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NATURAL RESOURCES CONSERVATION AUTHORITY (NRCA)
Development of Environmental Management Organizations (DEMO) Project

NRCA GUIDELINES FOR CONSTRUCTION, MAINTENANCE AND MONITORING OF UNDERWATER PIPELINES AND CABLES IN THE COASTAL ZONE

Natural Resources Conservation Authority (NRCA) and Development of Environmental Management Organizations (DEMO) Project

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NRCA Guidelines for Construction, Maintenance and Monitoring of Underwater Pipelines and Cables in the Coastal Zone

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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 appropriate Permitting and Licencing procedures designed to ensure that due consideration 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 Types of Facilities Covered by These Guidelines

This document offers guidance on the permitting process, and the engineering aspects, of projects involving the presence of ***pipelines*** and ***cables*** in the ***coastal zone*** -guidance that is intended to eliminate or mitigate the potentially harmful impacts that installation and operation of such elements could have upon the marine environment

The more common types of pipelines and cables that will be dealt with are

- pipelines for fuel oil and other petroleum products
- sewage effluent pipelines
- freshwater pipelines
- telecommunications cables
- electricity cables

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 GUIDELINES FOR PRELIMINARY PLANNING

The planning for a project is usually carried out in two distinct stages, viz i) preliminary studies, and ii) detailed design
This chapter offers general guidelines in relation to preliminary planning for the installation of pipelines and cables in the coastal zone
Guidelines for detailed design will be presented in a later section

3 1 The Objective of Preliminary Studies

The objective of preliminary studies is to identify possible sites/routes for the pipeline or cable, and to try to find out as much as possible about the key engineering and environmental issues associated with each possibility The purpose is to develop clear bases for comparative judgements and evaluations, leading up to selection of a preferred site/route that is technically, economically and environmentally feasible

3 2 Screening of Possible Sites/Routes for Pipelines and Cables

The screening that is usually done during preliminary studies hopefully will result in the identification of a number of alternative site locations and routes that are potentially viable, when considered in light of appropriate technical and environmental criteria

In identifying possible sites/routes, it is recommended that an environmental screening checklist be used The checklist given in Table 1 below, highlights the typical environmental concerns which should be taken into account in the siting/routing of pipelines or cables in the coastal zone

Table 1 - **General Environmental Screening Considerations for Site Selection and Route Evaluation for Installation of Pipelines and Cables**

AREAS of CONCERN	SCREENING CONSIDERATIONS
Route Alignment	▪ Choose routes that will have the least negative impacts upon critical habitats or spawning grounds, migration routes, aquatic vegetation, threatened, rare or endangered species ▪ Avoid passing through coral reefs ▪ Avoid passing through existing or proposed marine parks, dive sites, community bathing beaches ▪ Avoid passing through locations of archaelogical, historical, cultural or paleontological interest
Shoreline Stability	▪ Avoid locations where the shoreline is undergoing erosion, accretion, progradation **(Wherever shorelines are unstable, buried pipelines/cables could subsequently become exposed, or more heavily over-burdened than anticipated, leading to disruption)**
Seismicity	▪ Avoid sites that are close to known active geological faults **(If pipelines/cables are located near to active geological faults there will be increased risk of disruption due to earthquake)**
Bathymetry	▪ What are the natural seafloor gradients? **(Uneven, steeply-sloping seafloors can give rise to integrity and stability problems for pipelines and cables laid thereon)**
Seabed Soils	▪ What is the nature of existing seafloor soils, origin of the superficial deposits? ▪ How deep to bedrock? ▪ Is the material of a type that would present extraordinary difficulties for trenching and burial of pipelines or cables in the nearshore area? **(The answers to the above questions will be very important in determining whether it will be technically and economically feasible to bury portions of the pipeline or cable)**
Wind Waves, Currents	▪ Is there on-going shifting of seafloor sediments and seabed contours, due to strong wave action and bottom currents? **(The degree of exposure to strong wave and current action can be a very important factor in site/route selection for pipelines or cables in the coastal zone, as under such conditions extra engineering measures will have to be applied in order to preserve integrity**

3 3 Typical Environmental Impacts from Installation and Operation of Some Common Types of Pipelines and Cables in the Coastal Zone

The next step in the process of preliminary planning, after identification of possible sites/routes, will be to analyse and compare the main advantages and disadvantages of each potentially viable site/route From this process a preferred site/route will be identified, one that is satisfactory in terms of the critical technical and environmental considerations

In evaluating alternative sites/routes, the potential impacts upon the biological, physical and cultural environments during *construction* as well as during *operation*, should be compared Alternative sites or routes can also be assessed on the basis of minimizing or eliminating potential impacts by use of acceptable mitigation techniques

3 3 1 Impacts during *Construction*

It is almost inevitable that there will be some damaging impact upon the coastal zone environment during installation of pipelines or cables The degree of impact will mainly depend upon such important factors as the type and size of the pipelines or cables, whether buried or laid on the surface, types of plant and equipment and the installation techniques used The following are some typical construction impacts that developers must strive to avoid or minimize or mitigate

- damage/destruction of fisheries resources, seagrass coral, mangroves,
- temporary or even permanent displacement of other site users,
- noise and congestion from construction activities

Project Sponsors are advised that as a prerequisite before granting the necessary Construction Permits, NRCA will have to be satisfied that the least damaging approaches will be taken, that appropriate monitoring and mitigation measures will be implemented during construction, and that in the overall, the anticipated economic and social benefits will outweigh whatever costs may be incurred due to temporary or permanent damage to the existing environmental resources of the coastal zone

3 3 2 Impacts during *Operation*

Table 2 below indicates some of the more damaging types of environmental effects that operation of some common types of pipelines and cables can cause in the coastal zone

Table 2 **Some Typical Negative Environmental Impacts from Operation of Pipelines and Cables in the Coastal Zone**

Type of Pipeline or Cable (by function)	SOME TYPICAL NEGATIVE ENVIRONMENTAL IMPACTS DURING OPERATION
Sewage Outfalls	▪ If the effluent being discharged should contain excessive levels of pollutants, this could cause serious eutrophication in the receiving waterbody if the waterbody does not have the capacity to handle the inflow of pollutants Eutrophication leads to damage/destruction of existing fisheries resources, seagrass, coral, mangroves **To avoid such disastrous consequences, sewage effluent must be adequately treated prior to discharge, and outfall pipelines must be taken to termination points where the discharge plume will be effectively dispersed without causing damage to marine ecosystems**
Pipelines for oil and other petroleum products	▪ Spillages are virtually inevitable, most commonly through accidental damage to pipelines, or faulty procedures in coupling/uncoupling hoses for ship-to-shore transfer of products **Spilt oil can cause serious damage by smothering marine ecosystems Appropriate contingency provisions must be made to ensure that an adequate emergency res ponse capability is maintained at the site to deal with oil spillages**
Power Station Cooling water Pipelines	▪ The elevated temperature of cooling water discharge plumes can make this type of effluent damaging to temperature-sensitive marine ecosystems, e g coral reefs **In order to obtain NRCA approval for installation of cooling water pipes, it will be necessary for Developers to satisfy NRCA that the proposed *discharge* plume will not impact negatively upon any downstream marine ecosystems Sea-chests, and the ends of *intake* pipes must be properly screened so that small fish are not sucked into cooling-water systems**
Power and telecommunications cables	▪ Cables which are oil-cooled can cause environmental damage should they be accidentally damaged Apart from this if cables are adequately buried they should have no significant operational impact in passing through the coastal zone

3 4 Sources of Information for Preliminary Studies

At the very start of the planning process, the Developer will naturally seek to gather up all the existing site maps, charts and whatever other relevant information might be available, and try to glean a sound appreciation as to what are the likely key engineering and environmental issues that will have to be dealt with

Project sponsors can expect that in Jamaica they will be able to gather considerable information from the following sources, which they will be able to use for carrying out meaningful preliminary studies for installation of pipelines and cables in the coastal zone

- 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*,
- Seismic Unit, University of the West Indies, 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*

3 5 Project Sponsors Should Seek Early Contact With Local Interest Groups

Project sponsors are advised that they should make it an essential component of their preliminary studies to initiate contact with local interest groups, and seek to involve them in the selection of suitable sites/routes for their projects

4 PERMITTING PROCEDURES

4 1 Project Sponsors Should Make Early Contact With NRCA

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 urged 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

4 2 Project Sponsors May Be Required To Hold Public Meetings To Inform Local Communities Concerning Their Proposals

4 2 1 The NRCA may require that applicants for permits to install pipelines or cables in the coastal zone, 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

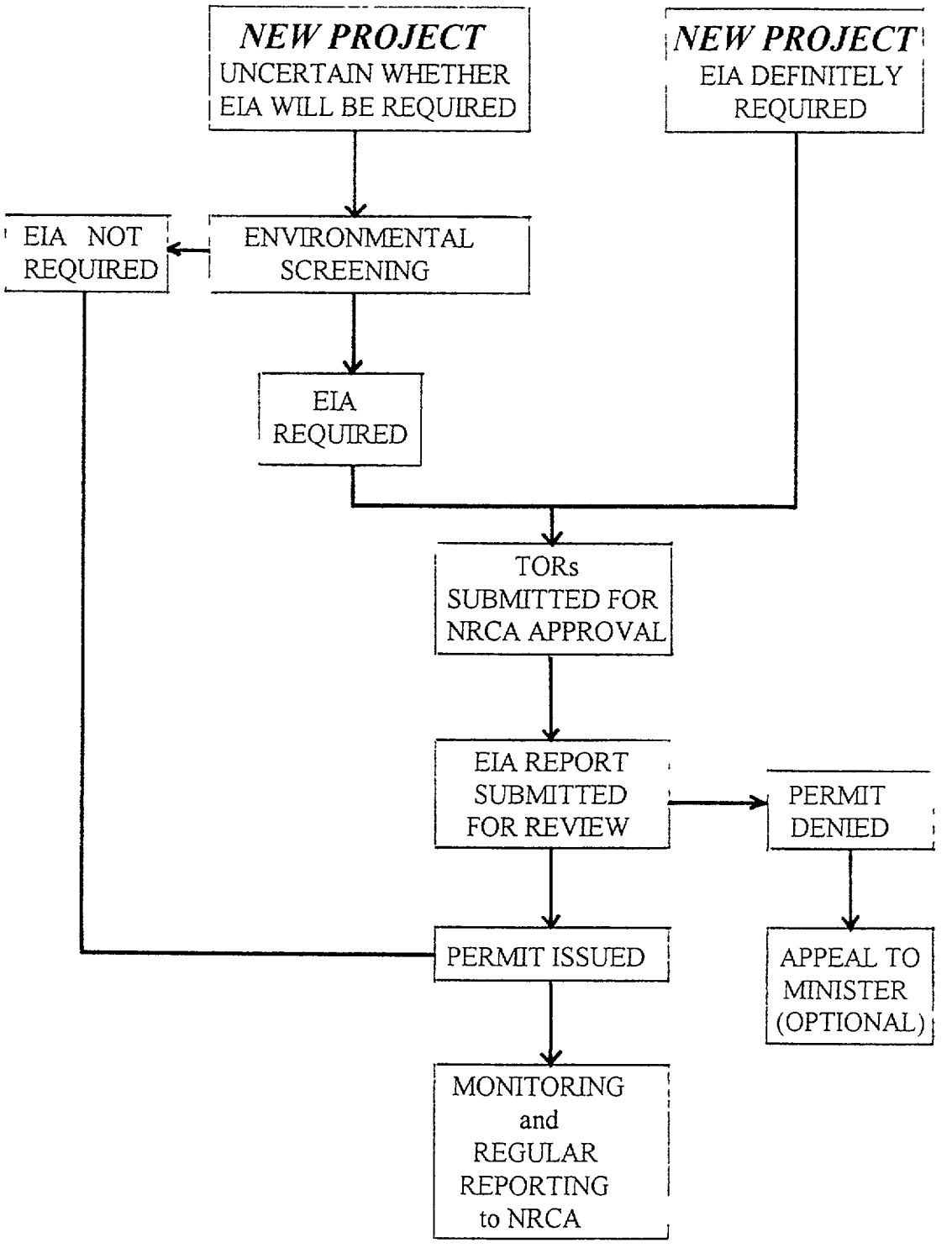
4 2 2 To foster genuine people participation, the site selection process itself must be comprehensive, clearly laid out, and presented in understandable language Project sponsors should regard town meetings as very valuable opportunities for open consultations with local communities The adoption of logical, comprehensive and open procedures in site selection may well produce the most satisfactory results for project sponsors as well as the public

4 3 NRCA's Environmental Review and Permitting Process

Any project in the coastal zone which has the potential of 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

The NRCA's Review Process, leading up to either the granting of a Permit for implementation, or denial 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



4 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 reviewed by NRCA staff using specific criteria, and a determination is made of the need for an EIA

Where the environmental impact of the project is expected to be minimal no EIA will be required

4 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 is available

4 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 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 full 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 initiate the project with specific conditions stipulated

4 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

4 3 5 *Public Presentation*

For some projects the Developer willbe asked to consult with the NRCA to set a date, time and venue for a public presentation/hearing The decision on the need for public presentation depends upon the scale and magnitude of the potential impacts, and other factors such as the ecological sensitivity of the area and the level of public interest in the project The hearing will allow the Developer an opportunity to answer questions raised by 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

4 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

4 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

4 4 **Schedule of Fees**

The fees payable to NRCA by Developers for being allowed to construct and operate facilities within the coastal zone are gazetted under The Beach Control Authority (Licensing) (Amendment) Regulations 1955

5 SITE DATA REQUIRED FOR DETAILED DESIGN

For sound route planning, and detailed engineering design it is essential to have the following range of site-specific data

5 1 **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 marine ecosystems, and fully document the baseline conditions
A typical checklist of data that will have to be provided will include water quality, aquatic vegetation, critical habitat, spawning, rearing and migration routes, threatened, rare or endangered species

5 2 **Sea-Currents and Bathymetry**

Normally, the information available on published navigation charts concerning sea-currents and water depths will not be adequate for detailed route planning 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

5 3 **Meteorology**

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

5 4 **Seabed Soils**

It will be essential to have a good appreciation of the nature of the seafloor soils Normally, sufficient qualitative information can be obtained from grab samples and probes However, if any trenching of the seabed to bury pipelines or cables is contemplated, boreholes will have be drilled, and appropriate sampling and testing carried out to determine stratification

5 5 Geomorphology

Project sponsors should take all necessary steps to ensure that appropriate investigations are carried out to clearly identify whatever geomorphological processes might be actively in force at a chosen locality, so as to be able to take such factors into account in the engineering of the project

5 5 1 For example, along many stretches of the island's south coast -from Cow Bay in the east to Sav-la-mar in the west, there is active *progradation accretion and erosion* taking place at the shoreline, (refer to P A Wood in Journal of the Geological Society of Jamaica Vol XV, 1976)

Progradation refers to the advance of the shoreline resulting from nearshore deposition of sediments brought to the sea by rivers
Accretion refers to beaches that are accumulating due to inflow of sediment from external sources other than nearby rivers
Beach *Erosion* refers to the removal of material from the shoreline due to wave action
Any man-made facilities that are introduced into these areas of the coastal zone will inevitably interrupt the on-going natural processes and could result in unintended complications For instance, if a pipeline or cable is laid upon the seafloor at a location where progradation or accretion is taking place, the pipeline/cable will obstruct the natural regime of sediment transport and could result in the rapid formation of dunes or sandbanks that could dramatically alter the nearshore environmental conditions Also, if pipelines/cables are installed at sites where there is continuing erosion, they might eventually become exposed and lose bearing support to the extent that the structural stability and integrity of the facilities are negatively affected

6 ENGINEERING DESIGN CONSIDERATIONS FOR PIPELINES AND CABLES IN THE COASTAL ZONE

Traditionally, engineers were trained primarily to respond to the task of applying technical knowledge in the design, construction and operation of systems that were intended to produce goods and services for mankind, in the most *economic* and *efficient* manner In more recent times however, it has become clear that many industrial practices that in the past were deemed to have been economic and efficient, were actually environmentally destructive, and therefore, in the longer term, truly *uneconomic*
And so, currently, the practicing engineer is constrained, not only by increasingly conservative regulations, but often also by his own heightened professional sensitivity, to pay careful attention to the external effects of his works, and to strive to ensure that his projects are environmentally sustainable, i e will not cause continuing environmental degradation

6 1 Site Selection is Paramount

The siting of a facility relative to the coastal zone may be of greater concern than the type of project itself, since location frequently can be the most significant factor in regard to the seriousness of the impacts that are delivered to the receiving environment The following are some basic siting guidelines

6 1 1 Avoid routing of pipelines and cables through ecologically or archaelogically sensitive areas

6 1 2 Avoid sites that are especially vulnerable to natural hazards such as earthquakes and hurricanes (Refer to the Geological Survey Department's hazard maps)

6 1 3 Avoid locating facilities in areas where there is evidence of shoreline and seafloor instability (Refer to Geological Survey Department)

6 1 4 Selection of a route for a pipeline or cable is often dictated, to some extent, by factors such as the coastal topography, shoreline configuration, and the location of any existing onshore facilities to which the lines or cables are to be con-nected However, the main objective in route selection is to avoid obstacles and to find the smoothest route to the desired water depth, maintaining as straight a course as possible

6 2 Pipeline Materials

Selection of the most appropriate type of material is a very important part of the process of designing submarine pipelines In choosing the type of material for a pipeline, the following are the most important aspects that engineers should evaluate

6 2 1 *Durability* The material must be able to last in the extremely corrosive marine environment

6 2 2 *Joint Strength* If the material uses mechanical joints, the joints themselves will be the weakest links in the pipeline system, and thus will impose certain limitations in regard to the range of construction methods that can be used to install the line

6 2 3 *Joint Tightness* Pipeline joints need to be leakproof, especially when carrying pressurized liquids and gases Properly welded joints are more reliable than mechanical joints

6 2 4 *Flexural Ability* The material must be able to flex without causing structural failure, because if the seabed is uneven the line will have to span across the low areas

6 2 5 *Resistance to Impact Puncture* The material must be tough enough to be able to withstand accidental impacts from boats, anchors, etc

6 2 6 *Resistance to Abrasion* The pipeline might be unintentionally scrubbing the seafloor at times, due to wave or current action, and therefore the material could be subject to abrasive forces which could cause serious damage,

6 2 7 *Requirement for Bedding* Pipelines made of material that is not strong enough to span across irregularities of the seafloor, will require special route preparation and bedding, which can be expensive

6 2 8 *High-Pressure Capability* For some usages, e g in the oil and gas industry, pipelines will have to be capable of sustaining high operating pressures, externally as well as internally, therefore the pipe material must be high strength

6 2 9 *Flexibility of Construction* In deciding upon the type of material that may be the most suitable for a project, very often, the criterion that is the most influential upon the decision, is the question of the ability of the material to allow a wide range of options in the choice of construction methods

6 2 10 Table 3 below gives comparisons of the qualities of some of the more commonly used pipeline materials in terms of some selected performance criteria

Table 3 **Comparisons of the Qualities of Some Commonly Used Types of Pipeline Materials**

	Coated Steel	Cast Iron	High Density Polyethylene	Fibreglass	PVC	Reinforced Concrete
Resistance to Corrosion	Excellent (with Cathodic Protection)	Good	Excellent	Excellent	Poor	Excellent
Joint Strength	Excellent (when welded)	Fair to Poor	Fair	Fair	Fair	Poor
Joint Tightness	Excellent (when welded)	Fair to Poor	Good	Good	Good	Poor
Flexural Ability	Good	Fair to Poor	Excellent	Excellent	Excellent	Poor
Resistance to Impact/Puncture	Excellent	Fair to Poor	Poor	Poor	Poor	Excellent
Resistance to Abrasion	Excellent	Excellent	Poor	Poor	Poor	Excellent
Requirement for Bedding	Good	Fair to Poor	Poor	Poor	Poor	Poor
High-Pressure Capability	Excellent	Poor	Fair	Fair	Fair	Poor
Flexibility of Construction	Excellent	Poor	Fair to Poor	Fair to Poor	Fair to Poor	Poor
Relative Cost	Good	Poor	Good	Good	Good	Excellent
OVERALL ATTRAC-TIVENESS	Most Useful	Very Limited Usages	Limited Usages	Limited Usages	Very Limited Usages	Very Limited Usages
USAGES	Used for everything Oil & Gas Sewage Outfalls Water	Formerly Used for Water & Sewage but hardly used anymore	Becoming popular for non-pressurized usages e g for power station cooling water intake and discharge pipelines			Too heavy Sometimes used for sewage outfalls

6 2 11 The comparisons made in Table 3 above indicate that coated steel is definitely the most versatile and useful material for submarine pipelines Although steel in seawater is very susceptible to corrosion, experience in the oil and gas industry and the water supply industry has shown that a well-coated pipeline with proper cathodic protection will last for a very long time Because of the need to protect steel from corrosion, steel pipe is likely to be more expensive than concrete or plastic But construction costs are usually lower when steel is used, because steel is readily adaptable to more construction methods, and thus allows greater construction flexibility However, the real economy from steel pipe usage lies in its adaptability to rapid fabrication and installation, the reliability of radiographically tested welded joints, and the inherent structural strength of steel

6 3 Cable Materials

6 3 1 Telecommunications Cables

Modern telecommunications cables consist of a transmission core of glass fibers, with outer layers of various types of materials to strengthen, insulate and protect the fibers (See Fig 1)
The degree to which cables need to be protected depends upon the nature of the underwater environment There are more hazards to cables in shallow-water environments such as coastal zone shelfs, than to cables that are deeply submerged upon the ocean floor Deep-water cables do not need armouring Shallow-water cables are given varying levels of external armour, (typically tapes or wires) Cables canbe classified according to their applications and the degree of armouring as follows

6 3 1 1 *Deepwater (DW) Cable*

Consists of the transmission core, composite power conductor, and an outer encasement of polyethylene insulation

6 3 1 2 *Special Applications (SPA) Cable*

This configuration consists of the basic DW cable, with additional protection provided by a longitudinal metallic barrier covered with a high density poly-ethylene protective layer This type of cable is suitable for use in areas where it might be subject to abrasive forces, where fish might gnaw upon it, and at locations where cables are to be joined

6 3 1 3 *Light Wire Armour (LWA) Cable*

In this configuration the basic DW cable is given a single layer of medium strength armour wires This type of cable is usually for burial in deep waters

6 3 1 4 *Single Armour (SA) Cable*

SA cables are very similar to LWA cables, but because this cable is not buried, the outer protective layer is made of thicker wires than those used for the LWA cables

6 3 1 5 *Double Armour (DA) Cable*

DA cables are for use in shallow, nearshore waters, where there is high risk of impact and abrasion damage This type consists of the basic DW cable with two layers of protective steel wire

6 3 2 Electricity Cables

There are two types of electricity cables that are commonly used for submarine installations, viz

I) High Pressure Oil Filled pipe-type, HPOF, (See Fig 2)

ii) Low Pressure self-contained and extruded dielectric, LPOF, (See Fig 3)

6 3 1 1 *HPOF Installations*

In HPOF pipe-type systems, three cables, comprising a circuit, are installed in a steel pipe

6 3 1 1 1 Each cable consists of a stranded copper or aluminium conductor with an electrostatic conductor shielding, many layers of oil-impregnated paper tape, insulation shielding, moisture seal and a helically wound skid wire The wire serves to protect the cable from mechanical damage during installation Each individual cable is typically 2 to 5 inches in diameter

6 3 1 1 2 The steel pipe provides protection for the cables from mechanical damage, and prevents the entrance of moisture, as well as providing a housing for the pressurizing oil which fills the remaining space in the pipe

6 3 1 1 3 The inside diameter of the pipe must be roomy enough to allow the three cables to be pulled in without jamming In HPOF systems, the distances between pressurizing stations is limited to around 2 kilometres, because, in practice, this is the maximum distance that the cables can be pulled into the pipe once it is installed

6 3 1 1 4 To protect the pipe against corrosion, various types of coatings are applied to its external surface The coating materials may be asphaltic mastic, coal tar enamel, polyethylene or polypropylene Also, cathodic protection is usually provided in submarine installations

6 3 1 1 5 HPOF pipe-type systems require external encasements of concrete to reduce buoyancy and provide additional protection for the pipe

6 3 1 2 *LPOF Installations*

Unlike the HPOF cable, which requires field-installed pipe for cable protection, the LPOF cable is complete as it leaves the factory and is therefore called self-contained' The cables may be either directly buried or installed in ducts Self-contained cables can be obtained in either single or triple-conductor design

6 3 1 2 1 The LPOF cable is made of an annular shaped conductor of stranded aluminum or copper Like pipe-type cables, self-contained cables utilize layers of oil-impregnated paper tape for insulation The diameter of the cable depends upon the design voltage

6 3 1 2 2 The cavity in the center of the conductor is filled with oil under pressure The oil penetrates into the paper insulation through small openings and together they furnish the necessary dielectric strength To assure complete saturation of oil at all times, the cable is shipped and stored on reels equipped with oil pressure reservoirs

6 3 1 2 3 The insulation is covered with an extruded lead or aluminium sheath which contains the insulating oil in the system and prevents moisture penetration Metal tapes are applied over the sheath to give it additional mechanical strength A polyethylene jacket is extruded over these tapes For submarine installations, armouring in the form of steel or aluminum alloy wires is applied to the cable

6 3 1 2 4 LPOF self-contained and extruded dielectric cables are well-suited for underwater use because of their flexibility, because they are delivered ready to be installed, and because they can be manufactured and installed in long lengths

6 4 Loadings on Submarine Pipelines

During fabrication, construction and operation, a pipeline can assume many configurations and resulting states of stress The various structural functions that a submarine pipeline can assume include tension member, compression member, suspension member, pressure pipe, and externally loaded cylinder Each of these con-ditions must be investigated and addressed, in order to assure the integrity and stability of the installed pipeline
Submarine pipelines have to be designed to withstand the range of static and dynamic loadings due to forces from gravitational influences, environmental factors, construction techniques, and operational conditions

6 4 1 Gravitational influences are static and include the weight of the pipe, corrosion coatings, weight coatings or anchor blocks These loads may be adjusted for the buoyancy of the sea water or the buoyancy force may be considered as an additional loading

6 4 2 Environmental loadings are derived from sea currents, wave action, sedimentation processes and seafloor variations Environmental forces are dynamic, not readily quantifiable, and therefore can present challenges to the designer as to how to assess their influence on the pipeline

6 4 3 If a pipeline is buried, many of the factors influencing stability become less important However, the type of seafloor soils, the strength of sea-currents, and the regularity of the seabottom, are very significant factors in relation to the possibility or likelihood of scouring around the pipe

6 4 4 If the sea-bottom is uneven, the pipeline will span across the depressions, and the hydrodynamic forces created by sea currents passing over (and under) the exposed pipeline can cause vortex shedding, which can have such forceful effects upon the pipeline itself as to cause sliding and lift-off

6 4 5 The designer of a pipeline needs to know the methods and techniques that will be used to install the pipeline Different installation methods will impose different configurations on the pipeline, resulting in different sets of construction forces and stresses

6 4 6 The loadings that are imposed when a pipeline is in use come from internal pressure surges, external pressure and support conditions Internal pressures and surges in a submarine pipeline are no different from those that would occur in a similar land-based pipeline, and therefore do not pose any special problems for designers External (hydrostatic) pressures are also quantifiable without any great difficulties However, assessment of conditions of support can be challenging, due to questions such as whether the pipeline will be exposed or buried, or spanning in places And support conditions can change over time, due to storm action, or on-going littoral processes

7 ENVIRONMENTAL IMPACT ASSESSMENT

Project sponsors are advised, that prior to embarking upon the preparation of their EIA, they should seek to develop and agree appropriate Terms of Reference with NRCA Typically, Terms of Reference should include at least the following information

7 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 will pose risks to the environment or generate positive impacts
- the anticipated timing of the project and schedule of the performance of the main construction activities

7 2 The Existing Environment of the Project Area

- the physical environment
- the biological environment
- the socio-economic and cultural environment

Baseline data should include

- ☐ Water quality at high and low tides
  Water samples should be tested for Suspended Solids, Coliforms, Nitrates, Phosphates, and other parameters as may be deemed necessary in relation to the particular purpose of the pipeline or cable that is to be installed,

- ☐ Water depths, bottom conditions, currents Water circulation patterns are to be evaluated in the context of the capability of the water body to flush itself,

- ☐ Identification of the existing pattern of coastline dynamics - i e determination of the prevailing pattern of littoral transport -whether the shoreline is stable, or prograding, or accreting, or eroding,

- ☐ Full descriptions of the condition of any existing natural resources, e g seagrass, mangroves, coral reefs Particular attention should be paid to sedimentation, algal growth, patterns of live and dead coral, and structure of fore and back reefs

7 3 The Relevant Legislative and Regulatory Framework

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

7 4 The Anticipated Environmental Impacts

The EIA report should contain descriptions of the anticipated direct and indirect effects of the construction and operation activities of the project In identifying the likely environmental *effects* of the construction and operation activities, 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

7 5 Monitoring and Mitigation Plans for the Construction Phase and for the Operational Phase

7 5 1 The EIA should include detailed plans for monitoring and mitigating any adverse effects that might arise during construction or operation of the facilities Any mitigatory measures recommended should be technically feasible and cost-effective, and should result in reduction of the negative effects to tolerable levels

7 5 2 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

7 6 Contingency Plans

7 6 1 Contingency plans should be presented for dealing with any emergencies that could arise during the construction or operation phases of the project, such as fire, explosion, or accidental spillage of petroleum products or other hazardous/toxic materials The appropriate response to leaks, breaks, explosions, fire and the resulting loss 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

7 6 2 To ensure the effectiveness of contingency planning, properly trained personnel and suitable equipment must be available Project sponsors should therefore include in their EIA, information concerning plans for providing appropriate training and equipment for the personnel who will be involved in dealing with the types of emergency situations that could arise

7 6 3 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 careful consideration by NRCA in making decisions as to the suitability of any contingency plans submitted

8 THE CONSTRUCTION PHASE

8 1 Developers Will be Required To Monitor Construction and Submit Reports to NRCA at Prescribed Intervals

8 1 1 Throughout the construction phase of their projects, Developers will be required to maintain continuing effective liaison with the concerned government regulatory Agencies and local communities, and to ensure that any issues or concerns that might arise during this phase, are clearly understood and appropriately dealt with

8 1 2 The particular construction activities which will require monitoring as the work progresses will have been 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

8 2 Methods and Equipment for Laying Pipelines

The main factors that influence the methods and types of equipment that are used to install submarine pipelines are the nature of the pipeline material itself, method of jointing, weight, size, flexibility, depth of water, velocity of sea currents, type of substrate, availability of equipment Pipelines hundreds of kilometres in length have been installed in waters over a thousand metres in depth for the oil and gas industry in the Gulf of Mexico and other parts of the world Such installations are carried out by purpose-built lay barges together with attendant unmanned mini-submarines ("Remotely Operated Vehicles", ROV's), and are designed and supervised by specialist engineers Such types of projects are outside the scope of these guidelines
The main types of pipelines, (by different usages), that are found *in the coastal zone* are oil and gas, freshwater, sewage outfalls, and cooling water intake and discharge lines The following are some of the methods and types of equipment that are commonly used to lay these pipelines

8 2 1 Conventional Laybarge, (S-lay)

The conventional laybarge is by far the most common method of installing welded steel pipelines -whether for oil, gas, fresh-water or sewage outfall Under this method, standard lengths of pipe are jointed up sequentially at

a series of welding stations aboard a long deck barge The jointed-up portion of pipeline passes through the stern of the vessel onto an extended cradle called a "stinger" The stinger prevents the pipe from being overstressed as it passes through the stern and curves downward into the sea The pipeline undergoes a second bend as it comes to rest on the seafloor The two bends give the pipeline an "S" shaped configuration as it is installed In S-lay operations, pipelines can extend over 300m from the vessel, but whenever such lengthy extensions are done several tensioning and anchoring systems employing long cables have to be applied to the pipeline to keep it from becoming damaged through overstress

8 2 2 Reel Method

Reel laying is used for fast laying of small pipelines of up to around 300mm diameter Under this method, the standard lengths of pipe are jointed up ashore and fed onto a reel of up to 13m diameter The reel is then mounted horizontally on a barge or ship that uses the S-lay method of installation

8 2 3 Bottom Assembly

This method consists of assembling relatively short lengths of pipes (say up to around 100m) on the seabed, using barge-mounted cranes, and then connecting up the pieces underwater by divers This method becomes impractical in water depths of over 100m

8 2 4 Bottom Pull

The bottom pull method entails pulling lengths of pipeline that have been jointed up onshore into place on the seafloor along the alignment that the pipeline is intended to finally rest The jointed-up pipeline lengths, (generally up to around 500m at a time), are set on skids ashore, parallel to the route of the pipeline A flat barge with a sufficiently powerful pulling winch mounted on deck is then anchored several hundred metres offshore, directly in line with the final route on which the pipeline is to be laid To commence installation, the pull cable is unreeled from the winch of the pull barge, taken ashore along the intended route of the pipeline, and attached to the leading end of the line that is to be pulled into place This first length of pipeline is then pulled into alignment on the seafloor, and as the back end reaches the shoreline, pulling is halted, so that the next length of pipe can be put into place onshore and connected to the back end of the section that is already on the seabed Pulling is then resumed and the process repeated until the total required length of pipeline is in place

8 2 5 Surface Pull

This method is essentially the same as the bottom pull method except that in this case the pipeline has to be light enough to float when empty, either by virtue of its own inherent lightness, or by having buoyancy elements attached As soon as it is pulled onto alignment, water is allowed to enter the pipeline and sink it into place

8 3 Methods and Equipment for Laying Cables

Submarine cables are currently providing linkages in many of the world's important intercontinental telecommunications systems Also, in many developed countries, subsea cables are in use for transmitting electrical power across waterways, from one region to another
The work of installing these trans-oceanic cables is performed by means of specially designed ships that povide highly maneuverable platforms loaded with sophisticated equipment for placing, pulling, jointing, coupling, and testing, the cables
A general outline is given below of how cable laying *in the coastal zone* is usually done

8 3 1 The first cable section to be installed is the shore end The cable ship or barge is anchored some distance offshore and the end of the cable facing the shore is pulled from the floating vessel towards a preconstructed manhole on land near the shoreline For safety and protection, the near-shore section of the cable almost always has to be buried -at least where it passes through the surf zone The cable is then secured inside the shore manhole and spliced to the previously installed land cable This section of cable is then tested to confirm that the integrity of the insulation and the transmission characteristics of the cable itself are unimpaired
Installation of the deep-water segment of the system begins after the shore-end testing is completed

8 4 Methods and Equipment For Burying Pipelines and Cables

It is usually necessary or desirable to bury at least the inshore sections of pipelines and cables, giving a metre or more of cover This is done for one or more of the following reasons

- to protect them from destructive wave action,
- to protect them from boat/ship/anchor damage,
- to avoid instability due to bottom currents,
- to allow unimpeded recreational use of beaches

A number of the more common methods and types of equipment used for excavating trenches for burying pipelines and cables are described below

8 4 1 Clamshell and Dragline

In shallow water close up to the shoreline it is feasible to use clamshell and dragline dredgers to excavate and backfill Trenches in the surf zone tend to get backfilled quickly by wave action and therefore it is necessary to plan and schedule the laying in this area especially carefully so that the operation can be carried out swiftly Sometimes it may even be cost-effective to install temporary sheetpiles along the sides of the trenching in order to minimize excavation and backfill

8 4 2 Stationary Cutter Suction Dredge

This type of machine can only operate where water depth is greater than around 4m Cutter suction dredges are effective for removing even the harder types of bottom material, but they cannot operate in rough sea conditions

8 4 3 Trailing Suction Hopper Dredge

This type of machine can dredge down to as much as 40m, and can operate in rougher sea conditions than the cutter suction, but it can only cope with the relatively softer types of seabed material

8 4 4 Marine Plow

Towed plows have been used for digging trenches up to around 2m deep - even in stiff clay

8 4 5 Jet Sled

When dredging machines such as those mentioned above are used for excavating trenches, the trenching is usually done *before* the pipeline or cable is laid The plow, however, is more often used to cut trenching *after* the pipeline or cable is laid, thereby providing a guide for the alignment of the plowing

If the bottom material is relatively soft clay, sand or silt, a jet sled can also be used for post-installation burial of pipelines The sled is in the form of a fork that straddles the pipeline and blasts out high velocity jets of water that penetrate and loosen the material on both sides of the line, spreading the arisings on both sides of the trenching The sled is pulled along by a surface barge, that carries the large pumps and prime movers required to power the water jets As the sled is pulled along, the pipeline settles into the trench behind it

8 4 6 Cutterhead Dredge on Sled

This is another type of post-installation trenching machine that travels along a pipeline in a manner similar to the jet sled, but is felt to have the following several advantages over the jet sled

- uses much less energy,
- can handle a wider range of soil conditions,
- cleaner cut, less disturbed cross-section,
- requires less support equipment,
- is not limited by water depth,
- can be self-propelled, thereby reducing the possibility of damage to the pipeline

8 4 7 Backfilling Trenches

Some nearshore trenches will tend to become sandtraps, and be naturally backfilled, if they are located in the surf zone, or where there is a heavy littoral drift crossing the line But trenches in deeper water sometimes will not backfill naturally, and the pipeline or cable in the bottom of the trench, though lowered below the general level of the seafloor, will not be fully protected In cases like this, for full protection, the trenching will have to be actively backfilled

8 5 Mitigation of the Potentially Harmful Effects That Might Occur During Laying and Burial of Pipelines/Cables in the Coastal Zone

In the Table 4 below some of the more harmful effects that might come from the construction processes required for installation of pipelines and cables in the coastal zone are identified, and some appropriate mitigation measures suggested

Table 4 - **Some Mitigatory Measures for Potentially Harmful Environmental Effects That Might Occur During Installation of Pipelines and Cables In the Coastal Zone**

Potential Negative Impacts	Mitigating 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 along the proposed route for the presence of any rare threatened or endangered species
3 Increased short term turbidity due to excavation and backfilling during burial of pipelines/cables	3 Reduce turbidity by efficient use of less intrusive trenching methods (e g thrust boring directional drilling) and scheduling of trenching to coincide with low current flow periods
4 Covering of valuable benthic species (e g mussels clams) by sediment	4 Monitor turbidity and maintain sediment concentrations within tolerable limits (to be agreed with NRCA in relation to the particular species at risk)
5 Interference of floating construction plant with other maritime traffic	5 Prepare a program in advance to co-ordinate and reduce interference to other waterway users
6 Damage to archaelogical treasures and artifacts due to excavation and backfilling of trenches	6 In areas where it is historically not unlikely that archaelogical treasures might be found (e g Port Royal Seville) engage divers to constantly monitor the underwater work
7 Objectionable high noise levels such as to cause disturbance to nearby residents	7 Reduce noise level by decreasing operating level during quiescent periods in the local community

9 THE OPERATIONAL PHASE

9 1 Monitoring of Pipelines and Cables During the Operational Phase, and Reporting to NRCA

9 1 1 Throughout the operational phase of a project, the project sponsors will be required to maintain continuing effective liaison with the concerned government regulatory Agencies and local communities, and to ensure that any issues or concerns that might arise during this phase, are clearly understood and appropriately dealt with

9 1 2 The particular activities and processes which will require monitoring during the operational phase will have been identified in the EIA report Each Operating Licence that is issued by NRCA will indicate the required frequency for submission of written reports from the Developers to NRCA

9 1 3 NRCA recommends that at the time of submission of application for licence to operate, the operators of pipelines and cables in the coastal zone should name an individual who will be responsible on behalf of the project sponsors for ensuring that the operators' responsibilities to NRCA and the public, for protecting the environment, will be adequately fulfilled
The individual who is appointed to be the operators' ***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 of 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 concerning operation of the pipelines or cables

9 1 4 Records of the following information should be maintained at site for operation and maintenance purposes

9 1 4 1 Detailed ' As Built drawings of all pipelines or cables and all ancillary facilities,

9 1 4 2 Route maps and accurate data defining vertical and horizontal alignment of the installed pipelines or cables,

9 1 4 3 Specifications for the particular coatings and/or cathodic protection systems,

9 1 4 4 Pressure test data,

9 1 4 5 Previous inspection reports,

9 1 4 6 Necessary operational data,

9 1 4 7 Records of past failures and repairs,

9 1 4 8 Records of inspection and maintenance of safety and emergency response equipment

9 2 Maintenance and Mitigation of the Operational Impacts of Pipelines in the Coastal Zone

Operators of undersea pipelines will be required to implement appropriate inspection, maintenance and mitigation procedures while their facilities are in use, so as to minimize the risk of damage to the environment, injury to personnel and threats to public safety The types of maintenance and mitigation procedures required will depend upon factors such as the pipeline material, its location in relation to sensitive habitats, whether buried or exposed, depth of water, bottom conditions, and the characteristics of the fluid being transported

9 2 1 Oil and Gas Pipelines

Oil and gas pipelines are usually made of steel, with welded joints They are normally coated for corrosion resistance and may also have cathodic anodes attached for added protection Larger size pipelines will have concrete encasements to counteract bouyancy and to protect the pipeline from mechanical damage

9 2 1 1 Operators of undersea pipelines will be required to establish and maintain appropriate underwater surveillance programs to detect leaks, encroachments, and any other conditions along the route that may affect the safe operation of the pipeline

9 2 1 2 Written procedures should be established for start-up, operation, and shutdown of the pipelines, and these procedures should be scrupulously adhered to Procedures should outline preventative measures and system checks to ensure the proper functioning of protective and shutdown devices and of safety, control, and alarm equipment

9 2 1 3 Pipeline systems should be operated so that the calculated predetermined operating pressures are not exceeded Over-pressure protection devices should be set to ensure that the maximum operating pressure (MOP) is not exceeded by more than 10% during surges and other deviations from normal operations

9 2 1 4 Communications equipment should be installed and maintained as needed for proper pipeline operations under both normal and emergency conditions In the event of an emergency, pipeline operators should immediately notify NRCA, the Jamaica Defence Force Coast Guard, and the Office of Disaster Preparedness and Emergency Management

9 2 1 5 Any necessary pipeline repairs should be performed under qualified supervision by trained personnel who are fully conversant with the maintenance plan and operating conditions of the pipeline, the company's safety requirements, and the hazards to employees, the public and the environment

9 2 1 6 A written emergency plan should be established for implementation in the event of system failure, accident, or other emergency, and should include procedures for prompt and expedient remedial action to safeguard personnel and limit the discharge from the pipeline system

9 2 3 Sewage Outfall Pipelines

9 2 3 1 Sewage outfall pipelines, like hydrocarbon lines, are also most often made of steel, but unlike gas and oil pipelines, they usually operate under gravity flow, with much lower internal pressures, and therefore if leakages develop, the discharges will not be as potentially impactful as those from pressure pipelines

9 2 3 2 Outfall pipelines are installed for the purpose of conducting effluent out to a location in the sea where effective dilution and dispersion can be achieved The diffusers that are usually installed at the ends of outfall lines are the elements that require the most monitoring and inspections to ensure that they are functioning properly Diffusers have to be regularly cleaned to remove accumulated grease, slime and grit Cleaning can be accomplished through flushing of the line

9 3 Maintenance and Mitigation of the Operational Impacts of Cables in the Coastal Zone

The great majority of faults that occur during the operating lifetime of modern telecommunications and electricity cables installed in the relatively shallow waters of the coastal shelf are caused, not from inherent material failures, but by physic-al damage from external sources such as dredging operations, fishing equipment, boat anchors, fish gnawing and abrasion from scrubbing on hard seafloor Although the impacts that are delivered to the marine environment as a result of normal operations of the cables are not usually seriously degrading, nevertheless submarine cables must be monitored and inspec ted regularly in order to ensure that appropriate maintenance and mitigatory measures are applied whenever called for

9 3 1 Telecommunications Cables

9 3 1 1 For repeatered undersea systems, because of the high voltages involved, the main operational hazard is electrical safety To mitigate this hazard, all high-voltage elements in these types of systems must be equipped with key interlocks, which prevent access to hazardous voltages, and cable repairs should not be conducted on cables that are energized

9 3 1 2 Typically, repairs done by ship are both random and infrequent, and therefore in some regions it is common industry practice for several system owners to share a repair ship, key repair personnel, tools and other maintenance resources This arrangement allows rapid, cost-effective response to system failures

9 3 2 Electricity Transmission Cables

9 3 2 1 A few of the more common causes of failure of submarine electricity transmission cables are

- impact from dredging equipment from anchors, from commercial fishing equipment, from bottom abrasion
- breakdown of electrical insulation from thermal electrical or mechanical stress
- defects in manufacture or installation

9 3 2 2 Cable failures frequently result in explosive electrical short circuits within the system, which can cause significant damage The short circuits are short-lived, since the installation is protected with circuit breakers which open automatically to stop the flow of current within a fraction of a second

9 3 2 3 Once a failure is detected, the exact location of the damage must be pin-pointed Some sophisticated techniques and equipment have been developed for use in locating cable defects, but very often human divers have to be called upon to find the exact locations of cable faults Once the fault is located, that portion of the cable is isolated from the rest of the system by closing particular valves which would have been installed at strategic points along the cable for emergency purposes

9 3 2 4 Failure of HPOF pipe-type and LPOF self-contained systems results in the leakage of insulating oil in cases where the pipe or cable is actually ruptured The HPOF systems have the potential for greater damage than LPOF, because of the greater quantity of oil and the higher pressures that are maintained in these systems The oils used are of varying viscosities and of relatively low toxicity When spilled, they tend to flow easily and disperse (HPOF and some LPOF oils are usually biodegradable)

9 3 2 5 In some cases, when relatively small leaks develop in submarine cables, operators tend to keep on pumping, to maintain a slight positive pressure This procedure is used to protect the cable system from further damage by preventing contaminating matter such as sand or water from entering through the damage break While continuation of pumping will result in a greater discharge of oil into the surrounding waters than if pumping is completely stopped continuation of pumping is probably more environmentally friendly because it may save a cable installation, and thereby avoid the cost, time and environmental consequences of having to pull in a new cable

10 OPTIONS FOR ABANDONMENT OF PIPELINES AND CABLES

Project sponsors should include in their project planning, consideration of options regarding de-commissioning, dismantling or abandonment of pipelines and cables in the coastal zone, whenever such installations shall have reached the end of their life cycle and are no longer required In planning for the termination and abandonment or removal of pipelines/ cables in the coastal zone, the environmental and socio-economic prob-lems associated with the different options should be carefully examined

10 1 For the safety of the public and wildlife, all equipment and above-ground facilities should be dismantled and removed, and the surface area of the land appropriately restored Wherever circumstances allow, consideration should be given to alternative uses of sites and structures

10 2 It is likely that the process for removal of buried or submerged pipelines/ cables would probably generate negative environmental impacts of similar extent to those delivered during the installation process The cost of miti-gating such impacts and of restoring the routes after removing the pipelines/cables must be assessed

10 3 To avoid the cost and environmental impact of removing unwanted pipelines/cables from the coastal zone, it is often acceptable to leave them in place If they are left in place they must be disconnected from any facility, and pipelines must be purged with freshwater, air or inert gas, and capped at open ends

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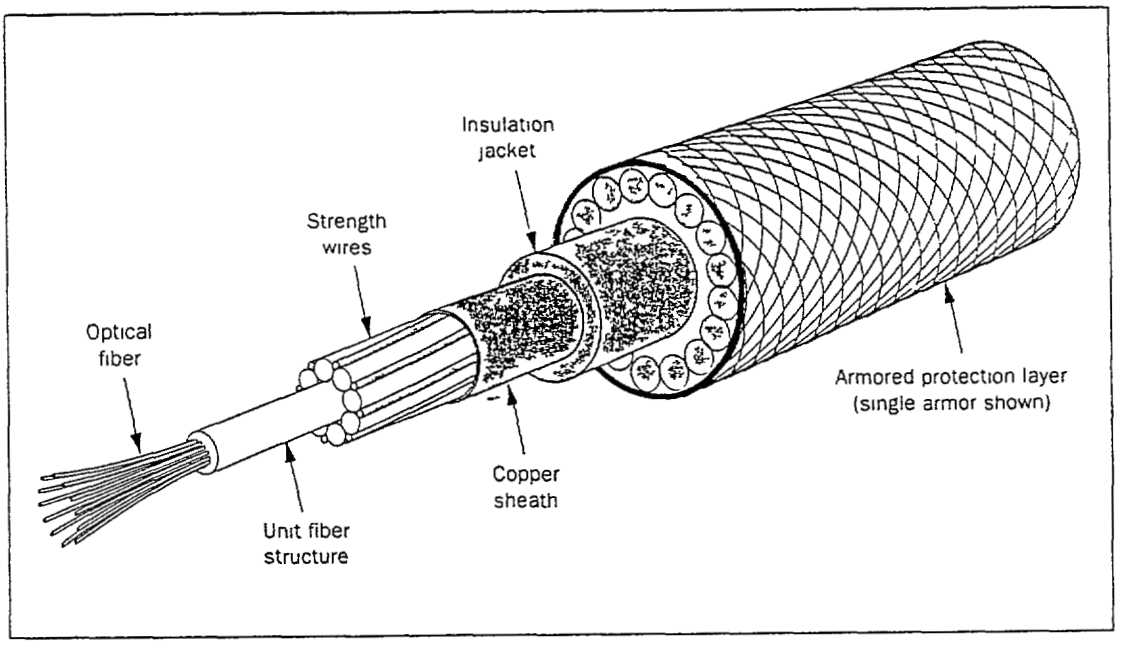

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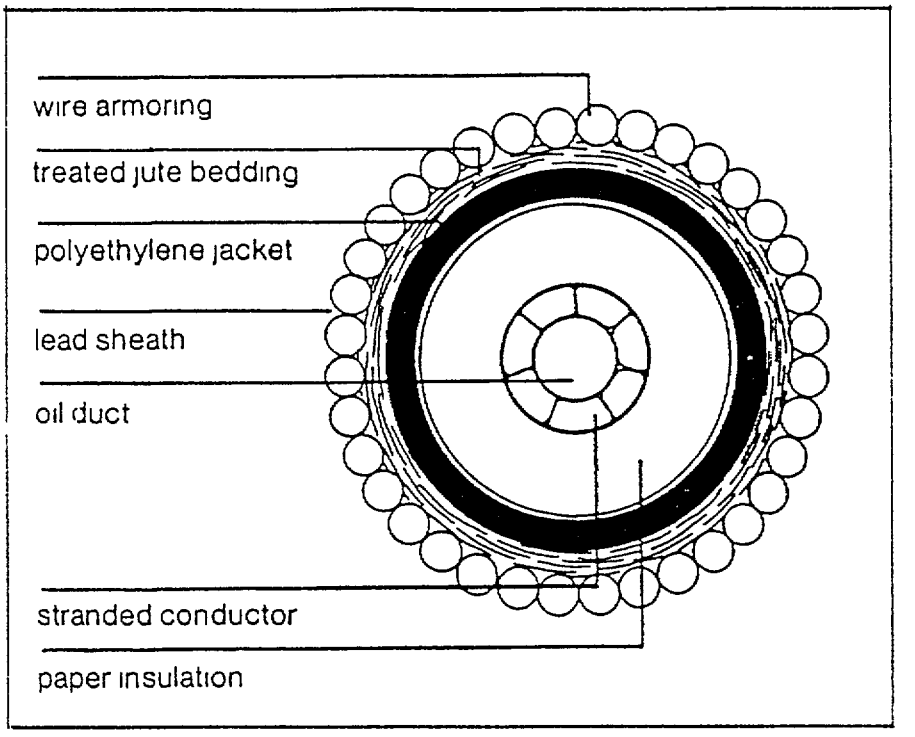
"UNDERSEA COMMUNICATIONS TECHNOLOGY"
dated January/February 1995, Volume 74 Number 1

Figure 1

TYPICAL ELEMENTS OF A MODERN (Fibre Optic) TELECOMMUNICATIONS CABLE SUITABLE FOR UNDERWATER INSTALLATIONS



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"STUDY OF THE ENVIRONMENTAL IMPACT
OF UNDERGROUND ELECTRIC TRANSMISSION SYSTEMS
prepared in 1975 by EDAW, Inc , San Francisco, CA
for the Electric Power Research Institute, Palo Alto CA
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Figure 2

TYPICAL LPOF SELF-CONTAINED CABLE FOR UNDERWATER INSTALLATIONS

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