GUIDELINES FOR THE PLANNING AND EXECUTION OF COASTAL AND ESTUARINE DREDGING WORKS AND THE DISPOSAL OF THE DREDGED MATERIALS

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GUIDELINES

for the

PLANNING & EXECUTION

of COASTAL and ESTUARINE DREDGING WORKS

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DREDGED MATERIALS

prepared for NATURAL RESOURCES CONSERVATION AUTHORITY

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NRCA Guidelines for the Planning & Execution of Coastal and Estuarine Dredging Works and Disposal of the Dredged Materials

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NRCA Guidelines for the Planning & Execution of Coastal and Estuarine Dredging Works and Disposal of the Dredged Materials

1. INTRODUCTION

1.1 NRCA's Mandate.

By legislation passed in Parliament in April 1991, government of Jamaica has endowed the NRCA with wide-ranging general powers to manage and protect the country's natural resources, and particularly to institute appro-riate Permitting and Licencing procedures designed to ensure that due con-ideration is given to conservation and environmental protection throughout the planning and implementation stages of development projects.

1.2 The Purpose of This Document.

In order to be able to more efficiently and effectively fulfill its mandate, the Authority intends to publish a series of Guidelines and Standards which will be made available to other Government of Jamaica agencies and to private interests, including potential investors in the various industrial sectors, to inform them of the relevant obligations that will have to be satisfied in order for them to obtain the construction permits and operating licences from NRCA that are required by law.

1.3 The Specific Subject of These Guidelines.

This document offers guidance on the permitting process, and the engineer-ing and environmental aspects, of projects involving *Capital Works dredging* and *Maintenance dredging* -guidance that is intended to eliminate or mitigate the potentially harmful impacts that dredging works can have upon the coastal and estuarine environment.

2. THE COASTAL ZONE

2.1 Definition of the Coastal Zone

There is no single all-purpose definition of the coastal zone that is internationally current. Definitions cover spatial areas ranging from relatively narrow marginal strips of land and sea, up to broad concepts encompassing even the watershed areas which drain directly to the sea as well as the entire marine area from the shoreline out to the edge of the continental shelf.
The working definition used by NRCA for the Jamaican coastal zone is "... the area of sea and seafloor extending from the high water mark out to the edge of the island shelf".

2.2 The Importance of the Coastal Zone

The coastal zone is ecologically and economically precious to Jamaica:

- it provides seafood habitat;
- contains elements essential for shoreline stability and flood control;
- provides feasible locations for ports and other vital industrial installations;
- offers natural resources that enhance recreational/tourism use.

However, in Jamaica, as in many other developing countries, the quality of the natural resources of some coastal zone areas is being increasingly degraded due to high population pressure and intensified usage by industrial, commercial and recreational interests.

2.3 Relevant Ecosystems and Other Resources of the Coastal Zone

The important natural ecosystems and other resources of the coastal zone may be categorized as follows: coral reefs, seagrass, coastal wetlands, muddy and sandy bottoms, rocky coasts, heritage sites.
These will be further described as follows:

2.3.1 *Coral Reefs*

Coral reefs are tropical, shallow water ecosystems that typically consist of carbonate rock with interspersions of rubble and sand. Growth of corals requires clear, warm, aerated and nutrient-poor conditions.Coral reefs perform many critical environmental functions:

- Their structure allows them to withstand and dissipate strong wave action, thus protecting land, islands, and beaches from wave damage and shoreline erosion.

- They provide habitat for animals and plants thereby accumulating nutrients for rather complex food webs.

- Coral reefs have the highest reported species diversity of any marine ecosystem, thus they play a substantial role in the preservation of global biodiversity.

- Some medicinal drugs and other natural products can be derived from coral reef organisms.

2.3.2 *Seagrass*

Seagrass is a group of vascular plants adapted to the marine environment. Some species are also able to live in freshwater. Seagrasses are biologically productive and serve as food for manatees, sea turtles and certain waterfowl. Seagrass beds serve as nurseries for commercial fish.

2.3.3 *Coastal Wetlands*

Wetlands are transitional areas between terrestrial and marine systems, in which the water table is usually at or near the surface, or the land is covered by shallow water. Coastal wetlands act as a buffer between land and sea in a number of ways, such as protecting the land from sea storms. Wetlands are nutrient-rich, provide protective habitat, and are productive nursery areas for fish and shrimp.

In regard to vegetation, the marine wetlands around Jamaica's coastline usually contain seagrass beds and varieties of mangroves. The word "mangroves" refers either to the constituent plants of a tropical intertidal forest community, or to the community itself. Many mangrove trees can grow in both saltwater and brackish environments.

Mangroves provide habitat for many terrestrial and aquatic animals and serve as temporary habitat for spawning, nursery and feeding. They are important in the preservation of biological diversity for many species of plants and animals. Mangrove forests protect coastal areas against erosion and mangrove vegetation filters and purifies water.

2.3.4 *Muddy and Sandy Bottoms*

These ecosystems are constituted by fine muddy or coarser sandy sediments overlain permanently or temporarily by water. The bulk of these sediments is derived from rivers, bedrock and reefs. The composition of the sediment that is eroded transported and deposited in the coastal zone can be further modified by inputs of organic matter contributed by adjacent wetlands.

Muddy and sandy areas serve as nursery grounds for rapidly growing juveniles of many valuable fishery stocks, particularly in shallow water by offering conditions such as reduced predation and greater food availability.

2.3.5 *Rocky Coasts*

Rock commonly forms the coastline wherever there is little sediment inflow, and wherever the onshore elevation is relatively high and wave action strong. Shoreline rocks and boulders are sometimes heavily colonized by large algae.

Rocky coasts provide environmental goods and services and perform important biological functions such as:

- Provide surfaces for attachment of productive marine algae and filter-feeding invertebrates such as oysters;
- Offer feeding or breeding sites for many rare, endangered or protected sea-birds;
- Help dissipate wave energy and thus protect shore sediments and soils from erosion by sea.

3. PERMITTING PROCEDURES

3.1 Project Sponsors Should Make Early Contact With NRCA

3.1.1 Certain types of activities in the coastal zone will give rise to particular effects, and therefore it is important for all concerned to be aware of the particular types of negative effects that are likely to arise from a given type of project. Project Sponsors are therefore encouraged to make contact with NRCA from the very earliest stages of project planning and to seek advice from the Authority in regard to the nature of the particular environmental issues that will have to be satisfactorily addressed in order for them to obtain the necessary permits.

3.1.2 Project Sponsors are advised that as a prerequisite for the granting of dredging Permits, NRCA will have to be satisfied that the least damaging methods of construction and operation will be adopted by the Developer, that appropriate monitoring and mitigation measures will be carried out during execution of the project, and that in the overall, the anticipated economic and social benefits of the proposed project will outweigh whatever disbenefits may be incurred due to either temporary or permanent damage to existing environmental resources.

3.2 Project Sponsors May Be Required To Hold Public Meetings To Inform Local Communities Concerning Their Proposals

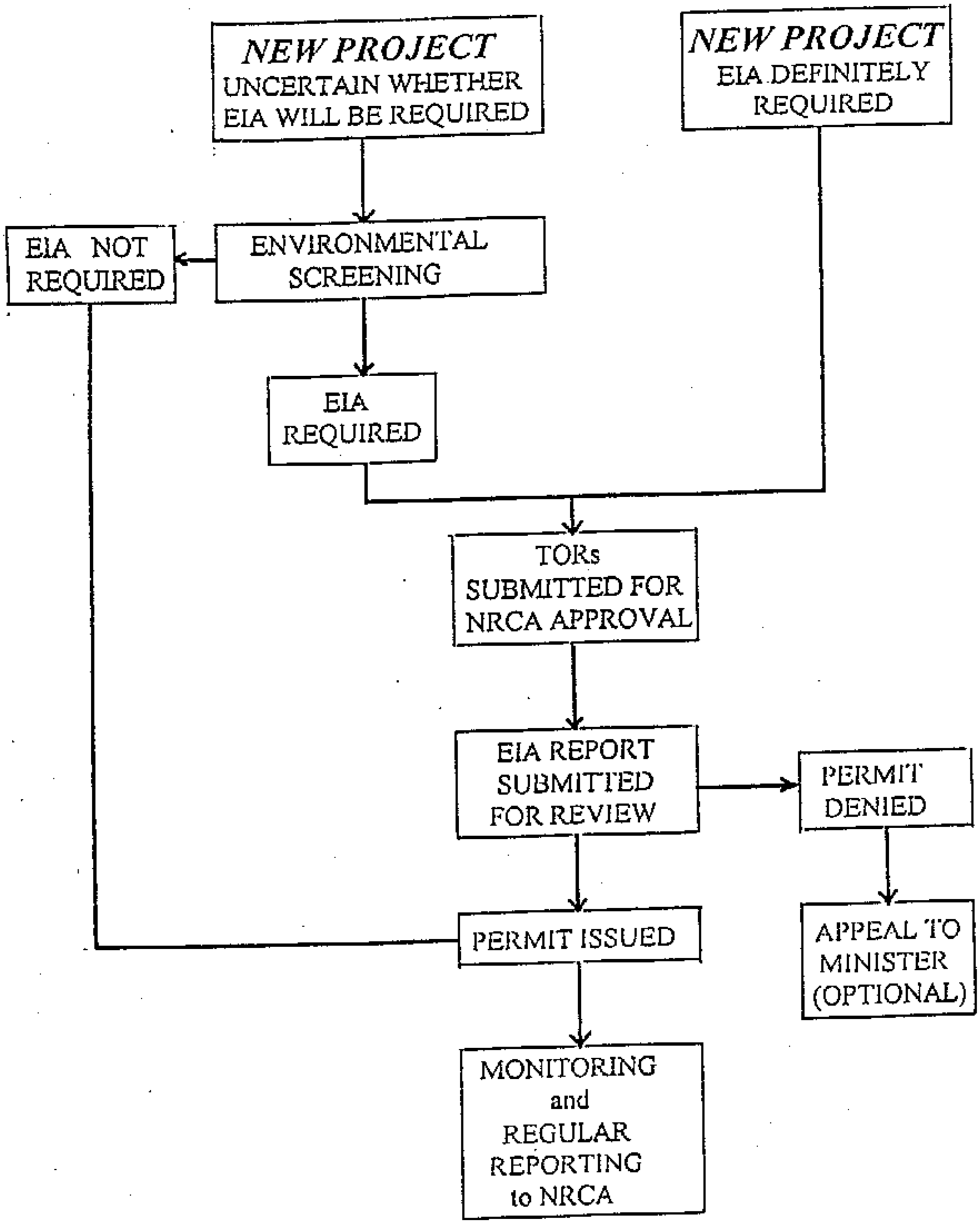
3.2.1 The NRCA may require applicants for dredging permits to consult with other government agencies, and with local interest groups that may be adversely affected. Project sponsors must be prepared to fulfill, as part of the permitting process, NRCA requirements to hold "town meetings" to give opportunities to local populations to voice their opinions concerning proposed projects.

3.2.2 To foster genuine people participation, the site selection process itself must be comprehensive, clearly laid out, and presented in understandable language. Project sponsors should regard town meetings as very valuable opportunities for open consultations with local communities. The adoption of logical, comprehensive and open procedures in site selection may well produce the most satisfactory results for project sponsors as well as the public.

3.3 NRCA's Environmental Review and Permitting Process

Any project which has the potential for affecting the environment must be referred to NRCA for consideration. Documentary information concerning NRCA's Environmental Review and Permitting process can be obtained from NRCA upon request. NRCA's Review Process, leading up to either the granting of a Permit for implementation of the project, or disapproval of the project, is illustrated in the flow chart given overleaf, and the salient points of the review process are explained below.

Flow Chart
NRCA's PERMITTING PROCESS



3.3.1 *Screening*

Every Developer whose project does not automatically require an EIA must submit a completed Project Information Form to NRCA. The form is then reviewed by NRCA staff using specific criteria, and a determination is made as to whether there is need for an EIA. If the environmental impact of the project is expected to be minimal no EIA will be required.

3.3.2 *EIA Notice.*

Based on the assessment of the environmental impact indicated by the Project Information Form, within 10 days of receipt of the Form, NRCA might issue a notice requesting the Developer to do an EIA. Every Developer so notified will have to submit draft Terms of Reference to NRCA for approval. At this stage the Developer will be given general guidelines for conducting the EIA as well as sample Terms of Reference for similar projects if any are available.

3.3.3 *EIA Review*

A draft EIA report (at least six copies) must be submitted to NRCA for review and comments. A preliminary review of the draft is done within ten working days after receival to see if any additional information is required. If additional information is needed this is requested immediately. Upon receipt of the information the NRCA EIA Review Committee will decide which external agency, if any, e.g. Port Authority, the Environmental Control Division of the Ministry of Health, Office of Disaster Preparedness, etc., must be asked to review and comment on the document as well. The Developer may also be granted an audience to fully explain any areas of the draft report that may not be clear enough to the Review Committee. The review process can take up to ninety days. At the end of the NRCA internal review the Developer may be granted provisional approval to proceed with the project, with specific conditions stipulated.

3.3.4 *Public Notification.*

Draft EIA reports are made available to the public at the NRCA library, at local libraries, and at Parish Councils; and the public is notified that an EIA report has been submitted, and that thirty days are allowed for comment. Any comments received from the public are brought to the attention of the Developer by the NRCA.

3.3.5 *Public Presentation*

Depending upon such factors as the scale and magnitude of anticipated impacts, the ecological sensitivity of the project area, and the level of public interest, the Developer might be asked to consult with the NRCA to set a date, time and venue for a public presentation. The hearing will allow the Developer an opportunity to answer questions from the public and to make changes in his proposals wherever necessary. A period of thirty days after the hearing is allowed for acceptance of written comments from the public.

3.3.6 *NRCA Assessment.*

The NRCA will take into account any and all comments received from the public and the concerned external government agencies and give a final response to the Developer as to whether or not his project is environmentally acceptable. The response will summarise the findings of the review of the EIA report, and indicate areas which need further attention, or impose conditions for approval.

3.3.7 *Appeals*

In cases where a project is found to be environmentally unacceptable and is not approved, the Developer may appeal to the Minister with responsibility for the environment against the decision of the Authority, within ten days after the date of the decision.

3.4 Schedule of Fees.

The fees payable to NRCA by Developers for being allowed to carry out dredging in estuaries and within the coastal zone are gazetted under The Beach Control Authority (Licensing) (Amendment) Regulations, 1996.

3.5 Project Sponsors' *Environmental Compliance Officer*

NRCA recommends that at the time of submission of application for a dredging Permit, project sponsors should name an individual who will be responsible on their behalf for ensuring that the Developers' responsibilities to NRCA and the public, for protecting the environment, will be adequately fulfilled. The individual who is designated to be the Developers' ***Environmental Compliance Officer***, shall be suitably qualified for the post, and his/her specific functions in relation to NRCA shall be as follows:

- to oversee on a continuing day-to-day basis, the collection of data and documentation covering all site activities relating to environmental matters;
- to prepare the environmental monitoring reports called for in the approved Monitoring Plan, and submit them to the NRCA at the prescribed time intervals;
- to be available to the NRCA at all times for consultations regarding any environmental issues that might arise during execution of the project.

4. EIAs FOR DREDGING PROJECTS

Dredging is a process whereby large quantities of submerged soil or rock are excavated and removed, and it is inherent in the very nature of such operations that they are likely to give rise to various types of environmental damage. National conservation agencies such as NRCA have to be informed and vigilant in performing their regulaory functions in order to ensure that the potential for negative impacts is satisfactorily controlled. The environmental concerns derive basically from three different perspectives, viz: firstly, the need to protect and conserve valuable in-situ aquatic resources; secondly, the duty to prevent interference with other legitimate users; and thirdly, the responsibility to safeguard the rights of the owners of resources that may be affected.
Typically, EIA reports for dredging projects should include at least the following information:

4.1 General Description of the Project and its Objectives

- background information identifying the need and justification for the project.
- description of the main features and activities of the project, and identification of the construction and operation processes that could either damage the environment, or generate positive impacts.
- indications of the anticipated timing of the project and schedule of the performance of the main construction activities.

4.2 The Physical and Biological Environment.

The EIA report must include adequate descriptions of the physical and biological environment of the project area. To facilitate NRCA's review process, as well as for sound planning and detailed design of a proposed dredging project, it is essential that the following range of site-specific data be provided:

4.2.1 *Water Quality*

Water quality should be tested separately at both high and low tides. Water samples should be tested for suspended solids, coliforms, nitrates and phosphates, and any other constituents as may be deemed necessary in relation to the particular project;

4.2.2 *Ecology* - Flora and Fauna

For projects of any appreciable size or scope NRCA will require that appropriate site surveys be carried out to properly identify existing critical habitats, any rare or endangered species or other valuable natural resources such as seagrass beds, mangroves, coral reefs -and fully document the base-line conditions. In regard to coral reefs, particular notice should be taken of any sedimentation, algal growth, patterns of live and dead coral, and the structure of fore and back reefs.

4.2.3 *The Nature of the Material to be Dredged*

It will be essential to have good qualitative information regarding the nature of the material that is to be dredged. Grab samples and probes can only provide information on soft overlying sediments. Normally, it will be necessary to drill an appropriate pattern of boreholes, extract sufficient samples, and carry out the necessary testing so as to be able to clearly establish the qualitative nature of the material that is to be dredged -with particular attention being paid to identification of the presence of any contaminants that could give rise to negative environmental impacts.
(Note: Discussion of the various types and occurrences of soil contaminants is given in a separate chapter of these Guidelines).

4.2.4 *Sea-Currents and Bathymetry*

Normally, the information available on published navigation charts concerning sea-currents and water depths will not be adequate for detailed planning of dredging projects. Project sponsors will have to be prepared to carry out appropriate current studies and hydrographic surveys in order to be able to prepare site-specific charts showing local current patterns and existing seabed contours at suitable intervals. Bottom conditions, and water circulation patterns are to be evaluated in the context of the capability of the water body to flush itself;

4.2.5 *Meteorology*

Site-specific data on rainfall, wind, waves and tides will be required. Usually, some useful data on these matters can be obtained from the Government Meteorological Office.

4.2.6 *Geomorphology*

Project sponsors should take all necessary steps to ensure that appropriate investigations are carried out to clearly identify the existing pattern of coast-line dynamics -i.e. the prevailing pattern of littoral transport; whether the shoreline is stable or prograding or accreting or eroding -so as to be able to take such factors into account in the engineering of the project.

4.3 The Socio-Cultural and Economic Environment

Sometimes, the feasibility and acceptability of a development project will depend not only on its effects upon the physical and ecological environment of the project area, but also more critically upon the socio-cultural and economic impacts that are generated. Therefore it is important that EIA studies should investigate the socio-cultural and economic conditions prevailing in the project area, and assess the effects that the project would be likely to have in regard to local ethnic, cultural, historical and religious sensibilities; and upon the levels of job-creation and commercial activities that the project would bring to the local scene.

4.4 The Relevant Legislative and Regulatory Framework.

Project Sponsors will be required to include in their EIA report, a section describing all the Jamaican legislative enactments, environmental policies, Standards and Regulations that are relevant and applicable to the proposed project; and should identify the appropriate authority jurisdictions that will specifically apply to the project.

4.5 Environmental Impacts from *Dredging*

The EIA report should contain descriptions of the anticipated direct and indirect effects of the project. In identifying the potential environmental *effects* of the construction and operation phases of a project, it would be helpful for project sponsors to analyze them in terms of the following terminology:

- *adverse effect:*
  an effect that is large in magnitude and has important consequences. Both of these characteristics (i.e. large magnitude and importance) must be present, in order for the effect to deserve to be termed *adverse.*

- *cumulative effect:*
  an effect that gives an incremental rise in the level of an impact, when added to other past, present and reasonably forseeable activities. Cumulative effects can result from individually minor but collectively significant activities taking place over a period of time.

- *triggering effect:*
  an effect that induces other indirect effects. These effects are not directly generated by (the instant) project activities, but they develop because the project came into being.

4.5.1 It is almost inevitable that there will be some damaging impact upon the aquatic environment during the excavation phase of the dredging process. The degree of impact will depend mainly upon such important factors as: the type of dredger and the method of operation, the quality of the material being excavated, whether there are any serious contaminants in the material, the method of handling and transporting the dredged material, and the particular method of disposal. The dredging process entails the underwater removal of large quantities of soil and rock, and therefore the types of equipment, the methods, and the scale of operations that are involved, can cause serious environmental impacts such as damage or destruction of existing ecosystems and other resources of the coastal zone, and infringements upon the rights of other stakeholders. These types of potential impacts will be further explained below.

4.5.1.1 *Damage/Destruction of Existing Ecosystems and Other Resources of the Coastal Zone.*

4.5.1.1.1 The coastal zone around Jamaica contains valuable natural resources such as coral reefs, seagrass beds and mangroves that are of critical importance to the sustainability of some of the nation's key industries, e.g. tourism and fisheries. Also there is increasing use of estuaries and coastal wetland areas such as those at Bowden in Morant Bay for oyster cultivation and other forms of mariculture. Any dredging that is carried out in such sensitive areas will inevitably cause some destruction/degradation of these fragile resources. In evaluating applications for permits to carry out dredging in such sensitive areas, NRCA will be critically interested in comparing the anticipated long term costs and benefits that would accrue to the society as a whole, from the implementation of such projects. In order to be permitted, such projects will have to show long-term, sustainable benefits that convincingly outweigh the environmental disbenefits.

4.5.1.1.2 Also, any applications for permits to carry out dredging at "heritage sites" such as Port Royal in Kingston, and Seville in St. Ann, which are of known archaelogical significance, will be required to perform special studies and investigations and submit evidence to ensure that the proposed dredging will pose no threat of damage/destruction to in-situ historical resources.

4.5.1.2 *Infringements upon the Rights of Other Stakeholders.*

Attention is hereby drawn to the following possible types of infringements upon the rights of other stakeholders that can arise from the execution of dredging projects:

4.5.1.2.1 Displacement of Vulnerable Occupants.
A proposed dredging project will be deemed unacceptable if it will displace or seriously disadvantage vulnerable existing stakeholders such as local fishermen, who may have been accustomed to using the area as their base -unless provision is made for satisfactory compensation of those who will be adversely affected. In exercising their regulatory function, NRCA in such circumstances would have the added responsibility of seeing to it that the level of compensation from the Developer to the persons who will be displaced shall preferably leave them better off -but certainly no worse off, than they were, prior to displacement.

4.5.1.2.2 Impairment of On-shore Groundwater Usage.
Subsurface groundwater flows near the land/sea interface can be altered by dredging near the shoreline. Should there be extensive freshwater flow toward the estuary or seacoast, then the dredging could accelerate the flow and lower watertable levels in the adjacent upland. If freshwater flows are minimal or slow, dredging could increase saltwater intrusion into nearby water supply aquifers. If a proposed dredging project would raise the possibility of such types of impacts occuring, then the NRCA will have to ensure that the rights of the on-shore stakeholders are protected.

4.5.1.2.3 Exploitation of Seabed Minerals and Other Public Goods.
The licence fees charged by NRCA for allowing private Developers to carry out dredging for extraction of seabed minerals and other natural resources of the coastal zone shall be so determined as to allow the society at large to share equitably in the benefits arising from exploitation of public goods.

4.5.1.2.4 Seabed Mining That Might Cause Degradation of Adjacent Shores

Mining for minerals or for sand-and-gravel in river estuaries and in beachlands will only be permitted if it is convincingly shown by the project sponsor that the proposed dredging will not adversely affect other properties.

4.5.1.2.5 Obstruction of Traffic -Dredging operations must be planned and executed in a manner that avoids obstruction of waterways, and respects the rights of licenced users to unhindered passage along routes normally open to marine traffic.

4.5.1.2.6 Noise. Dredging projects shall be carried out with due care being taken to avoid disturbance of residents in the vicinity of the project area by excessive noise generated by heavy machinery.

4.6 Environmental Impacts from the *Disposal* of Dredged Material

In some circumstances, the most damaging environmental impacts of a dredging project would be liable to occur, not during the actual *excavation* operation of the dredging, but more likely during the *disposal* of the dredged material. The EIA must therefore clearly indicate the methodology that will be used for handling, transportation and disposal of the dredged material; must explain how/why the particular methods of handling, transportation and disposal were chosen; and describe the alternative methods that were considered and how they were evaluated.

(Note: Further guidelines in reguard to transportation and disposal of dredged materials are included in a separate chapter).

4.7 Potential Long-Term Impacts from Dredging

The altered bathymetry that results from dredging and reclamation can, in the long term, cause significant changes in the local hydraulic regime of estuaries and the coastal zone in general. The consequences of such changes can be quite damaging to local communities, in terms of their negative impacts upon water quality and aquatic resources, and upon the local geo-morphological processes. Some specific long-term impacts that can arise from dredging are identified below:

4.7.1 *Estuarine Salt Wedge Intrusion*

Serious problems may result from dredging in an estuary when the extent of the bottom deepening is such that the salt wedge intrusion is able to travel higher upstream than previously, thus causing significant changes in the regime of the river itself as well as in bankside wetlands.

4.7.2 *Saline Intrusion into Groundwater*

As previously mentioned, coastal groundwater (freshwater) reservoirs can become contaminated due to inflows of seawater resulting from coastal dredging, thereby reducing the availability of freshwater to on-shore users.

4.7.3 *Increased Shoreline Vulnerability/Instability*

Deepening of areas of the coastal zone, and removal of natural underwater berms and sandbars, can expose stretches of shoreline to more powerful wave action than hitherto prevailed, thereby leading to serious shoreline erosion and degradation of beaches.

4.7.4 *Changes in Sedimentation Patterns*

Bathymetric alterations in the coastal zone can cause changes in wave refraction and reflection, in currents, and in sediment transport. Such changes in sedimentation patterns can have serious negative implications in regard to maintenance of navigable channels in estuaries and coastal waterways.

4.8 **Monitoring, Mitigation and Contingency Plans**

The EIA report should contain detailed plans for monitoring and mitigating any adverse effects, and should include contingency plans for dealing with any hazardous situations that might arise during the dredging and disposal operations. The mitigatory measures and contingency plans proposed should be technically feasible and cost-effective, and should show convincingly that the proposals will result in reduction of negative effects to tolerable levels.

4.8.1 Developers will be required to maintain continuing effective liason with the concerned government regulatory Agencies and local communities throughout the construction phase of their projects, and to ensure that any issues or concerns that might arise during this phase, are clearly understood and appropriately dealt with.

4.8.2 The particular construction activities which will require monitoring as the work progresses will have to be identified in the EIA report. Each Construction Permit issued by NRCA will indicate the required frequency for submission of written reports from the Developers to NRCA.

4.8.3 Wherever possible, estimates of the financial and economic costs of the potentially degrading effects that the project might have upon the environment, and the costs of the mitigatory measures proposed, should be included in the EIA report.

4.8.4 Contingency plans should be presented in the EIA report for dealing with any emergencies that could arise during dredging such as fire, explosion, or accidental spillage of petroleum products or other hazardous/toxic materials. The appropriate response to leaks, breaks, explosions or fire, and any resulting spillage of fluid, will vary according to the toxicological and physical properties of the spilled material, and the potential impact it may have upon public safety and the environment.

4.8.5 To ensure the effectiveness of contingency planning, properly trained personnel and suitable equipment must be available on site. Project sponsors should therefore include in their EIA report, information concerning their plans for providing appropriate personnel and equipment to deal with the types of emergency situations that could arise.

4.8.6 In developing contingency plans for dealing with emergencies, it will be useful for Developers to seek consultations with the Coast Guard of the Jamaica Defence Force, and also with the Office of Disaster Preparedness and Emergency Management, since in anycase, NRCA will refer any contingency plans to those Agencies for comments, and any comments received from those Agencies will be given due consideration by NRCA in making decisions as to the suitability of any contingency plans submitted.

4.9 Table 1 below gives a summary of potential impacts that could come from dredging projects, and some corresponding mitigatory measures that might be adopted to counteract the negative impacts.

Table 1 . **Summary of Potential Environmental Impacts from Dredging and Some Typical Mitigatory Measures**

IMPACTS	MITIGATORY MEASURES
1. Project *location* may affect sensitive habitats and/or valuable fisheries resources or otherwise significantly degrade environmental quality.	1. Perform screening analysis of site environs and ecology and select an area that is not adjacent to sensitive habitat and would not displace valuable fisheries resources.
2. Unintended removal or disturbance of precious flora or fauna in areas where they are indigenous.	2. Have divers double check the proposed site area for the presence of any rare, threatened or endangered species.
3. Damage to archaelogical treasures and artifacts due to excavation.	3. In areas such as Port Royal and Seville, which are of major archaelogical importance, no dredging will be allowed unless extra special precautions are taken to avoid the possibility of damage.
4. Increased short-term turbidity due to release of sediment into the water column. This could lead to smothering of valuable benthic species.	4. The amount of turbidity generated depends, to a large extent, upon the type of equipment and the method of dredging used. If there are sensitive resources that may be affected then equipment and method must be especially carefully chosen. Various types of turbidity barriers can be used to retard/limit the travel of sediment plumes.
5. Interference of floating construction plant with other maritime traffic.	5. Prepare a program in advance to co-ordinate and reduce the potential for obstruction of other userswaterway users.
6. Objectionably high noise levels such as to cause disturbance to nearby residents.	6. Reduce noise impact by decreasing operating level during quiescent periods in the local community.

5. GUIDELINES FOR PLANNING DREDGING

5.1 *Sources of Relevant Physical Planning Information*

In Jamaica, project sponsors will be able to obtain information that should be useful for planning dredging projects, from the following sources:

- Survey Department -*comprehensive topo/cadastral maps, some hydrographic charts*;
- Geological Survey Department -*geological maps, reports, earthquake hazard map, hurricane hazard map*;
- Government Meteorological Office -*weather data:wind, rainfall waves, tides, storm surge*;
- Earthquake Unit, UWI Mona -*various publications on -local & regional seismicity*;
- Underground Water Authority -*underground water resources, flood maps*.
- Natural Resources Conservation Authority -*the NRCA Docucentre is the most important source for information on govt. environmental policy, national environmental Standards, and the Permitting process.*
- Port Authority of Jamaica -*the PAJ is government's chief Agency for the regulation and monitoring of all maritime activities and Dock and Harbour constructions.*

5.2 World Bank Technical Paper Number 126 of the Transport and Environment series gives an authoritative five-step guide for the planning of dredging projects:

5.2.1 *Step 1 -Determine if any of the materials to be dredged are contaminated, and if so, are they contaminated to an extent that might cause pollution.*

In areas where contaminated sediments are suspected to exist, tests should be carried out in typically representative areas and depths to characterize the degree of contamination in the materials to be dredged. This does not mean that each sample should be subjected to exhaustive organic and inorganic chemical analyses to establish the presence and the concentrations of a wide-ranging list of compounds, since knowledge of local discharge/disposal practices can be used to make a list of "most probable to occur" substances. Selective analysis can be used to assess the potential for pollution effects. Alternatively, the substances identified in the London Dumping Convention (See Appendix I for information on the London Dumping Convention and other International Agreements Rgulating Pollution), could be used as the list of compounds to be investigated. If the results of these tests indicate that there are sediments which have sufficiently high levels of contamination that they would probably result in harmful effects (i.e. pollution) when disposed of in open-water or unconfined upland disposal sites then a carefully prepared action plan must be undertaken. Concentrations that define "contaminated" are still not universally accepted. As a guide, the London Dumping Convention has defined concentrations for some trace metal contaminants.

5.2.2 *Step 2 -Carry out a detailed characterization of all of the sediments to depths that are likely to be disturbed or exposed by the dredging.*

This detailed characterization will allow the site area to be divided up into dredging zones each of which may require different types of dredging techniques and methods of disposal. The objective of this characterization program should be to reduce the volumes of dredged materials which are difficult to dispose of to a minimum. It is likely that the design concept of the proposed project may have to be amended at this stage in order to avoid dredging excessive volumes of polluted materials.

5.2.3 *Step 3 -Select the type of Dredging Equipment to be used for each zone.*

Use specialist equipment to deal with the material that is very polluted. The objective should be to avoid excessive disturbance and re-suspension of the very polluted sediments as much as possible.

5.2.4 *Step 4 -Select the method of disposal to be used for each type of material to be removed from each zone, using the various options available.*

The choice of method of transportation of the dredged materials to the disposal site should also be considered at this stage.

5.2.5 *Step 5 -Carry out studies and tests at the intended disposal site to check the actual effects of the chosen method of disposal.*

If open-water disposal is intended, the studies and tests to be carried out may include:

- the general requirements of the LDC
- chemical and physical analysis
- biological testing
- formulation of the impact hypothesis
- the development and use of quality standards

Considerable information is readily available on the objectives and scope of these studies and tests from sources such as IMO and well established national laboratories.

5.2.5.1 It is important to appreciate that open-water disposal of sediments, even if they are uncontaminated, can also cause major environmental damage to ecosystems such as corals and gravel beds that are habitats and spawning grounds for valuable marine species. This might occur due to reduction of penetration of sunlight down through the water column, due to increased amounts of suspended sediments, and/or the smothering of the organisms by deposits of silts or clay fines from the dredged dumping.

5.2.5.2 It is important to put in place adequate long term monitoring procedures for all dredging and disposal options, but this is particularly important if the dredged material is actually polluted. Apart from chemical/physical testing, biological testing is extremely important -especially testing for bio-accumulation using a fish, a crustacean and a mollusc typical of the disposal site.

6. SOME COMMON TYPES OF DREDGING PROJECTS

The process of excavation and removal of underwater soil and rock by use of certain types of heavy machinery is called "dredging". Dredging is done all over the world, and for many purposes. But the most common objectives for carrying out dredging projects in river estuaries and in the coastal zone are: to create or improve navigable waterways, to restore the depths of water-ways that have become silted-up over a period of time, or to recover submerged material for land reclamation or some other beneficial use. For reasons mostly relating to the associated environmental impacts, dredging works are generally categorized under two broad headings, viz: **Capital** dredging, or **Maintenance** dredging. A specific listing is given below indicating the types and purposes of the major dredging projects that have been carried out in Jamaica over the past few decades.

6.1 Capital Dredging

6.1.1 *Kingston Oil Refinery, (1962)*
-dredging of nearshore seabed material to reclaim approximately 25 hectares of waterfront land for building an oil refinery.

6.1.2 *Kingston Transhipment Port, (1965/70)*
-dredging of millions of cubic metres of nearshore seabed material to reclaim around 200 hectares of waterfront lands for development of a modern transhipment port with over a dozen deepwater berths.

6.1.3 *Newport East Harbour For Government Vessels, (1966)*
-dredging of nearshore seabed material to create waterfront lands for the Kingston Harbourmaster's compound, including a breakwater and marina for sheltering government vessels such as the coast-guard, fire-floats, ferryboats, and pilot boats.

6.1.4 *Montego Freeport Complex, (1967/68)*
-dredging of millions of cubic metres of nearshore seabed material to reclaim over a hundred hectares of waterfront lands for development of a commercial/light industrial/resort complex, including deepwater berths for general cargo vessels and cruiseships.

6.1.5 *Ocho Rios Waterfront Re-development, (1968)*
-dredging of nearshore coral sands to reclaim waterfront lands for a commercial/resort development, including construction of 250m of artificial beach, (Turtle Beach), condominiums, a shopping center, onshore facilities for a cruiseship terminal, and two deepwater berths.

6.1.6 *Kingston Waterfront Re-development, (1971)*
-dredging of around half-a-million cubic metres of nearshore material to reclaim several hectares of waterfront lands as part of a major urban renewal programme for the capital city of Jamaica.

6.1.7 *Rockfort Power Barge, (1984)*
-shoreline dredging at Rockfort, Kingston, to create a deep basin for accommodation of a 40MW floating power plant.

6.1.8 *Old Harbour Power Barge, (1995)*
-shoreline dredging at Old Harbour Bay, St. Catherine, to create a deep basin for mooring of a 74MW power barge; and trenching of the seafloor over a distance of approximately 1 kilometer to bury a steel pipeline for receiving fuel for the power barge.

6.2 Maintenance Dredging

6.2.1 *Kingston Refinery Dock, (1981)*
-dredging to restore the original water depths in the turning area in front of the refinery dock, where nearly two decades of siltation had significantly reduced the available berthing depth.

6.2.2 *Port Bustamante Turning Basin, & Kgn. Harbour Main Channel, (1995/96)*
-dredging and disposal at sea of over two million cubic metres of seafloor material to restore and improve the navigability of the Newport West turning basin and the main ship channel giving access to Kingston Harbour.

7. TYPES OF DREDGERS AND THEIR MODUS OPERANDI

Dredging equipment can be divided into two broad classifications: *mechanical* and *hydraulic:*

7.1 *Mechanical Dredgers*

Mechanical dredgers are very similar to their dry-land counterparts. Material is excavated and usually placed in an intermediate transport mode. This can be scows, self-propelled or towed barges, trucks or even conveyor belts. Mechanical dredgers are typically used for materials where the physical nature requires and permits distinct excavation zones. Examples of mechanical dredgers are clamshell and dragline; bucket-ladder; dipper; and back-hoe. These types of machines are illustrated in Figs.1, 2, 3 & 4.

7.1.1 Clamshell and Dragline Dredger

These employ either rotating cabs or fixed A-frame type barge-mounted equipment, which have hoisting and control systems and use clamshell digging devices or buckets rigged on cables to excavate the material from the bottom and transport it vertically out of the water and into barges for subsequent transport to a disposal area. Clamshell dredgers can be used in sand, some types of clay, gravel, cobbles and some broken rock dredging situations. They are not particularly effective in fine silts which have a tendency to run out of the bucket. Clamshell dredgers can dredge in fairly deep waters, and their ability to do precise dredging makes them well favoured for removing isolated high spots or for dredging along dock faces or around the corners of docks. Depending upon the type of material being dealt with, the production rate of clamshell dredging is only low to moderate. Normally, clamshell dredgers are not self-propelled; and they are fixed at the excavation site using anchors or spuds.

7.1.2 Bucket-Ladder Dredger

Bucket-Ladder dredgers use a series of buckets mounted on an endless chain loop. The loop is powered causing the bucket to travel in such a manner as to scoop material from the bottom, carry the material in upright buckets to the top of the ladder where the buckets then rotate into an upside down position thereby dumping their contents into a chute. The material is then sent through the chutes to barges or scows that are used to transport the dredged material to the disposal site. Bucket-Ladder dredgers can be effectively used to remove a wide variety of materials up to and including soft rock. This type of dredger has become somewhat outmoded because of low production rate, need for anchor lines which extend outwards and interfere with navigation, and the relatively high noise levels generated by the buckets when they are in operation.

7.1.3 Dipper Dredger

Modern Dipper dredgers have a rotating cab, luffing boom and a stick and bucket. These dredgers use vertical spuds to anchor themselves to the bottom and a digging spud to the rear of the vessel to provide resistance to the massive digging forces of the bucket. Dipper dredgers come in all sizes up to a 15 cubic metre bucket. The dipper dredge operates by using teeth on the lip of the bucket to excavate the material from the bottom. When the bucket is full the dipper stick is withdrawn upwards and the cab and boom rotated so that the bucket is over the barge or scow into which the dredged material is dumped for subsequent transportation to the disposal site. Dipper dredgers are particularly suited for dredging hard rock or other highly compacted materials, but the depth for effective work with this type of machine is somewhat limited.

7.1.4 Back-hoe Dredger

The typical back-hoe dredger consists of an articulated excavation bucket mounted upon an articulated boom, which in turn is mounted on a barge. Back-hoe dredgers can deal with a broad range of materials such as sands, clays, gravel, cobbles and fractured and unfractured moderately hard rock -but they have radius and depth limitations. Back-hoe dredgers are not usually self-propelled, and they require anchors or spuds to fix them at the dredging location.

7.2 *Hydraulic Dredgers*

Hydraulic dredgers suction up sediment in the form of a fluidized slurry, containing typically between 5% to 20% solids. The suction action is augmented by the use of agitators, a cutter head, or a trailing drag arm. The dredged material is pumped through a pipeline either directly into a disposal facility or into an internal or external hopper. When the material has to be transported long distances, pipelines with booster pumps are used. The two most commonly used types of Hydraulic dredgers are the Cutter-head and the Trailing Hopper Dredger, which are illustrated in Figs.5 & 6.

7.2.1 Cutter-head Dredger

The cutter-head dredger, (sometimes called "cutter-suction" dredger), has a rotating head attached to the end of the suction pipe which churns up the material that is being exacavated into suitably-sized particles which are then sucked into the suction pipe as a slurry and then pumped to the surface. By use of pumps mounted on the ladder that extends down into the water, this type of dredger can dig effectively at depths of up to 25-30m. Cutter-head dredgers give high production rates, and they are capable of effectively digging even material as hard as unfractured rock. Some are self-propelled, and they work in stationary mode, located either by spuds or anchors. They are flexible in terms of disposal alternatives. They generally discharge through pipelies to the disposal site, but they can also discharge into barges or dump scows. By use of booster pumps in the discharge lines, they can transport and dispose of materials at considerable distances from the excavation site.

7.2.2 Trailing Hopper Dredger

Trailing hopper dredgers are self-propelled ships with capacity for self-contained storage of dredged slurry. They sail along with either one or two drag arms slung over the sides of the ship extending down to the submerged bed, sucking up sediments in a manner like giant vacuum cleaners and pumping the slurry into their own on-board hoppers. The drag heads can be either passive or active. In the case of passive drag heads, no additional power is applied at the heads, and the amount of loose sediment made available to be sucked up depends only upon the un-powered hydraulic scouring of the bed material as the ship slowly moves along. In the case of active drag heads however, power is delivered to drive either cutters or water jets to excavate the bed material so that more sediments are produced to be sucked up into the ships' hoppers. Trailing hopper dredgers are quite flexible in regard to transportation and disposal alternatives. Most commonly, the dredged material is transported within the vessel itself to the disposal site and either dumped through doors or valves in the hopper bottom, or in the case of a split-hull vessel, out of the bottom when the hull is split. Alternatively, transportation and disposal can be effected by pumping from a stationary hopper dredge through discharge lines that deliver to on-shore disposal sites, with or without booster pumps.

8. CONTAMINANTS IN DREDGED MATERIALS

8.1 Dredged material is the sediment, soil or rock that is excavated underwater during the the process of dredging. World Bank Technical Paper No. 126 in the Transport and the Environment Series gives the following useful categorization of dredged materials based on the levels of pollution that can be expected due to the type of dredging -i.e, **Capital** or **Maintenance**, and the **location** from whence the material is excavated:

8.1.1 *Material derived from maintenance dredging of areas affected by sedimentation resulting from rivers or estuaries or land run-off.*

This material tends to be fine-grained (silts and clays) and often contains large quantities of organic matter (from plant detritus to sewage).
The process of sedimentation and the nature of the materials typically creates a heterogeneous distribution of contaminants within the sediments, including particular "hotspots". The variation in the vertical profile of contaminant concentrations is a function not only of the depositional history, but also the frequency of dredging, the environmental quality of the overlying waters, effluents and run-off, and the history of activities in the port area.
This category of materials is usually the most contaminated of the four groupings and therefore is the focus of the most serious environmental concerns in regard to control and regulation of the manner of disposal.

8.1.2 *Material derived from maintenance dredging of sandbars at the entrance to harbours or channels.*

This material tends to be fine to coarse-grained sands resulting from long-shore transport, or from erosion/accretion processes near the harbour entrance. The nature of the sources of such materials tends to result in much less contamination compared to the material of the first category mentioned above.
This material can often be used beneficially for purposes such as beach nourishment or as construction fill material.

8.1.3 *Material derived from capital dredging within a port* (e.g., a new berthing facility).

As in the first category above, these materials consist of a layering of sediments over a period of time and therefore the concentrations of contaminants can vary substantially over a vertical profile of the dredge cut. Typically, the top layer is the most contaminated, is organic-rich and fine grained. The deeper materials are usually less contaminated and often coarse-grained or hard-pan materials.
The variable nature of these sediments leads to a multi-option program for disposal, wherein some of the material would have to be contained, while other portions would be suitable for open-water disposal or even for a beneficial use.

8.1.4 *Material derived from capital dredging of channels or outer harbour areas.*

This material tends to be relatively coarse-grained and uncontaminated, although the nature of the materials is a function of the historical activities within the region. Such materials are often used to counter shoreline erosion, for beach nourishment or as filling.

8.2 Many organic contaminants (e.g., PCB, and pesticides) have a low solubility in water, are therefore primarily associated with suspended solids and are transported to the sediments via particle deposition.
Metal pollutants often enter the coastal waters associated with suspended solids in sewage or as dissolved metals from land use practices and industrial activities

8.3 Sediments requiring maintenance dredging are typically fine-grained and rich in organic matter. The sediments are fine-grained because the port is often located in areas of low water circulation, which promotes the settling of the finer grained sediments and associated detritus. The organic matter usually comes from sewage, industrial effluent or general detritus. Decomposition of the organic matter consumes oxygen, leading to anoxic, sulphide-rich sediments.

8.4 Some countries have developed qualitative standards for classifying dredged materials according to the degree of contamination of the sediments. In this regard, the Netherlands' Standards are perhaps the most widely quoted set of limiting values of Contaminants that are applied by Regulatory Authorities in stipulating the manner in which project proponents may be allowed to dispose of the arisings from dredging.
The Netherlands' Quality Standards are shown in overleaf.

Table 2 - QUALITY STANDARDS FOR DREDGED MATERIALS IN THE NETHERLANDS

CONTAMINANT (mg/kg dry matter)	REFERENCE VALUE	TESTING VALUE	SIGNALLING VALUE	(*)
Chromium	100	480	1000	
Nickel	35	45	200	
Copper	36	90	400	
Zinc	140	1000	2500	
Cadmium	0.8	7.5	30	
Mercury	0.3	1.6	15	
Lead	85	530	1000	
Arsenic	29	85	150	
Napthalene	0.01			
Chrysene	0.01	0.8	3	0.2
Phenanthrene	0.1	0.8	3	0.2
Abthracene	0.1	0.8	3	0.2
Fluoranthene	0.1	2	7	1.2
Benzo (a) pyrene	0.1	0.8	3	0.2
Benzo (a) anthracene	1	0.8	3	0.2
Benzo (k) fluoranthene	10	0.8	3	0.6
Indeno (1,2,3cd) pyrene	10	0.8	3	0.2
Benzo (ghi) perylene	10	0.8	3	0.2
Mineral Oil Total	50	3000	5000	
Octane, Heptane	1			
Pentachlorophenol	0.1	0.3	0.5	
Hexachlorobenzene	0.001	0.02	0.5	
PCB IUPAC-number:				
28	0.01	0.03	0.1	
52	0.01	0.03	0.1	
101	0.01	0.03	0.1	
118	0.01	0.03	0.1	
138	0.01	0.03	0.1	
153	0.01	0.03	0.1	
180		0.03	0.1	
Hexachlorocyclohexane	0.001	0.02	0.5	
Aldrin	0.01	0.04	0.5	
Dieldrin	0.01			
Endrin	0.001	0.04	0.5	
DDE	0.01	0.02	0.5	
Endosulphan	0.01	0.02	0.5	
Chlordane	0.01			
Heptachlorepoxide	0.01	0.02	0.5	
Hexachlorbutadiene	0.01	0.02	0.5	

Note: (1).In general, sediments with levels of contamination lying below or equal to the "Reference Value" can be deposited on land or in freshwater or seawater without restriction.

(2).When the levels of contamination lie between the "Reference Value" and the "Testing Value" open water disposal may be permitted under certain conditions. One of the conditions concerns the chemical changes which are expected to take place when the particular contaminants are deposited in seawater.

(3).Whenever dredged materials have higher concentrations of contaminants than the "Testing Value", they must be disposed of in controlled containment facilities subject to constant monitoring.

(4). The values in the outer right-hand column headed (*) indicate general sediment environmental quality: current quality of sediments in relatively unpolluted regions.

9. DISPOSAL OF DREDGED MATERIAL

The ultimate step in the dredging process is to deposit the dredged material at a location away from where it was excavated. If at all possible, it is always desirable to use the dredged material for a beneficial purpose, such as to reclaim land for construction, to create wildlife habitats, to enhance shoreline stability, or for beach nourishment. However, if beneficial usage is not possible, then disposal should be carried out in such a manner as to ensure that the very minimum environental damage is caused.

The choice of disposal option is dependent upon a number of important factors such as: environmental considerations, cost, accessibility of the dredging site, type of dredger and transport system being used, and whether or not the material contains contaminants.

In terms of the location of disposal sites, there are basically three options, viz:
- i). open water sites;
- ii). shoreline sites; and,
- iii). upland sites.

In each case, the material may be deposited either with provisions for confinement, or dumped without confinement.

9.1 Open-Water Disposal

9.1.1 Fig.7 gives an illustration of the typical outfall of sediment from an unconfined open-water discharge. In this type of disposal, although normally most of the material would be expected to fall to the bottom approximately within the boundaries of the disposal site, if there are strong currents in the water column much of the discharged sediments can be carried considerable distances away from the disposal site. Therefore, if the disposal site is located up-current of the dredging site, or in the vicinity of sensitive marine ecosystems, unconfined open-water dumping could lead to re-infilling of dredged areas, or smothering of valuable marine resources.

9.1.2 If the material to be disposed of is known to contain serious contaminants, then special precautions will have to be taken to eliminate/minimize the potential for damage to the marine environment that could come from open-water disposal. Figs.8 & 9 and show illustrations of methods of delivering and "capping" polluted sediments at an open-water disposal site. Capping is a technique that is employed to confine dredged deposits in a manner similar to how the the material existed at the dredge site, so that the contaminants, particularly the trace metals, remain chemically immobilized, and thus will have a low level of bioavailability. Basically, capping involves placing a layer of "clean" sediment approximately one metre thick all over the contaminated deposit.

9.1.3 Recent studies have shown that certain sections of Kingston Harbour are heavily polluted, due mainly to continuing inflows of sewage and industrial effluent. The Newport West area is one that is known to be seriously affected, and so, in 1995 when application was made by the Port Authority to NRCA for a Permit to carry out a major programme of maintenance dredging in the turning basin and ship channel, the Permit was granted only on condition that the contaminated dredged sediments would have to be transported over ten nautical miles outside of Kingston Harbour, to a dumpsite on the edge of the island shelf, where the material would be dispersed out into the open sea.
With Kingston Harbour being as polluted as it is reported to be, it is unlikely that NRCA will allow any sediments arising from maintenance dredging to be disposed of in any manner other than as was stipulated for the 1995 dredging.

9.2 Disposal at the Adjacent Shoreline

9.2.1 So far, in Jamaica, in all cases where development projects involving major dredging at coastal sites have been carried out, the dredged materials were excavated by cutter-suction dredgers and pumped ashore into bunded areas that were designed to retain the sediments, while allowing the huge volumes of water that were pumped with the sediments to run-off back into the sea. By this process, reclamation of valuable waterfront acreage and/or enhancement of recreational beaches have been achieved in recent decades at Montego Freeport, Montego Bay Waterfront, Ocho Rios Waterfront, Kingston Waterfront, Newport West.

9.2.2 However, one major disadvantage of the "pump-ashore" method of reclamation that occurs sometimes when there is a high percentage of fines in the material being dredged, is the generation of turbidity plumes that flow back out into the coastal waters due to insufficient retention time within the on-shore containment bunding of the dredged discharge, thereby allowing significant volumes of fines to run-off back into the sea, where nearshore currents might be able to transport the plume to locations where sensitive aquatic resources can be negatively affected.

9.2.3 In this context however, it will be of interest to quote from World Bank Technical Paper Number 126 in the Transport and Environment Series, p.2. "Impacts caused by dredging. A common problem, particularly in tropical countries, is the dispersal and settlement of resuspended sediments on sensitive aquatic ecosystems (e.g. coral reefs) as a consequence of a nearby dredging operation. Concern may be expressed that the reef may be permanently damaged. This is not often the case, however, and there are many examples of coral reefs where, soon after the completion of the dredging activities, examination showed that the reef was quite undamaged. In the case of maintenance dredging (though), the consequences may not be the same and would need to be carefully investigated."

9.3 Upland Disposal

9.3.1 In developed countries, the upland disposal option is generally only chosen when the dredged sediment is seriously contaminated, and for one reason or another, open-water disposal (even with capping), is not considered feasible -(e.g., may be too expensive due to long travel distance to a permissible dumping site), or may be prohibited by International Convention, (e.g., London Dumping Convention).

9.3.2 Currently, in some developed countries where in the past dredged estuarine sediments used to be deposited ashore and were regarded as useful for agricultural purposes, (e.g. The Netherlands), as the understanding of contaminant chemistry increased and the presence of chemical and organic pollutants became more evident, limitations have had to be placed on on the practice of on-shore disposal of dredged material.

9.3.3 If confined upland disposal is chosen, the facility, (such as that depicted in Fig.10), will require careful design, construction and monitoring. In particular, aspects to be considered will possibly include: lining the containment basin with impermeable materials to avoid leaching into the underlying aquifers; treatment of the run-off before returning it to the regime; and , the final land use when the containment basin is filled.

9.3.4 It is important to put in place adequate long term monitoring procedures for all of the dredging and disposal systems mentioned in these guidelines, and this is particularly important if polluted dredged materials are involved.

3. INTERNATIONAL AGREEMENTS REGULATING POLLUTION

The oceans have long been considered to have a limitless capacity to receive and absorb all manner of wastes. Beginning in the 1950's, various scientists began to warn that this limitless capacity was running out and that the very survival of the marine environment was in doubt.

Many environmental groups began to demand that all waste disposal in the marine environment cease. The initial focus was on disposal of waste chemicals or incineration at sea of waste organo-halogen compounds (e.g., PCB). In particular the cases of industrial disposal from the Netherlands and Scandinavia[4] led to various national proclamations against such practices. Subsequently the disposal of sewage sludges and the large volumes of dredged materials, particularly the materials from heavily industrialized urban centres (e.g., New York, USA), led to demands that these materials also not be permitted to be ocean disposed. Such demands were not limited to the oceans; for example, in the early 1970's both the United States and Canada limited the disposal of dredged sediments from the Great Lakes to confined shoreline or upland facilities with very little material being permitted to open-water sites.

The Conventions

Beginning with the Oslo Convention of 1974[5] and the Paris Convention of 1978[6], the European nations sought to limit the input of contaminants to the adjacent marine waters (the Baltic and North Seas in particular). The conventions addressed international waters. It was accepted that the disposal of dredged materials could occur provided the materials contained only "trace quantities of contaminants". Materials which are primarily sand, gravel or rock, from areas of strong currents and are therefore not likely to contain significant concentrations of fine-grained contaminated sediments and which are intended for beach nourishment or other forms of shoreline protection should not have to be tested.

The intergovernmental convention on the dumping of wastes at sea, commonly called the London Dumping Convention (LDC),[7] adopted the general philosophy and has many similar articles of the Oslo Convention and applies to all international waters.

The LDC contains a series of Annexes[8] listing a large number of chemicals and chemical compounds which are deemed hazardous or potentially hazardous and therefore worthy of regulation (e.g., mercury or organohalogen compounds). As with the earlier conventions, the LDC was designed primarily to regulate the dumping of chemical or industrial wastes in the marine environment.

The LDC guidelines on dredged material disposal recommend:

* representative sampling
* measuring the general characteristics
* measuring the priority contaminants, and
* biological testing, if necessary, to show that the material can be dumped so as not to cause acute chronic effects or bio-accumulation in sensitive marine organisms typical of the disposal site

Subsequent to the LDC, various regional seas agreements (e.g., the Mediterranean Sea; United Nations, 1985) have been developed. These provide a facility to focus on particular problems for a region and take into account the particular ecosystem for that region (e.g., tropical

FIGURE 1

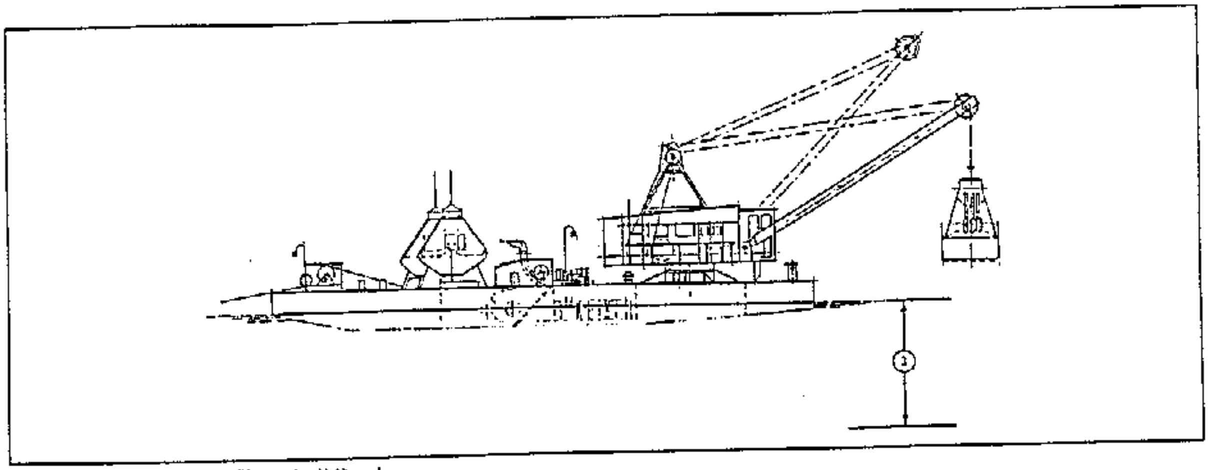


Figure 4a-4b - Grab or Clamshell Dredger

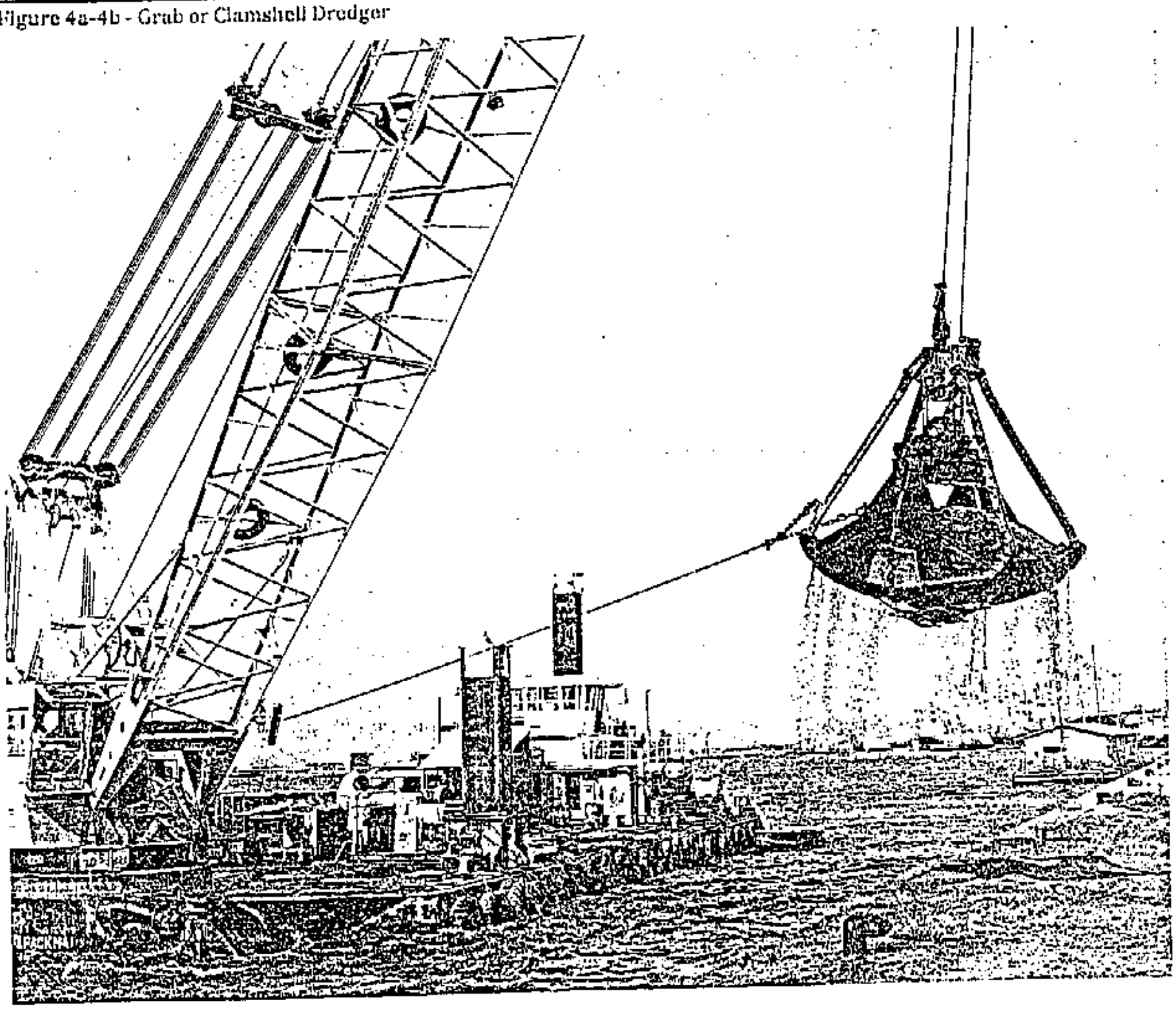
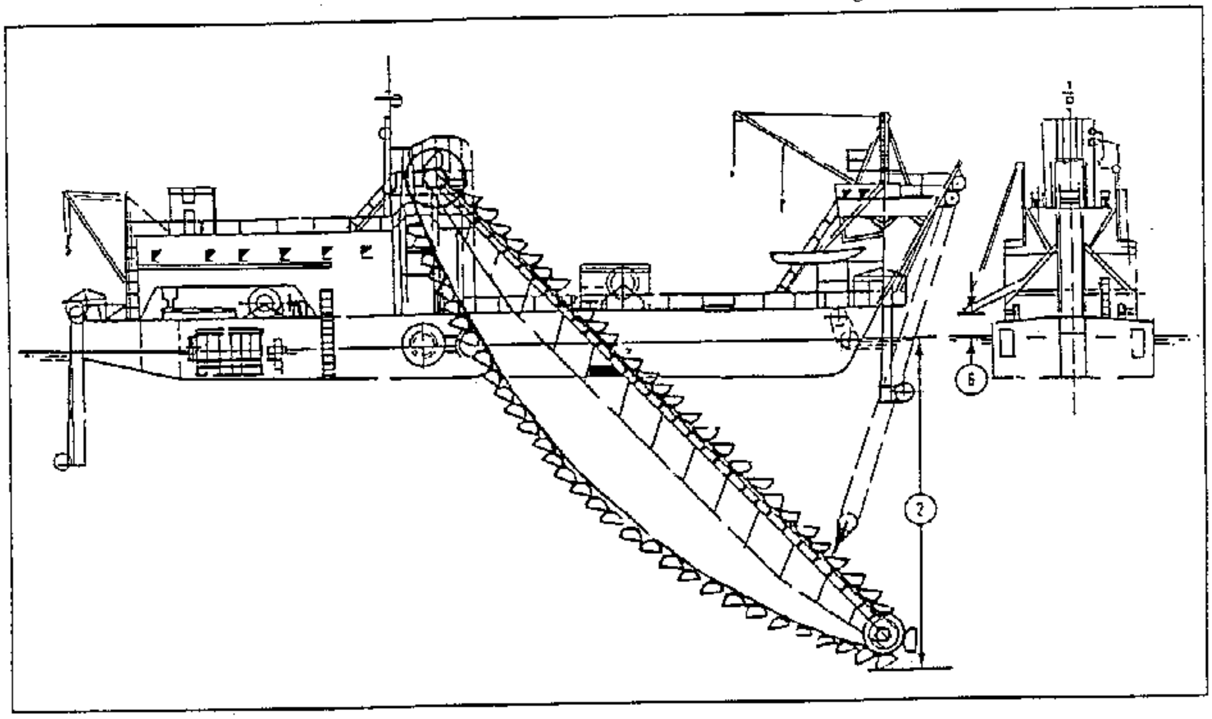


FIGURE 2

Figure 7a-7b - Bucket-ladder Dredger



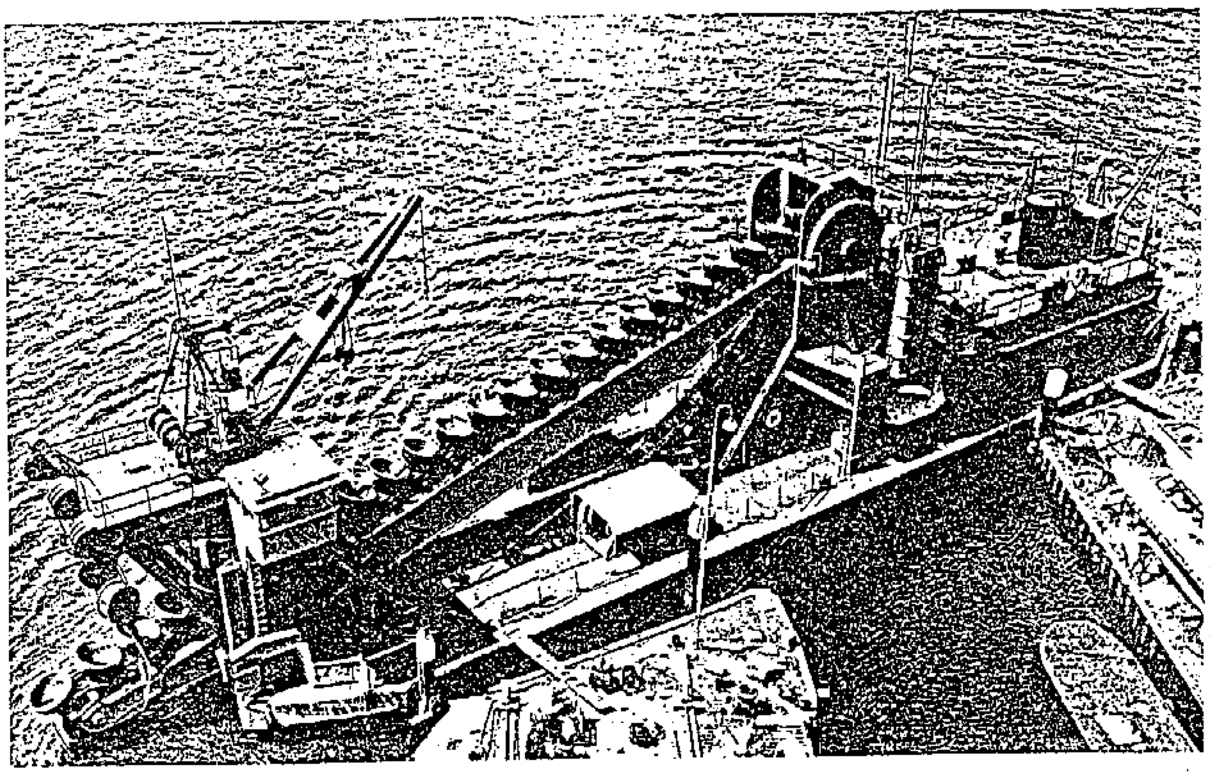
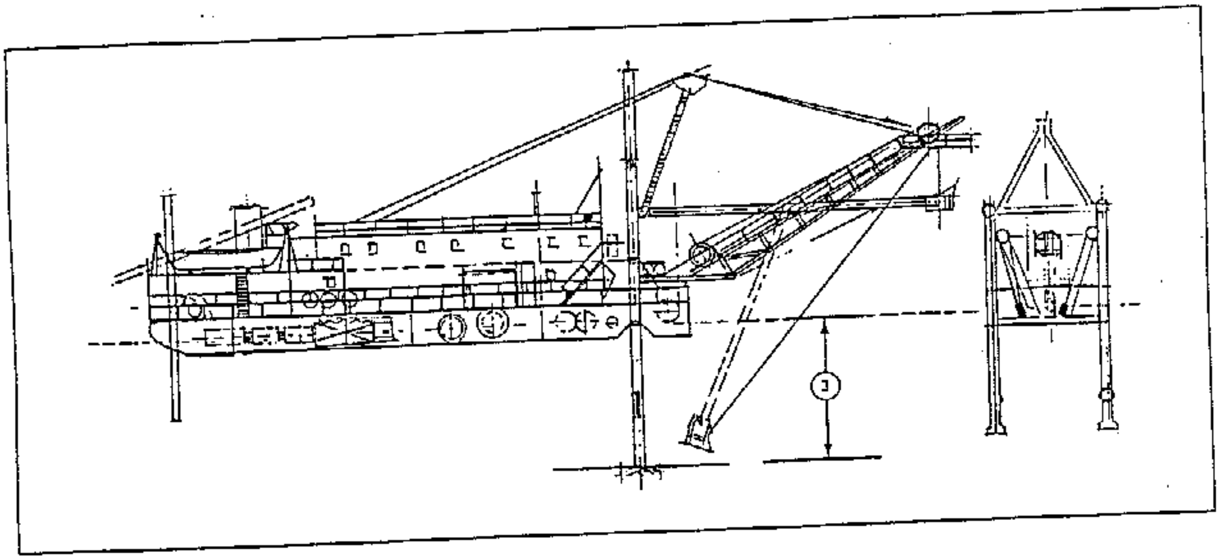


FIGURE 3

Figure 6a-6b - Dipper Dredger



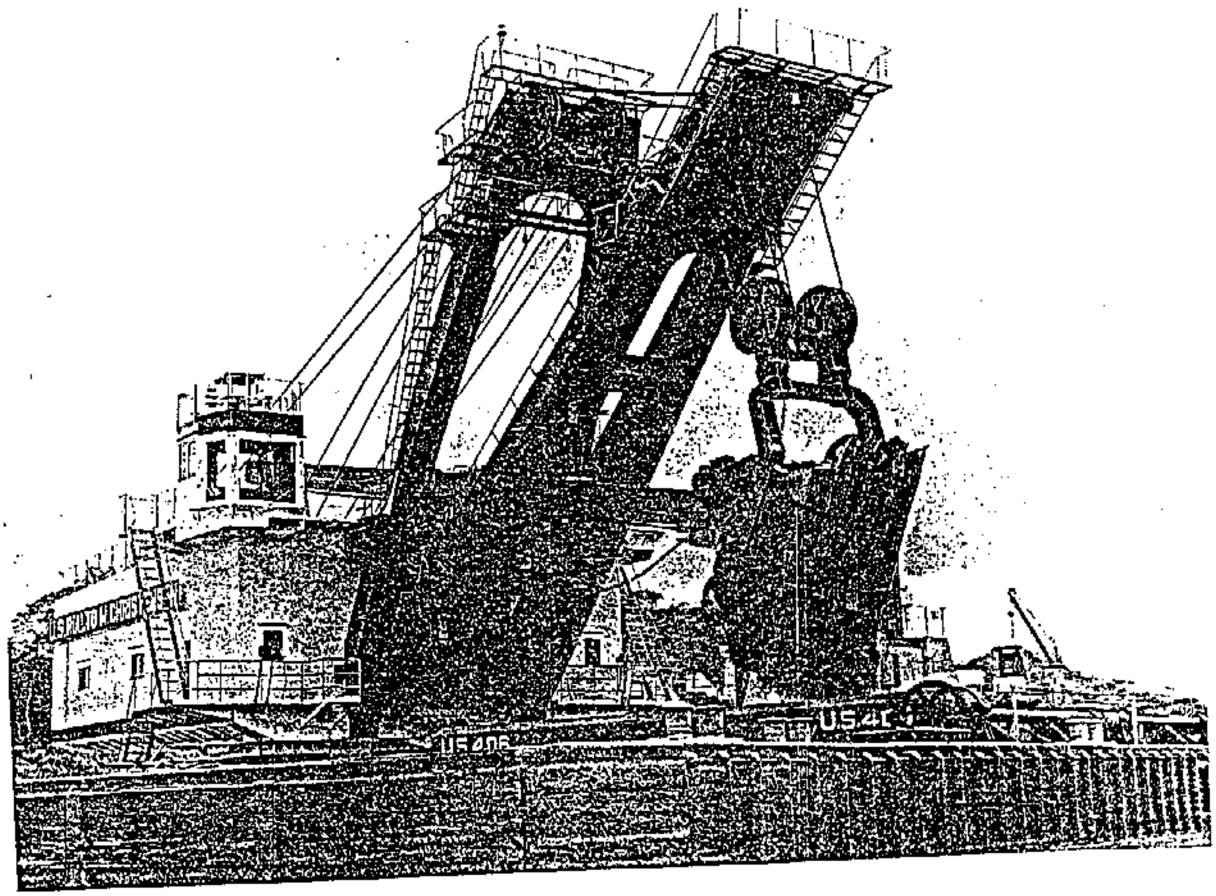


FIGURE 4

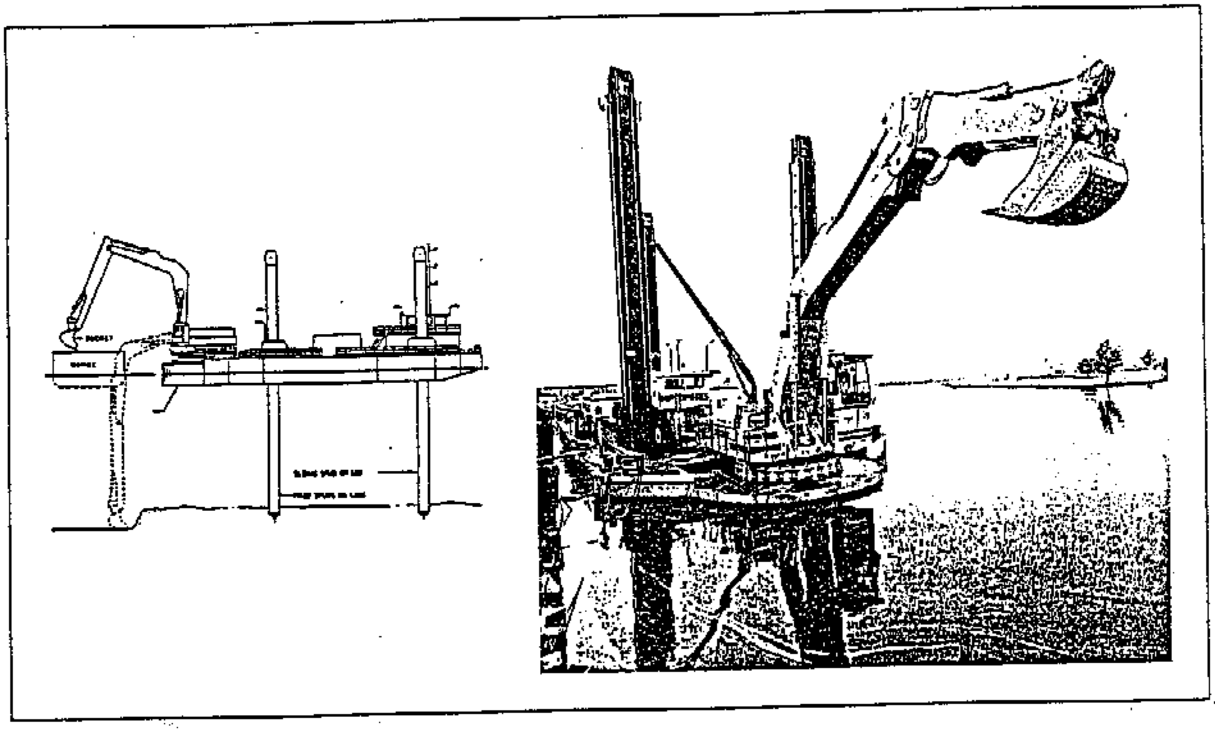


Figure 5 - Backhoe Dredger

FIGURE 5

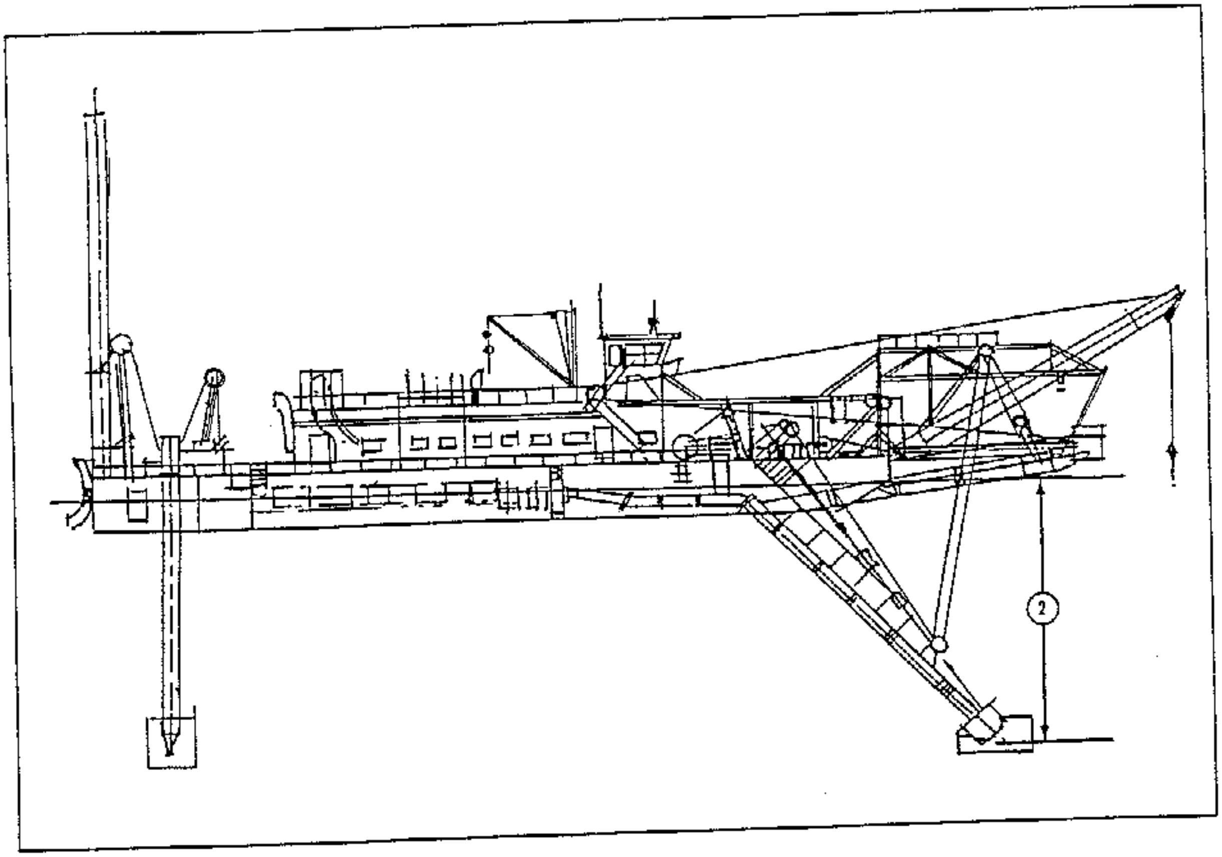


Figure 11a-11b - Cutter-head Dredger

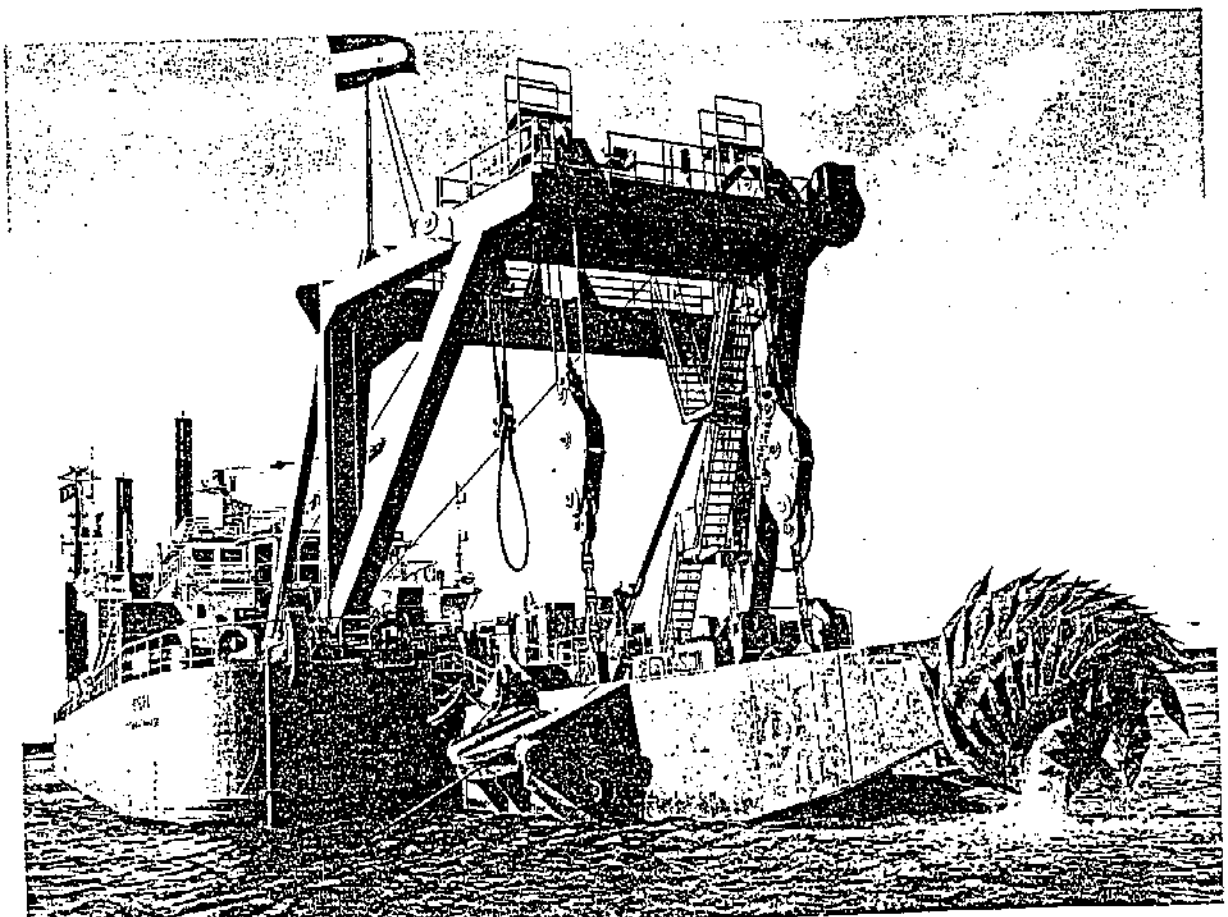


FIGURE 6

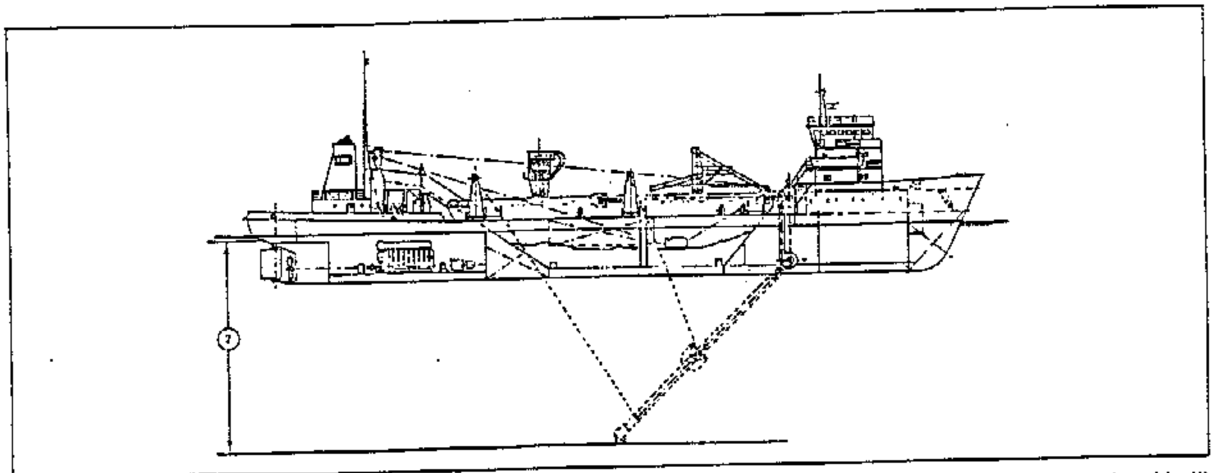


Figure 13a - Trailing Hopper Dredger

Figure 13b - Trailing Hopper Dredger (Conventional hull)

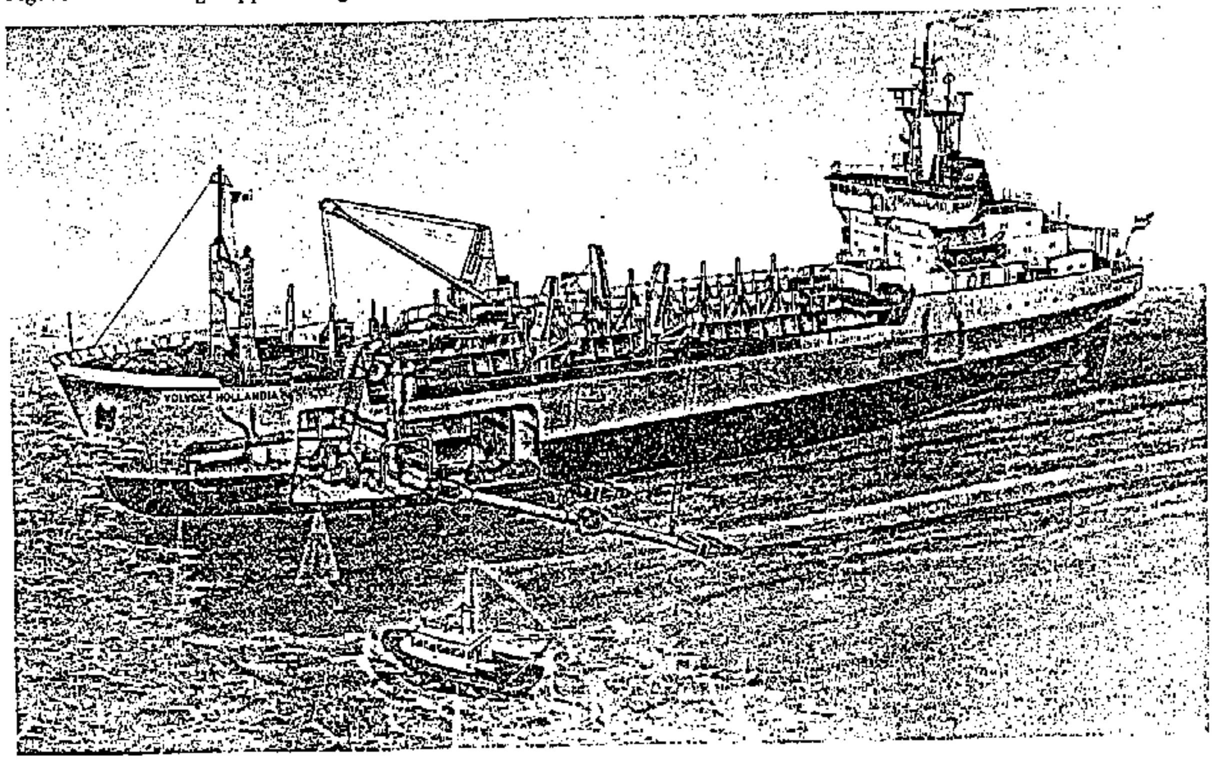
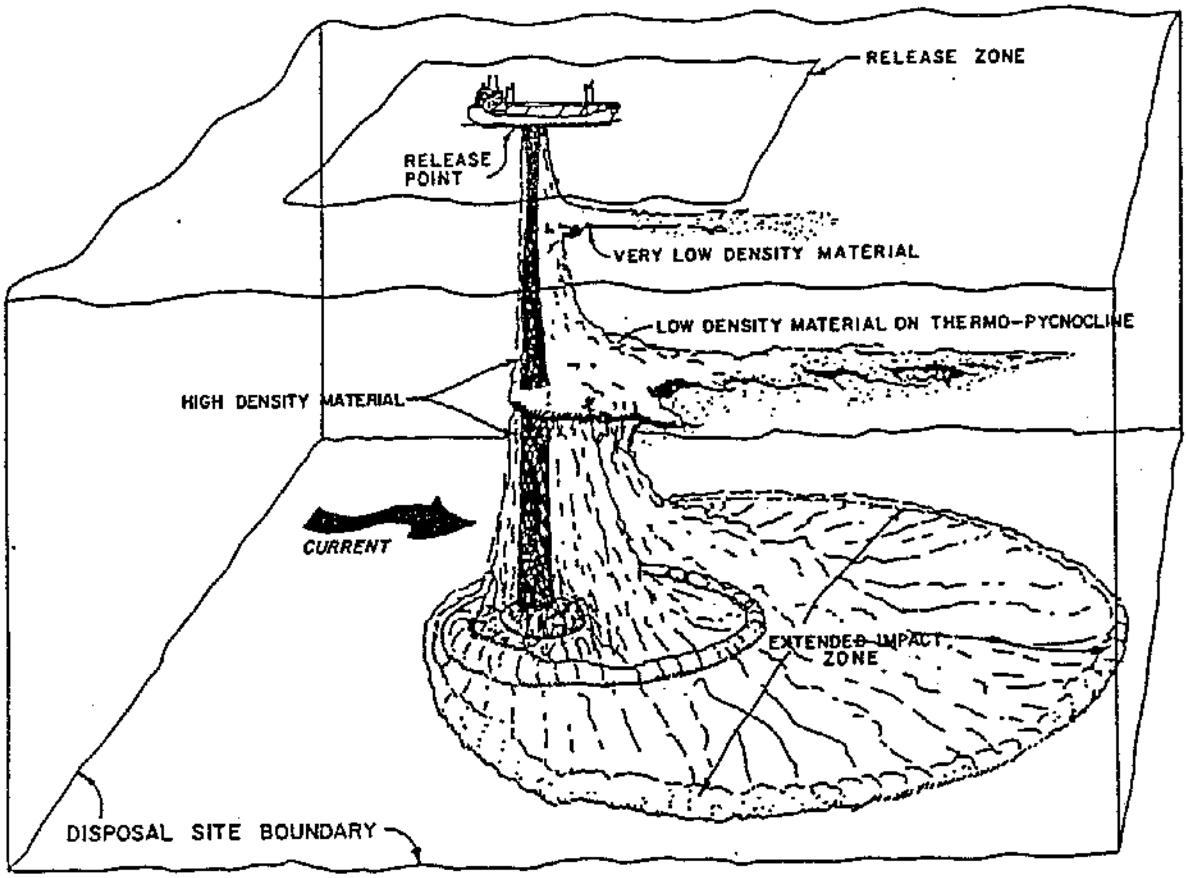
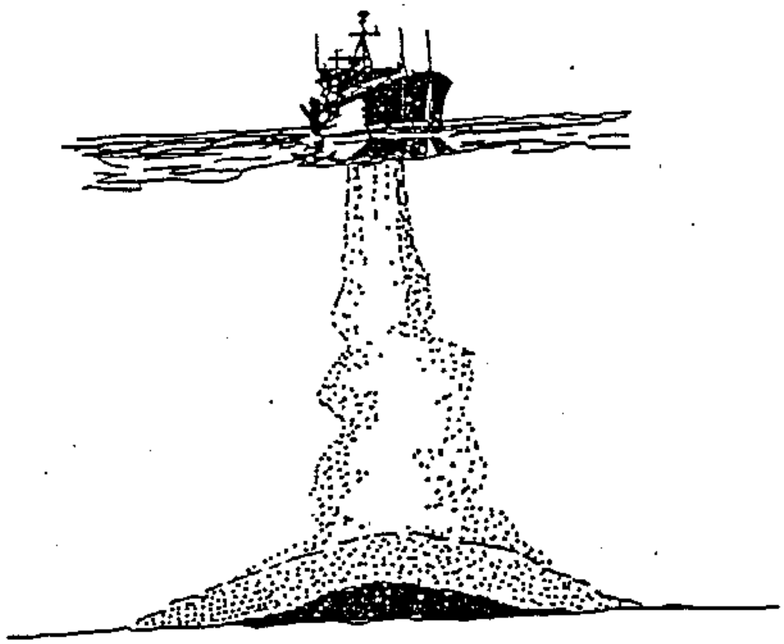


FIGURE 7



Releasing Dredged Material from a Hopper Dredger or Barge

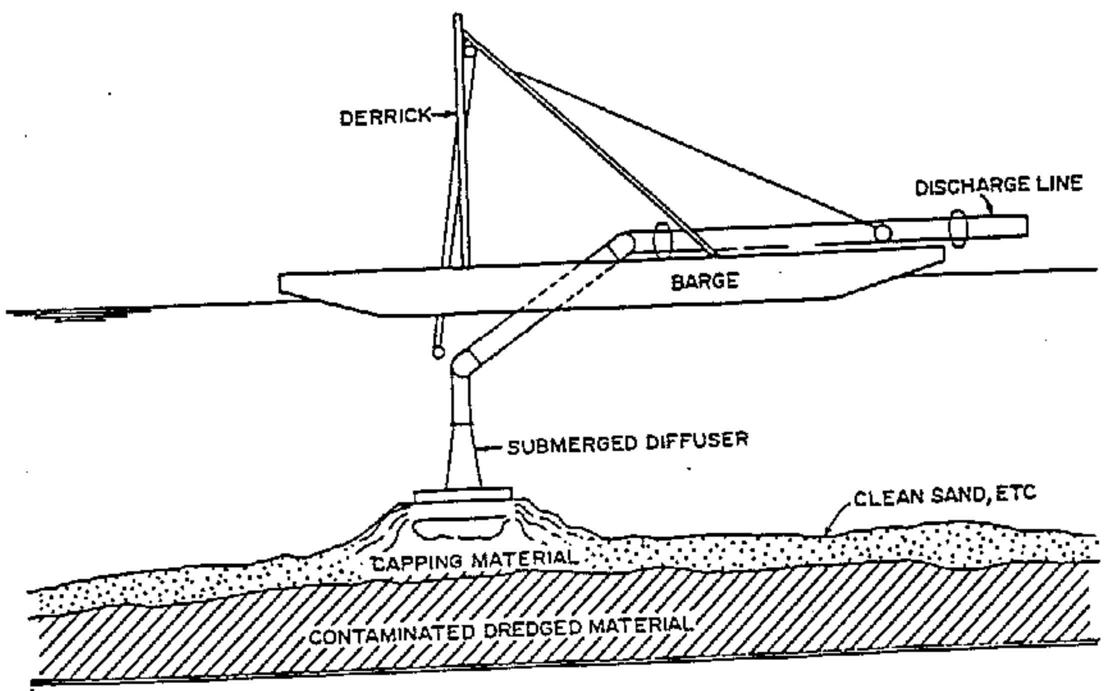
(Source: Pequegnat et al., 1980)



Open Water Capping of Polluted Sediments

(Source: Pequegnat, 1981)

FIGURE 8

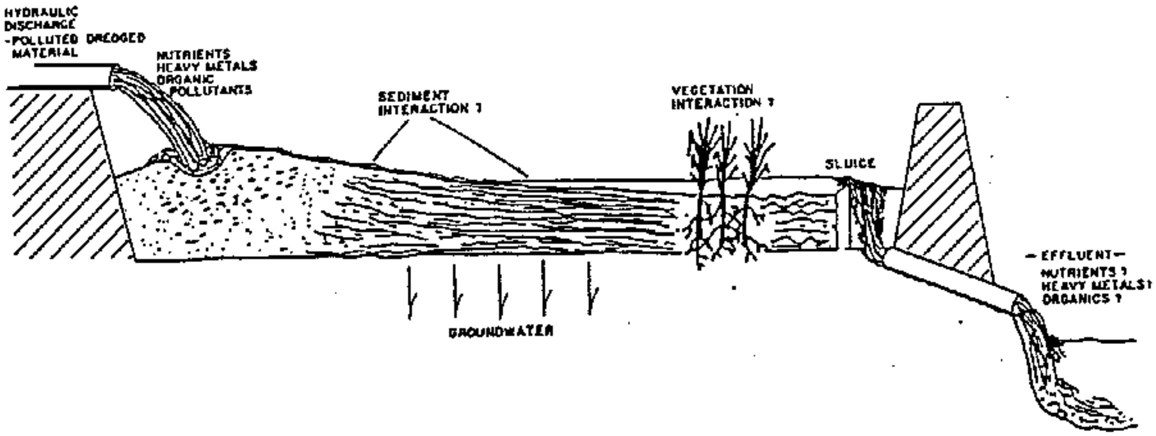


Submerged Difuser System for Placing Materials

(Source: Shields and Montgomery, 1984)

FIGURE 9

<u>FIGURE 10</u>



Cross Section of a Simple Confined Disposal Site

(Source: Chen et al., 1978)