to other ship traffic		3	**Mod**	**Yes**		3	3			3	3	
Dredged material disposal													
2. Deep-sea disposal													
2.1 Leakage of sediments during transport to disposal site	Increased turbidity over sensitive inshore habitats		3	**Mod**	**Yes**		3		3		3		3
2.2 Sediment disposal	Sedimentation of deep-water benthic habitat		3	**Mod**	**No**		3		3		3	3	
	Degradation of pelagic habitat		3	**Mod**	**No**		3	3			3	3	
3. Harbour entrance disposal													
3.1 Coarse material spreading	Smothering of benthic biota		3	**Mod**	**No**	3		3		3			3

8. Short-term impacts on pelagic environment due to suspended sediments and turbidity arising from deep-sea disposal of fine dredged material.
9. Hindered ship traffic due to dredging operations.

6. PROJECT ALTERNATIVES

6.1 'No Dredging Project' Scenario

The approach channel leading to West Harbour has not been dredged since 1938 and the safe passage of larger cruise ships is presently compromised by rocky outcrops on either side of the channel. Furthermore, water depths at the southern end of the berthing line at the Ken Wright Pier are too shallow to allow safe mooring of these larger vessels. Not implementing the required channel and basin dredging implies that Jamaica will not be able to attract larger cruise vessels to West Harbour and this opportunity for increasing the tourism market will not be realised. There is no alternative to achieving the project objective apart from dredging.

6.2 Dredge Type

The two kinds of dredge vessels presently available in Jamaica to undertake dredging at the West Harbour will be employed since each is appropriate to the two types of dredging to be undertaken. The HSCD is especially suited for the cutting and maceration of the rocky outcrops occurring in the approach channel, which the THSD would not be able to do. The THSD is better able to remove the soft sediments found near Ken Wright Pier in a manner that would least disturb and place the sediments into suspension.

6.3 Disposal Options

The dredged material disposal options proposed for this project have been discussed above at Sections 2.5 and 5.2.

6.3.1 On-land disposal

No appropriate sites for on-land disposal were found in proximity to the proposed dredging operations, primarily due to the physiographic constraints and intensive land use in the coastal area. Therefore the only option available for disposal of dredged material taken from West Harbour is at sea.

6.3.2 Sea disposal

Sea disposal is the only option available for the THSD. This mode of disposal is preferred for the fine dredged materials arising from West Harbour since they would have limited re-use value and would be difficult to treat and de-water on land.

6.3.2.1 Inshore disposal

The disposal of fine dredged materials in shallow inshore waters is problematic in that it can lead to the re-suspension of the materials in the water column and the generation of turbidity, both with attendant adverse consequences for marine biota. It also causes the direct smothering of any sedentary biota at the disposal site. The issues related to suspended solids and turbidity are lessened in the case of coarser materials since these tend to settle relatively quickly, especially where there are no strong water currents to disperse them as they settle.

Consideration has been given to the deposition of the coarse cuttings produced by the HCSD in the approach channel, to be picked up afterwards with the THSD for deep-sea disposal. However, this is apparently not feasible given the uneven nature of the channel bottom, making it difficult for the hopper dredge to find the relatively small amounts of dredged material. Therefore it is presently proposed to spread the coarse dredged materials over the sea floor in 30m - 40m depths at the entrance to East Harbour. However, a rapid survey of the area will be carried out before commencement of dredging to determine the nature of the biota and the potential impacts before an option is selected.

6.3.2.2 Deep- sea disposal

Given the inherent problems associated with the disposal of fine sediments in shallow waters around West Harbour it is proposed to cart this type of material in the THSD out to the 1000m contour for disposal at a site approximately 3km north of Port Antonio. Here, the strong predominantly westerly current will disperse the sediments in the water column as they settle to the bottom.

7. IMPACT MITIGATION MEASURES AND COSTS

7.1 Mitigation Measures

Table 7.1 below list the potential impacts identified above in Section 5 and describes the corresponding mitigation measures that should be put in place during implementation of the proposed dredging works at West Harbour. In summary the impact mitigation measures proposed should entail:

1. Good dredging practice to minimise sediment suspension and dispersal at the dredging sites

2. Deployment of a silt barrier across the eastern side of the Navy Island/Nose Point shallow reef community. The silt screen should extend southwards for 300m from a convenient point at the SW end of the Navy Island shoreline, approximately along the 6m contour.

3. Independent environmental monitoring of the project to ensure use of silt screens, disposal of dredged material only at approved sites, and compliance with turbidity standard over reef area. (Monitoring should include aerial overflight of first deep sea disposal trip confirm acceptable sediment dispersion at disposal area).

4. In consultation with the manager of Boundbrook Wharf, schedule dredging operations so as to avoid or minimise disruption of regular banana shipping.

5. Advise local residents and yacht persons, prior to commencement, of the intended dredging operations, associated noises, and the short duration of nuisances.

7.2 Mitigation Costs

The mitigation measures associated with significant costs, beyond those of dredge equipment rental and deployment, and good dredging practice, are identified below along with the major cost elements.

Table 7.1 West Harbour Dredging – Potential adverse impacts and corresponding impact mitigation measures.

ACTIVITY	POTENTIAL IMPACTS	IMPACT MITIGATION MEASURES
Dredging		
1. Excavation and suction pumping		
1.1 Substrate removal	Loss of coral community at Site H1	1. Minimise habitat loss by applying careful control of cutter head, restrict digging to specified boundaries.
	Loss of benthic biota at Site H2	2. Apply measures at #1 above to minimise habitat loss.
	Modification of current & wave pattern	3. N/A
1.2 Sediment disturbance and overfilling of hopper dredge	Settlement of suspended solids on reef	4. Apply good control of ladder swing speed and cutter head rotation speed to minimise sediment dispersion. 5. Do not allow overfilling of hopper and resultant spillage. 6. Deploy silt screens in front of Navy Island/Nose Point reef to prevent sedimentation on corals and turbidity. 7. Do not exceed NEPA turbidity standards over same reef above.
	Attenuation of light in water column	8. Apply measures at #4 & #5 above to minimise sediment dispersion.
	Dispersion of contaminated sediments	9. N/A
	Degradation of pelagic habitat	10. Apply measures at #4 above to minimise sediment dispersion.
	Damage to fishing gear	11. Apply measures at #4 above to minimise sediment dispersion.
1.3 Presence/location of dredger	Increased ambient noise level	12. Advise local residents before commencement of dredging works.
	Impaired visual aesthetics/landscape	13. N/A
	Hindrance of other of ship traffic	14. Coordinate location of dredging activity with Boundbrook Wharf manager to reduce shipping delays.
Dredged material disposal		
2. Deep-sea disposal		
2.1 Leakage of sediments during transport to disposal site	Increased turbidity over sensitive inshore habitats	15. Independently monitor vessel logs and records for each disposal trip. Employ appropriate electronic monitoring equipment.
2.2 Sediment disposal	Sedimentation of deep-water benthic habitat	16. N/A
	Degradation of pelagic habitat	17. N/A
3. Harbour entrance disposal		
3.1 Coarse material spreading	Smothering of bottom-living biota	18. N/A

1. Control of suspended sediment dispersal
   - Silt screen purchase and repairs
   - Deployment of turbidity meters over reef

1. Monitoring of deep sea disposal
   - Employment of environmental persons to monitor TSHD during deep sea dredged material disposal
   - Aerial monitoring flight (1 hour)

8. IMPACT MONITORING PLAN

The impact monitoring plan (IMP) is presented below in outline form. It should be detailed and completed when the final dredging action plan has been determined.

The purpose of the IMP is to monitor or control the environmental effects of the dredging process. It should be based on compliance, verification, feedback, and know-how. It should be able to provide responses to the following three questions:

i) Why is monitoring being conducted?
ii) What specifically is being carried out?
iii) How are the data and information to be used in planning and decision-making?

In the case of the proposed dredging works, environmental monitoring is particularly necessary to ensure that suspended sediments generated during excavation and during disposal of the dredged materials, do not adversely affect the health of the coastal ecosystems within West Harbour and elsewhere along the coast. This could be achieved by:

1. ensuring that the deliberate disturbance and removal of bottom sediments during dredging are done technically in a manner (i.e. appropriate dredge type and operational procedures) that minimises the degree and extent of fugitive sediment suspension;
2. ensuring that the fine sediments generated from Areas S1 and S2 are only released at the approved deep sea disposal site.

The monitoring programme should therefore focus on;

1. use of appropriate and specified dredging equipment for maintenance and capital dredging;
2. confinement of dredging to the specified dredging areas;
3. frequent measurements (say twice daily) of water turbidity at the active dredging areas, and at two sampling stations located at the coral reef between Navy Island and Nose point;
4. constant surveillance of the operations of the TSHD during transit to and sediment release at the approved deep sea disposal site;
5. constant surveillance of the operations of the HCSD during deposition of coarse dredged materials at the entrance to East Harbour.

The turbidity compliance standards will have to be established for the project, particularly for the reef area, after consultation with NEPA. The standards set should take into account normal prevailing water quality conditions and the relatively short duration of the dredging works.

The results of the turbidity measurements, which should be taken independently with *in situ* instrumentation, should immediately be recorded formally and made available to the dredging supervisor so that any corrections and adjustments to dredging operations can be made quickly.

The environmental monitor must have the authority to halt dredging and/or sediment disposal operations should this become necessary to protect the reef ecosystems at risk.

9. EMERGENCY CONTINGENCY PLAN

In an environmental context, the critical emergency situation that could arise during the proposed dredging works is the collision between one or other of the dredge vessels and another ship in the harbour, resulting in the significant release of oil.
In that event, reference should be made to the national oil spill response procedures. Adequate oil spill containment equipment should be available for immediate deployment at or near the project site during the dredging works. Major spills should immediately be reported to the JDF Coast Guard, and the Office of Disaster Preparedness and Management. Emergency contact numbers should be made available to the dredging contractor.

10. CONCLUSIONS AND RECOMMENDATIONS

This EIA has been carried out on the basis that it is necessary to carry out capital and some maintenance dredging at West Harbour to increase the capacity of the approach channel to accommodate larger cruise ship vessels and to extend the berth space at Ken Wright Pier.

10.1 Conclusions

The main conclusions arising from the EIA study are:

1. The substrate to be removed along the sides of the approach channel into West Harbour (Areas H1 and H2) is predominantly hard limestone material with some overlay of fine sediments.

2. Removal of the above substrate will result in the irreversible loss of small coral reef communities established on the rocky ledges.

3. The substrates to be removed within West Harbour at Areas S1 and S2 are comprised of soft grey muds not containing or supporting any significant biota.

4. The total amount of dredged material to be removed by the proposed dredging works is estimated at 50,000 cu.m., approximately made up of coarse rock cuttings (35,000 cu.m.) and of fine sediments (15,000 cu.m.).

5. Given the absence of any major industrial and on-going boatyard activity in the vicinity of Port Antonio it is unlikely that the dredged material will contain any significant levels of contaminants.

6. The remaining potential impacts of the proposed dredging works that have been identified are:
   a. suspension of fine sediments in the water column during dredging excavation that could result in deleterious turbidity and sedimentation over the shallow reef system between Navy Island and Nose Point;
   b. suspension of fine sediments in the water column during disposal of the fine sediments at the proposed deep sea disposal site; and

c. smothering of any sessile biota on the sea floor by coarse dredged materials at the proposed disposal site at the entrance to East Harbour.

7. Given the very short duration of dredging works (2 – 3 days) and the levels of turbidity normally experienced in West Harbour after heavy rainfall events it is unlikely that the effects of suspended sediments and turbidity due to the proposed dredging project would cause intolerable impacts on the biota.

8. Satisfactory mitigation of these impacts identified at #6 above can be achieved by:
   a. properly controlled dredging operations and restriction to designated dredging sites to minimise sediment suspension;
   b. deployment of silt screens along the eastern face of the Navy Island/Nose Point shallows to prevent movement of any suspended sediments over the reef; and
   c. disposal of the fine sediments at deep water site where prevailing currents will disperse materials away from inshore habitats.

9. Fishing areas currently used by fishermen from the three fishing beaches around Port Antonio will not be adversely affected by dredging since the works will not be carried out in traditional fishing grounds, they will be of short duration, and any dispersal of suspended sediments will be contained within West Harbour.

10. It is possible to carry out the proposed dredging works at West Harbour without unacceptable adverse environmental effects.

11. There are no known plans for further dredging at West Harbour within the foreseeable future. It is also not likely that maintenance dredging will be required in the near future but note should be taken of the current levels of sediment deposition at the mouth of the Annotto River (see 10.2, #4 below).

10.2 Recommendations

1. An investigation of proposed inshore disposal site for coarse materials will be carried out to determine the nature of the benthic biota in that area and its suitability for dredged material disposal. The findings of the survey will be presented to NEPA by 17 June 2002. If the site is not suitable, then the coarse materials from the channel will be piled at its mouth and removed by the THSD for deep-sea disposal.
2. Implementation of the dredging works should conform to the mitigation methods and procedures outlined above at Section 7.1.
3. Hold consultations with PAJ, the consulting engineers, the dredging contractors and NEPA to detail best technology for monitoring programme, discuss/agree on compliance standards.
4. Consideration should be given of the present opportunity to remove at least some of the sediments at the mouth of the Annotto River. The river is a constant source of sediment input to the bay and the river delta is fairly rapidly encroaching into the West Harbour basin.

11. REFERENCES

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Smith Warner International Limited (1996). *Port Antonio Sanitation Project: Chapter IX - Oceanographic Study*. Report submitted to Environmental Solutions Limited/Louis Berger International, Inc., Kingston, Jamaica.

UK Hydrographic Office (1973). *Admiralty Charts and Publications: West Indies, Jamaica - North Coast, PORT ANTONIO (Map #458),* Taunton, Somerset, U.K..

12. APPENDICES

Appendix 1. Terms of Reference for West Harbour Dredging EIA approved by NEPA.

ENVIRONMENTAL SOLUTIONS LTD.
20 WEST KINGS HOUSE ROAD
KINGSTON 10

FINAL AND APPROVED EIA TOR

FOR

PORT AUTHORITY OF JAMAICA

West Harbour Dredging Project

Terms of Reference for Environmental Impact Assessment

The following TOR for the EIA of the proposed dredging works in Montego Bay Harbour are adapted from World Bank and NEPA environmental assessment guidelines. They make reference to NEPA *Guidelines for the Planning and Executing of Coastal and Estuarine Dredging Works and Disposal of the Dredged Materials* and also address specific NEPA requirements for this EIA as given in letters to PAJ dated 21 February 2002 and 8 April 2002.

1. *Introduction - Identify the development project to be assessed and explain the executing arrangements for the environmental assessment. Describe the rationale for the development and its objectives. Describe the context for the proposed dredging works in relation to future plans for development of Montego Bay port.*

2. *Background Information –Briefly describe the major components of the proposed project, the implementing agents, a brief history of the project and its current status.*

3. *Study Area - Specify the boundaries of the study area for the assessment as well as any adjacent or remote areas that should be considered with respect to the project (e.g. dredged material disposal site/s).*

4. *Scope of Work - The following tasks will be performed:*

   Task 1. Description of the Proposed Project - Provide a full description of the relevant parts of the project, using maps at appropriate scales where necessary. This is to include: quality and volume of sediments to be excavated in each area to be dredged; type of dredging equipment to be used and the manner of deployment including handling, transportation, and disposal of dredged material, sediment containment settling and turbidity control measures; alternative dredging methods considered; project schedule; and life span.

Task 2. Description of the Environment - Assemble, evaluate and present baseline data on the relevant environmental characteristics of the study area (and disposal sites), including the following:

a) Physical environment: geomorphology, meteorology (rainfall, wind, waves and tides), sea currents and bathymetry, surface hydrology, estuarine/marine receiving water quality, and ambient noise.

b) Biological environment: terrestrial and marine vegetation and fauna, rare or endangered species, wetlands, coral reefs, and other sensitive habitats, species of commercial importance, and species with the potential to become nuisances or vectors.

c) Socio-cultural environment: shipping activities and use of the port, population, land use, planned development activities, employment, recreation and public health, community perception of the development, vulnerable occupants.

d) Hazard vulnerability; vulnerability of area to flooding, hurricanes, storm surge, and earthquakes.

Characterise the extent and quality of the available data, indicating significant information deficiencies and any uncertainties associated with the prediction of impacts.

Task 3. Legislative and Regulatory Considerations - Describe the pertinent legislation, regulations and standards, and environmental policies that are relevant and applicable to the proposed project, and identify the appropriate authority jurisdictions that will specifically apply to the project.

Task 4. Determine the Potential Impacts of the Proposed Project – Identify impacts related to dredging, spoil disposal and possible land filling. Distinguish between significant impacts that are positive and negative, direct and indirect (= triggering), and short and long term. Identify impacts that are cumulative, unavoidable or irreversible. Identify any information gaps and evaluate their importance for decision-making. Special attention will be paid to:

- *Effects of the project (dredging and spoil disposal) on water quality and existing coastal ecosystems and resources with specific reference to the Montego Bay Marine Park and the Bogue Lagoon Fish Sanctuary,*
- *Effects of storm water drainage from proposed spoil disposal sites, including potential for off-site flooding,*
- *Effects of dredging on the coastal stability of adjacent shorelines,*
- *Effects of dredging works on the existing operations of the port, the adjacent yacht club, fishermen, and on the rights/operations of any other stakeholders,*
- *Effects of the project on future port development and the tourism sector,*
- *Effects of the project on maritime, boating and road traffic,*

- *Effects of the project on ambient noise levels, and*

- *Effects of the project on any historical resources.*

Task 5. Analysis of Alternatives to the Proposed Project. – Describe the alternatives examined for the proposed project that would achieve the same objective including the "no action alternative. This includes dredging vessel types and disposal sites. Distinguish the most environmentally friendly alternatives.

Task 6. Mitigation and Management of Negative Impacts – Identify possible measures to prevent or reduce significant negative impacts to acceptable levels with particular attention paid to dredge spoil disposal and dispersal/sedimentation control, as well as measures to minimise disruption to existing port and yacht club operations. Cost the mitigation measures, equipment and resources required to implement those measures. Propose mechanisms for investigating claims for compensation put forward by affected stakeholders.

Task 7. Development of a Monitoring Plan – Identify the critical issues requiring monitoring to ensure compliance to mitigation measures and present impact management and monitoring plan for dredging/disposal operations.

Task 8. Assist in Inter-Agency Coordination and Public/NGO Participation – Identify appropriate mechanisms for providing information on dredging activities and progress of project to stakeholders. Assist in co-ordinating the environmental assessment with the relevant government agencies and in obtaining the views of local stakeholders and affected groups. (It is anticipated that there will be considerable public interest concerning issues of sediment disposal and turbidity with respect to the marine park, and the economic benefits to be derived from the project.)

Report - The environmental impact assessment report, to be presented in digital format, will be concise and focus on significant environmental issues. It will contain the findings, conclusions and recommended actions supported by summaries of the data collected and citations for any references used in interpreting those data. The environmental assessment report will be organized according to, but not necessarily limited by, the outline suggested below.

- *Executive Summary*
- *Description of Proposed Project*
- *Policy, Legal and Administrative Framework*
- *Description of the Environment and Hazard Vulnerability*
- *Significant Environmental Impacts*
- *Impact Mitigation Measures*
- *Impact Monitoring Plan*
- *Inter-Agency and Public/NGO Consultation Process*
- *Appendices/List of References*

Appendix 2. Notice to Mariners taken from the *Daily Gleaner*, 6 January 1938.

Appendix 3. PAJ Project brief

The following is a transcript of the project brief provided to the environmental consultants by PAJ and which formed the basis for subsequent discussions leading to the preparation of the Terms of Reference for the EIA. The Consultants were specifically instructed to confine their attention at this time to the impacts directly attributable to the proposed dredging works and not to any consideration of options for future port development and construction.

PORT ANTONIO – WEST HARBOUR
PROPOSED DREDGING

With the imminent development of the yacht marina, there is further interest in improving the maritime access to accommodate larger cruise vessels for the general development of tourism in Port Antonio.

The objective of this exercise is to study the hydrographic charts of the harbour and determine the areas, which need to be dredged in order to safely accommodate larger cruise vessels at Ken Wright pier. Currently the maximum size of vessels operating in West Harbour is:

- ◊ Maximum length – 167.6m (550 feet)
- ◊ Maximum draught – 7.92m (26 feet)

From a review of the newer cruise vessels up to 228.6m (750 feet) – the maximum draught was found to be 7.75m. (The "Celebration" – 223.5m – maximum draught 7.75m).

Allowing for an underkeel clearance of 800mm it would require a minimum depth of 8.72m (28.6 feet) to safely accommodate vessels with the current recommended maximum draught of 7.92m (26 feet).

Allowing for siltation, the minimum depth should be maintained at 9m.

If Port Antonio is to accommodate the older cruise vessels such as the "Sea Breeze" (184.6m) and "Enchanted Isle" (188.2m) which regularly called at Montego Bay, the depth will have to be further increased as their maximum draughts are 8.846m (29 feet) and 8.3m (27.4 feet) respectively.

Allowing for 800mm clearance, the minimum depth of available water would need to be 9.6m ($31^1/_2$ feet). With the small increase in the proposed dredged area to take the depth to 9.6m from 9m; consideration should be given to increasing the designed depth to 9.6m in order to give the port more flexibility.

Entrance Channel

The entrance channel is quite deep on the "leading line" or centre line with depths varying from 10.7m to 17m. However, there are shallow areas, which extend towards the centre of the channel, limiting the useable width of the channel.

The proposed area of dredging in the channel will create a straight and uniform sided channel of approximately 91.5m wide, which is approximately 3 times the width of the cruise vessels – "Veendam" and "Statendam" of length 219.21m and beam of 30.8m.

Basin

At present the depths in the basin vary between 10m and 14m with a swinging area of approximately 300m (984 feet).

With the proposed dredging, the turning area would increase to approximately 440m (1440 feet).

Using the guidelines of $1^1/_2$ to 2 times the length of the vessel needed for a safe turning area; it therefore means that theoretically, a vessel of 213m (700 feet) to 228m (750 feet) can be accommodated.

Notwithstanding the above, it is strongly recommended that a simulation exercise be carried out with 750 feet vessels to confirm that they can safely manoeuvre in Port Antonio West Harbour.

This is necessary due to other factors, which have to be taken into account; such as:

- ◊ Proximity to hazards such as reefs
- ◊ Narrow Channel
- ◊ The dead end configuration of the port
- ◊ The proximity of Boundbrook Wharf, Ken Wright pier and the proposed Yacht pier

Consideration must also be given to the strength of the Ken Wright pier and the mooring arrangements for the larger vessels to be accommodated.

Attached is a survey chart of 1992 of West Harbour indicating the limit of the 9m and 9.6m depths, and the proposed area for dredging. A recent hydrographic survey has been carried out (September 2001) and the results will be available shortly. It is expected that minor adjustments may be required to the proposed dredge areas when the new survey sheets are available.

Captain Gimen Mendes

October 12 2001

13. PLATES