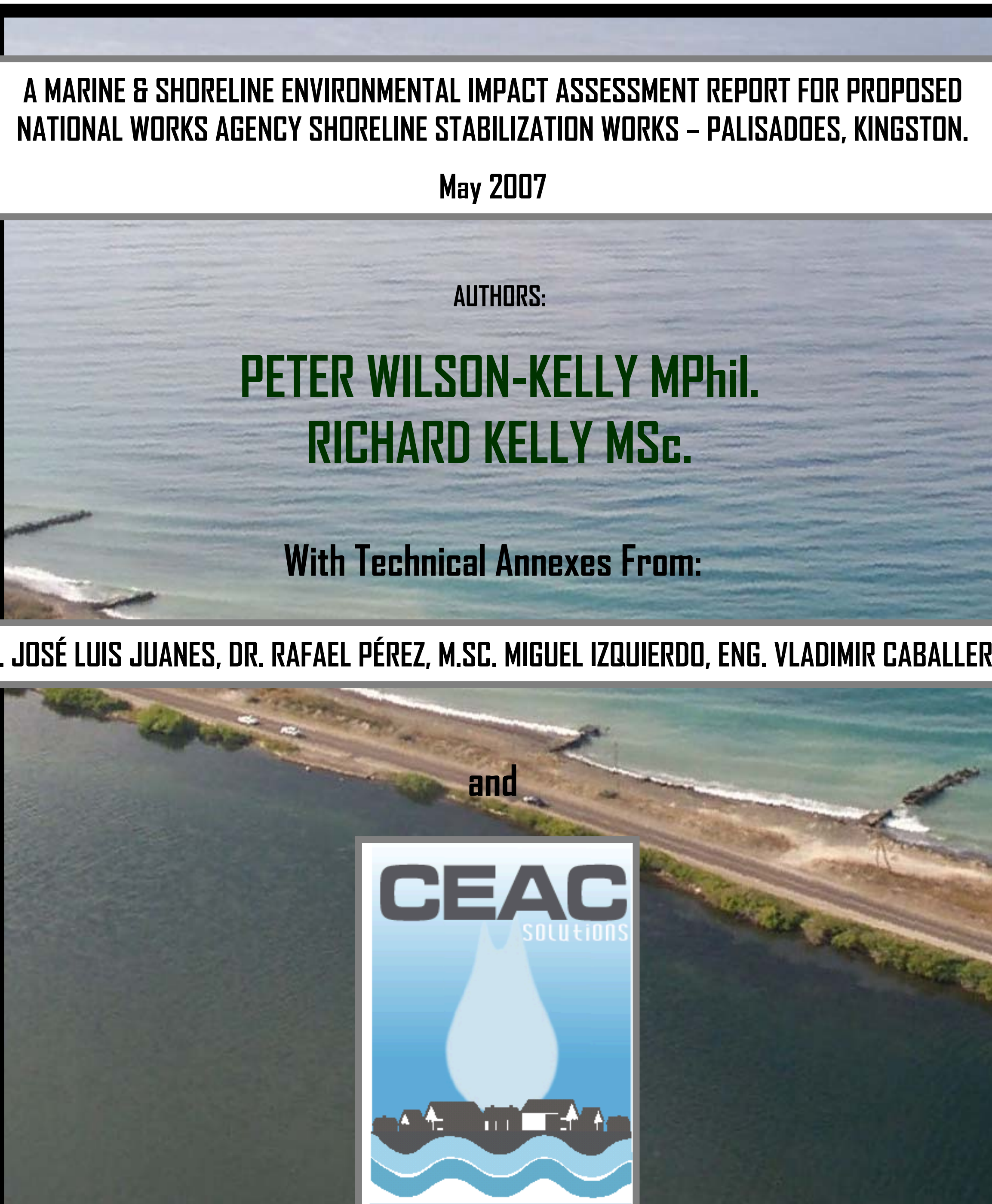

A MARINE & SHORELINE ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR PROPOSED NATIONAL WORKS AGENCY SHORELINE STABILIZATION WORKS – PALISADOES, KINGSTON.

May 2007

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EXECUTIVE SUMMARY

Introduction:

The National Works Agency (NWA) was tasked with the responsibility of designing a method of restoring the stability of the Palisadoes Tombolo, after the area was impacted by the passage of Hurricane Ivan in 2004. The NWA, in partnership with the Ministry of Local Government and the Environment, and with the technical input of the Government of Cuba, prepared a report that proposed methods for the re-stabilization of the tombolo.

The technical report, summarized that:

1. Approximately 5 kilometers of the Palisadoes Tombolo was currently at risk of being breached in the event of another Hurricane.
2. A section of the tombolo, approximately 1.5 kilometers in length was in urgent need of stabilization and, within this zone; approximately 300 meters of shoreline would not survive even a minor storm.

The report recommended the following:

1. That an elevated roadway be built on the north side of the existing one, increasing its level to about 2.0 meters. The beach, dune and the existing roadway would act as protection for the new roadway.

2. Boulder revetments were to be used at the current location of the Makepeace - Wood groynes to create further protection for the tombolo at this point, since this represents the narrowest section of the tombolo.
3. Approximately 1,100,000 cubic meters of sediments existing within 300 meters of the Tombolo's seaward shoreline were to be pumped onto shore to be used to re-nourish and recreate the eroded dunes currently at the site

The Cuban technical document anticipated that the process of dredging, conducted as a 24 hours a day work regime, would take an estimated 125 days to complete. The works, however, would be conducted in phases with the initiation of revetment construction works at the Makepeace – Woods groyne-field being the first steps taken at re-stabilization.

An Environmental Impact Assessment was commissioned to evaluate the impact of the proposed re-stabilization works. This study focussed on the following components:

- The current spatial distribution and status of any sensitive benthic lifeforms (coral, seagrasses etc) within the project area
- The current spatial distribution and status of free-moving (fish) fauna within the project area.

- The current spatial distribution of important environmental resources existing within the area from which sediments will be accessed (hereafter known as the “borrow area”).
- The current spatial distribution and status of dune vegetation landward of the Tombolo shoreline
- The establishment of ambient total suspended solids conditions experienced between the Palisadoes shoreline and the Borrow area.
- The establishment of expected sedimentation conditions during and after the dredging works.
- The determination of the extent to which turbidity and suspended solids will move within and outside of the project area.
- Current fishing practices in the area, inclusive of approximate numbers of users, their origins, seasonality in fishing practices and estimates of catch.
- The confirmation of the proposed impacts associated with the project.
- The generation of mitigations for defined impacts.
- The generation of a monitoring plan to show adherence to mitigations that will ultimately be agreed to by NEPA.

Study Area:

The study area for this development was defined as the geographical area bordered by:

1. The Palisadoes roadway to the north,
2. Plumb Point to the west,
3. The residential community of Caribbean Terrace to the east
4. The seaward limit of reef resources within the Plumb Point to Harbour Head reference points (also encompassing the proposed sediment access area -hereafter regarded as "borrow area") to the south.

Additionally, a marine benthic site was chosen, which would provide information on impacts outside of the geographical scope of the study area. This site was the NEPA/University of the West Indies (UWI) CPACC monitoring site, located near to South East Cay, Port Royal. This site was chosen due to the fact that this reef system would, theoretically, be within the path of any turbidity disturbances emanating from dredging works at the borrow area **IF** such disturbances migrated that far.

Foreseeable Negative Impacts:

The foreseeable negative impacts resulting from the implementation of the proposed works have been summarized below:

1. Sediment plume modelling conducted as a part of the EIA pointed to the potential for sedimentation impacts in excess of limits that could be tolerated by adjoining coral reefs at sediment discharge areas along the shoreline.

2. At a minimum, Beach and Dune vegetation currently existing at the re-stabilization site will be impacted by burial. This will mean that a significant percentage of the existing area of vegetation remaining after the onset of Hurricane Ivan will be lost.

3. The fisheries impact of greatest concern would be the negative impacts that could occur due to the exposure of prime nursery or adult fish habitats (such as the adjoining near-shore coral reefs) for fish near to sedimentation from dredge spoil deposition sites at the shoreline.

4. Construction works on shore would curtail any availability of that location for recreational activities during the period of construction.

Anticipated Positive Impacts:

The foreseeable positive impacts resulting from the implementation of the proposed works have been summarized below:

1. The proposed works will not only result in the re-stabilization of the area (reducing economic risks and social upheavals in the event of a breach of the Tombolo) but will also create a new substrate for the re-growth of dune vegetation at the site.

2. It is unlikely that there will be any negative impacts emanating from the accessing of sediments from the borrow area.

3. it is unlikely that both the deep reefs located immediately south of the proposed restoration area and reef systems located in the vicinity of the Port Royal / Palisadoes reef systems, will be affected by the dredging and spoil disposal works proposed.

4. it is unlikely that both the deep reef fisheries located immediately south of the proposed restoration area and those fisheries located in the vicinity of the Port Royal / Palisadoes reef systems, will be affected by the dredging and spoil disposal works proposed

5. The new dunes will contribute to an increase in the aesthetics and marketability of the area for recreation and sports.

6. Reefs in the vicinity of the work areas may be able to tolerate sedimentation disturbances. This would be possible particularly if the periods of exposure to dredge spoil loading is finite.

Proposed Mitigations:

The following list of mitigations is proposed to minimize any negative impacts that may emanate from the conducting of proposed re-stabilization works:

Sedimentation Mitigations:

- Sedimentation ponds should be used to facilitate settling of sediments out of pumped dredge water, thus reducing the total suspended solid load to be returned to the marine environment once water is decanted.

- Dredge pumping rates should be maintained that will facilitate adequate retention time in the ponds, thus facilitating rates of settling that could result in discharges achieving prescribed water quality standards.

- Silt curtains should be deployed at dredge spoil disposal areas to contain sediment movement at the shoreline.

- Strict attention be paid to the prevention and immediate mitigation of leaks that may occur from the floating pipeline deployed between the dredge and the shoreline.

Fisheries Mitigations:

- The implementation of the sedimentation control mitigations outlined above will be the primary mechanism for avoiding negative impacts on fishing areas immediately adjoining shoreline construction sites.

- The fishing public should be kept informed as to the operation plans for the dredge and the times at which it will be operation within defined locations. This will ensure that fishers have enough information to avoid being within the vicinity of the dredge, its floating pipeline and the shorelines at which re-stabilization works will be conducted.

- Since popular fishing seasons for both Mutton and Lane Snappers are well known (December – January and August to October respectively), dredge timings should be planned to avoid these periods.

- The fishers should be consulted and informed about the project **in detail** before start-up to garner their understanding and support. This might involve multiple meetings with the fishers.

- A **Fishers Compensation Mechanism** be designed and implemented to deal with any claims for damages that can be properly substantiated. Such a mechanism could be based on a compensation mechanism promulgated through the Fisheries Division for seismic surveys recently conducted on the Pedro Banks (**see Appendix 4**).

Dune Vegetation Mitigations:

A landscaping and dune re-vegetation plan should be developed by the Department of Life Sciences – UWI to maximize the collection and use of threatened dune and beach vegetation for replanting after construction has been completed.

Recreational Mitigations:

- Dune areas at Palisadoes will be available to the public, owing to the fact that re-stabilization work will not be conducted along the entire tombolo at one time.

- The public will have to be properly advised in advance of the intended progression of works at the Tombolo so that inconveniences can be avoided.

- Once completed, the re-stabilization process could easily be advertised as a comprehensive recreational package, with boardwalks, lay-bys, jogging trails and sitting / fishing areas incorporated.

- Recreational designs for the dunes must be sensitive to the fact that human activities are one of the leading causes of dune destabilization. Any recreational designs for the tombolo must reflect this fact.

ACKNOWLEDGEMENTS

The Authors would like to thank the following persons for their involvement in or contributions to the preparation of this document:

1. **The members of the Palisadoes Protection and Rehabilitation Project Steering Committee**, firstly for their expression of confidence in nominating the Authors to conduct the study and for their technical insight into the design of the study. The members include

- Mr. Calvin Thompson, National Land Agency.

- Mr. Earl Patterson, NWA, Committee Chairman
- Mr., Roger Smith NWA Manager Technical Services
- Mr. Lynval Ramdial, NWA.
- Mrs. Maureen Hendricks, NWA.
- Mr. Jeffrey Spooner, Meteorological Services.
- Mr. Cowell Lyn, Airports Authority of Jamaica.
- Mr. David Smith, Smith-Warner International.
- Mr. Chris Burgess, CEAC.
- Mr. Sean Green, NEPA.
- Mr. Kapleton Hall, NEPA.
- Mr. Anthony McKenzie, NEPA.
- Prof. Ted Robinson, Marine Geology Unit, UWI, Mona.
- Miss. Shakira Khan, Marine Geology Unit, UWI, Mona.
- Dr. Rafi Ahmad, UWI, Mona.
- Mr. Philbert Brown, Min. Local Government and Environment.
- Mr. Joseph Shako, Min Local Government and Environment.
- Mr. Franklyn McDonald, UNEP.

2. **Dr. José Luis Juanes, Dr. Rafael Pérez, M.Sc. Miguel Izquierdo and Eng. Vladimir Caballero**, whose technical inputs lead to the designs examined and eased the field work load on the EIA study team.
3. **Mr. Chris Burgess** and his team from CEAC Solutions Ltd for their technical contributions to the document, both in design and in the sediment plume modeling work contributed.
4. **Messrs Dave Guinness and Andrew Bennett**, sport fishermen and commercial divers, whose extensive diving and fishing experience in the Palisadoes area guided the completion of the marine assessment component of the study.
5. **Commander Sydney Innis** - Commanding Officer and **Lt. (sg) Steve Batchelor** - Operations Officer – JDF Coast Guard, for their permission to use their surface assets to facilitate data collection for the study.
6. **Petty Officer Hall K., Leading Seaman Butler M. and Ordinary Seaman Yee Shui R.** for their expert and safe handling of the JDF Coast Guard Inshore Patrol Vessel CG – 124 during the collection of marine data for the study.
7. **Ms Carol Thompson** – Team Leader, Analytical Services Division of the Scientific Research Council for the analysis of water samples collected during the marine survey component of the EIA study.

8. **Drs. Dale and Mona Webber** for their assistance in the identification of plant types observed and recorded on the dunes of the Palisadoes Tombolo and for the discussions leading to the development of vegetation mitigations for the tombolo.
9. **Ms Eileen Jones** and the technical staff at T.P.G. Imaging Services Ltd for office services provided.

PAGES

1.0 Introduction

"**All motion is cyclic. It circulates to the limits of its possibilities and then returns to its starting point**" – ***Robert Collier***. There is truth to the statement that life is cyclical.

In 1952, after Hurricane Charley, the then Public Works Department embarked on a programme to stabilize a section of the Palisadoes main road that had been severely eroded by wave action from the storm. The technology used at the time was the deployment of a series of groynes designed by an American coastal engineer known as Mr. Sidney Makepeace Wood, who was, at the time working with the Works Department (**see figure 1A & 1B – Appendix 1**).

Over half a century later, the National Works Agency, successor to the Public Works Department, has been tasked with a similar responsibility, after the Palisadoes Tombolo was similarly impacted by the passage of Hurricane Ivan in 2004. The NWA, in partnership with the Ministry of Local Government and the Environment, and with the technical input of the Government of Cuba, prepared a report that proposed methods for the re-stabilization of the tombolo[1](**see Appendix 2**).

[1] Refer to report titled Palisadoes Protection And Rehabilitation Project, written by Authors Dr. José Luis Juanes Dr. Rafael Pérez M.Sc. Miguel Izquierdo and Eng. Vladimir Caballero.

In summary, the report established that approximately 5 kilometers of the Palisadoes Tombolo was currently at risk of being breached in the event of another Hurricane. Of these 5 kilometers, a section approximately 1.5 kilometers in length was in urgent need of stabilization and, even within this zone; approximately 300 meters of shoreline would not survive even a minor storm.

The report recommended that "a new roadway be built on the north side of the existing one, increasing its level in about 2.0 meters and incorporating a drainage system that allows water to pass toward the inner part of the Harbour at times of severe sea penetrations".
The beach, dune and the existing roadway would act as protection for the new roadway.

The report further acknowledged the need for what it called "Urgent Measures" for the 5 km section of tombolo currently at risk. Urgent measures were defined as measures that could be implemented with the process of not more than 6 months. This is considering the current vulnerability of the Palisadoes tombolo.

The urgent measure proposed is that sand deposits existing within 300 meters of the Tombolo's seaward shoreline (**see Figure 2 - Appendix 1**) be pumped onto shore to be used to re-nourish and recreate the eroded dunes currently at the site (**see figure 3A – Appendix 1 for crossectional illustration**).

Approximately 1,100,000 cubic meters of sediments will be required for this purpose.

Additionally, boulder revetments would be used at the current location of the Makepeace groynes to create further protection for the tombolo at this point, since this represents the narrowest section of the tombolo and the most critically threatened section of the tombolo at this time (**see figure 3B –Appendix 1 for crossectional and plan illustration**).

The dunes would be created with the steps outlined on **Figure 3C & D -Appendix 1,** with sand being deposited by floating pipeline from the dredge to the shoreline in 100-meter segments, where the sand will be applied and shaped with the use of bulldozers.

The Cuban technical document anticipated that the process of dredging, conducted as a 24 hours a day work regime, would take an estimated 125 days to complete.

The works, however, would be conducted in phases with the initiation of revetment construction works at the Makepeace – Woods groyne-field being the first steps taken at re-stabilization.

The report defended this approach by outlining the following:

1. This measure could be implemented in a time not greater than 6 months.
2. This measure would be recreating the pre-existing beach and dune conditions at the tombolo and, as a result, would be very compatible with the natural nature of the Tombolo.

3. This measure would be a medium term solution that can withstand events of return periods between 4 years (tropical storms) to 130 years (Category 5 hurricanes)
4. This measure will not negate against the implementation of more long-term solutions.

In order to demonstrate environmental compliance locally and to satisfy the environmental criteria of the International Development Bank – financiers of the project, the National Works Agency proceeded to conduct an Environmental Impact Assessment (EIA) in order to evaluate the impacts that could occur due to the implementation of the project.

This report represents the findings of the Environmental Impact Assessment.

2.0 Regulatory Setting:

THE Natural Resources Conservation Authority (NRCA) Act Permit and Licensing Regulations (1996) gives the National Environment and Planning Agency (NEPA) the power to require that all developments of prescribed categories occurring within Jamaica be subjected to an environmental examination process. This includes a process of environmental screening that could point to the need for an Environmental Impact Assessment, in the event that there are components of the development that could impact negatively on the environment.

The favourable conclusion of this review process leads to the granting of permission to execute for those developments that have been deemed to be environmentally sound.

THE NRCA Act also provides regulations governing the declaration and management of Parks and Protected areas in Jamaica. The Port Royal / Palisadoes area of Kingston was declared a protected in 1998. This declaration is binding over an area of land, water column and seafloor bound by the boundaries outlined in **FIGURE 1** and the declaration seeks to ensure that the diverse wildlife found within these boundaries are protected and preserved.

THE area defined in **FIGURE 1** also represents the boundary of Jamaica’s second declared RAMSAR site. The RAMSAR

Convention (signed in Ramsar, Iran in 1971), seeks to protect and preserve wetlands and their biological and physical functions.
NEPA also administers the Beach Control Act (1956), which governs the use of the foreshore and the floor of the sea. Basically, any activity that could impinge on the foreshore and the floor of the sea will require a licence under this act. As is the case with the Permit and Licensing Regulations, there is also a provision for the conducting of an EIA in the event that the activities intended on the foreshore or the floor of the sea could lead to environmental impacts.

APART from NEPA and the NRCA Act, other Agencies and legislative instruments that would apply to the governance of the proposed development would include:

1. **KINGSTON AND ST. ANDREW CORPORATION (KSAC)** – provides public services, road and recreational amenity maintenance, plus urban and rural building and development control within the Kingston and St. Andrew area.
2. **THE NATIONAL SOLID WASTE MANAGEMENT AUTHORITY** (**NSWMA**) – under the guidance of the Solid Waste Management Authority Act (2001) seeks to promote the proper collection and disposal of solid wastes. Any debris or construction wastes generated by the development would have to be disposed of in accordance with the NSWMA.
3. **NATIONAL WORKS AGENCY** -has the responsibility for approving roads, traffic access arrangements and drainage conveyances.

4. **FISHERIES DIVISION** – Min of Agriculture and Lands – has the mandate under the Fishing Industries Act (1971?) to manage both inland and marine fishing in Jamaican waters.
5. **PORT AUTHORITY OF JAMAICA** – This is a statutory organization established under the authority of the Port Authority Act of 1972. The Port Authority of Jamaica has the responsibility for the regulation and control of shipping operations and the maintenance of safe maritime navigation in and around the internal waters of Jamaica.
6. **AIRPORT AUTHORITY OF JAMAICA –** has the authority under the Airports Authority Act (1974) has the responsibility for the development and management of a safe and secure airport system for Jamaica.

It would be critical that any environmental document prepared for this development be circulated to the agencies afore mentioned.

3.0 Study Focus and Area Demarcation

It is anticipated that, with the stabilization methods proposed, the following areas of impact are possible:

1. Impacts to marine benthic and free-swimming resources adjoining both the Tombolo shoreline and the area from which sediments are to be accessed due to turbidity[2] and sedimentation[3]
2. Impacts to marine benthic and free-swimming resources between the sediment supply area and locations to seaward due to turbidity and sedimentation.
3. Impacts to the biological components of the shoreline and land components of the Tombolo due to excavation and sand deposition works required to create the proposed protective works.
4. Impacts to environmental features present within the confines of the seafloor area from which sediments are to be accessed.
5. Impacts on the livelihoods of fishers that may ply their trade within the vicinity of the work area.

[2] The reduction in the ability of light to penetrate the water column due to the presence of suspended materials. This will create an impact on light dependent organisms, such as corals.
[3] The smothering of bottom dwelling organisms by sediments

6. Impacts on persons who use the Palisadoes area, particularly its south beach face, for recreational purposes (Jogging, Walking, Sightseeing etc).

The study would therefore have to focus on the following components:

- The current spatial distribution and status of any sensitive benthic lifeforms (coral, seagrasses etc) within the project area
- The current spatial distribution and status of free-moving (fish) fauna within the project area.
- The current spatial distribution of important environmental resources existing within the area from which sediments will be accessed (hereafter known as the “borrow area”).
- The current spatial distribution and status of dune vegetation landward of the Tombolo shoreline
- The establishment of ambient total suspended solids conditions experienced between the Palisadoes shoreline and the Borrow area.
- The establishment of expected sedimentation conditions during and after the dredging works.
- The determination of the extent to which turbidity and suspended solids will move within and outside of the project area.

- Current fishing practices in the area, inclusive of approximate numbers of users, their origins, seasonality in fishing practices and estimates of catch.
- The confirmation of the proposed impacts associated with the project.
- The generation of mitigations for defined impacts.
- The generation of a monitoring plan to show adherence to mitigations that will ultimately be agreed to by NEPA.

The proposed works will ultimately be implemented along the length of the Palisadoes Tombolo, extending from Caribbean Terrace to the east to the Plumb Point Lighthouse to the West (**see Figure 4 – Appendix 1**). The study area for this development was defined as the geographical area bordered by the Palisadoes roadway to the north, Plumb Point to the west, the residential community of Caribbean Terrace to the east and the seaward limit of reef resources within the Plumb Point to Harbour Head reference points (also encompassing the proposed sediment access area -hereafter regarded as "borrow area") to the south (**see figure 5 –Appendix 1**).

Having defined the study area, it was opined that if turbid water movement were a possible source of impact, then an examination of environmental resources down current of the study area would be critical. **Figure 6-Appendix 1** shows what appears to be turbid water, possibly from a riverine source[4], moving westward and seaward over what will be the borrow area.

With the above in mind, a marine benthic site was chosen, which would provide information on impacts outside of the geographical scope of the study area. This site was the NEPA/University of the West Indies (UWI) CPACC[5] monitoring site, located near to South East Cay, Port Royal. This site was chosen due to the fact that this reef system would, theoretically, be within the path of any turbidity disturbances emanating from dredging works at the borrow area. Additionally, NEPA and the UWI had conducted coral reef monitoring at this location over a period of 4 years, starting in 2000. Data on this monitoring has been published[6] and was used as a contribution to the establishment of a baseline for marine benthic distribution and status within the Palisadoes area (**see Figure 7-Appendix 1**).

4.0 Climate & Hydrology – Influence on River Discharge:

FOUR rivers discharge within 5 kilometers of the proposed work area. These are (ranging from west to east) the Hope, Cane, Chalky and Bull Park rivers. Incidentally, the Hope River discharge point is located within the shoreline boundary of the study / work area.

[4] The Hope, Cane, Chalky and Bull Park rivers empty into the sea to the east, close to this area.
[5] Caribbean Planning for Adaptation to Climate Change – www.cpacc.org
[6] Coral Reef Monitoring for Climate Change Impacts Jamaica 2001-2003 Prepared by Marcia Chevannes Creary Centre for Marine Sciences UWI-Mona

PETER Allen Wood's paper entitled "Sediment transport in the Hope River, Jamaica[7]" gives a good insight into the climatic and riverine processes that could lead to turbid discharges to the proposed work area.

IT outlines that rainfall occurring the Hope River catchment area is seasonal (occurring between May to November) with annual averages being between 1250 and 2550mm (must of which falls within the rainy period). The rainfall often occurs as intense events with 250mm a day fall rates being possible.

A combination of catchment and rainfall characteristics have lead to in-channel suspended solid measurements of over 60,000 mg/l being measured, translating into a total sediment transport of over 8000 tonnes over a 30 hour period.

IT is likely that the other river systems flowing up-current of the work area, make suspended sediment contributions to the marine environment equivalent to that made by the Hope River. The importance of these riverine discharges is outlined in fact that their contributions during heavy rainfall periods could mimic or exacerbate any turbidity related issues that may result as a consequence of the proposed works.

[7] www.cig.ensmp.fr/~iahs/redbooks/a122/iahs_122_0149.pdf

5.0 Baseline Assessments:

5.1 Marine Assessments

5.1.1 Seafloor Assessment Methods

With a total coastal frontage of 5 kilometers, a number of approaches were taken to ensure adequate area coverage:

5.1.1.1 Aerial Assessments

Aerial and satellite image interpretation and mapping was initially conducted using a combination of the following:

1. 2003 LIDAR imagery obtained through the Survey Department,
2. 1961 Aerial Imagery obtained from the Survey Department
3. (circa) 2005 IKONOS images obtained from Google Earth[8]
4. Obliquely oriented[9] aerial photographs of the site taken in 2007 with a digital camera.

[8] earth.google.com
[9] Oblique aerial photographs are those that are taken at any angle other than vertically downwards

The objective of this mapping effort was to identify the spatial extent of benthic (coral reef, seagrasses) and land-based (dune vegetation) life form features that could be interpreted from these images using characteristics identified with photogrammetry[10]. These characteristics relate to colour, 3-dimensional form and texture patterns, which can be used by a suitably trained and experienced remote sensing technician to identify the various types of bottom substrates, benthic features[11] and coastal formations existing within and surrounding Jamaica's waters.

For benthic air photo interpretation, the characteristics were used to identify bottom substrates that are often indicative of habitats for various attached and mobile marine lifeforms and would, by deduction, hint to the spatial extent of these live components. Image interpretations were rendered on aerial images scaled to represent the same dimensions as the design plans for the development. This was done with a Geographical Information System [12] software (MapMaker Pro[13])

5.1.1.2 Coastal / Marine Assessment Method Description - Ground Verification:

[10] Photogrammetry is the science of using aerial photographs and other remote sensing imagery to obtain measurements of natural and human-made features on the earth www.Physical Geography.net
[11] organisms attached permanently to the seafloor
[12] GIS utilizes software to layer various geographical information onto one another, facilitating interpretations.
[13] www.mapmakerpro.com

After the process of aerial assessments was completed, ground truthing was conducted to verify interpretations made during aerial photo assessments and to provide general information on the status of natural resources that may exist within the immediate study area.

For the confirmation of the nature of the seafloor north and south of the proposed borrow area and within, dives utilizing SCUBA[14] were conducted and visual observations made at the sites defined on **Figure 8-Appendix 1**.
The positions of the dives were defined using a Global Positioning System (GPS[15]) so that observations could be spatially mapped.

Extensive sediment mapping work was conducted by the Cuban Technical Team within the Borrow area. The observations of the Cuban diving team were confirmed with SCUBA and their results used for the characterization of the seafloor within the area.

The product of both photo assessments and ground truthing was the generation of a diagram outlining the spatial distribution of both hard

[14] Self Contained Underwater Breathing Apparatus.
[15] A satellite based positioning and navigating tool implemented by the US Military, but accessible by the civilian public. The system involves the use of a hand held receiver, which interprets signals transmitted by a system of 24 satellites set in a geostationary orbit around the earth.

and soft substrates on the seafloor within the study area and the distribution of land lifeforms on the tombolo.

5.1.1.3 Benthic Status Determination

Status determination of marine benthic lifeforms identified during ground truthing was done using transects deployed within the areas defined on **Figure 8 –Appendix 1** to guide the positioning of photoquadrats[16] taken with underwater cameras.

Where the photographic methods proved to be inadequate (due to unforeseen technical difficulties), a more traditional visual quadrat method was used[17].

Percentage cover of corals in relation to algae was used as the basis for reef status, since there is a loosely established relationship between the ratio of corals to algae on a reef and its overall health. This ratio was interpreted from work done by Hughes 1991[18], which identified Jamaican north coast reefs as having 54% area cover of corals and 4% area cover of algae in the 1970s. Owing to the effects of eutrophication[19] due to development, the influence of a pan-Caribbean die-off of the Black Spiny urchin in 1983 (at the time, the dominant herbivore on coral reefs) and the impacts of Hurricanes Allen (1980) and Gilbert (1988), this ratio changed to 5% coral cover

[16] Vertically oriented photographs of features, used for the purpose of estimating percentage cover of various features, such as corals. Each photoquadrat covered an area of 0.4m x 0.4m

[17] Method similar to the photoquadrat, with the exception that a 1m x 1m PVC pipe square is laid on the seafloor and sketches are made of the relative areas covered by lifeforms within the quadrat.

[18] www.agrra.org/reports/jamaica2.htmlAgrra report summary

[19] The impact of nutrient pollution on the marine environment resulting in the overgrowth of attached and free-floating plant life.

and 95% algae cover in the 1990s. These two ratios were used as a general indication of reefs of good health (1970s) and reefs of poor health (1990s).

5.1.2 Fishery Assessment and Status Methods

Types of fish observed at the ground truthing sites outlined on **Figure 8 –Appendix 1** and estimates of their numbers were obtained using the Transect and roving fish count methods defined for the Atlantic Gulf Rapid Reef Assessment (AGRRA) protocol [20].

Fish examined using AGRRA transect method were those that were important as herbivors[21] and commercially important fish. The roving method allowed for a wider understanding of the various types of fish that would be observed on site.

The results of AGRRA surveys conducted on the North, West and East Coasts of Jamaica in 2000[22] were used as a basis for the evaluation of the status of reef fish at the Palisadoes site.

An assessment was done to determine the number of fishers fishing in the Palisadoes area (Harbour View Round-A-bout to the vicinity of the shipwreck of the "Pillar De Caribe", which is in close proximity to the Norman Manley International Airport), and the type and quantity of fish caught. The assessment included interviews with fishers from

[20] www.agrra.org/method/methodhome.html
[21] Plant eaters – important as controllers of vegetation growth on reef systems.
[22] www.agrra.org/reports/jamaica.html

relevant beaches within the area and also dialogue with the Fisheries Division.

The catch data from the Fisheries Division's Data Collection Programme is not organized to produce data by area. Hence, it was difficult to capture the actual catch data for the area. However, the fish catch for the Palisadoes area was estimated by interviewing fishers and analyzing the Division's fish production data to get a suitable estimate of fish catch.

5.2 Land Assessments

5.2.1 Aerial Assessments

As was done for Marine Assessments, aerial and satellite image interpretation and mapping was initially conducted using Google Earth images of the study area. These were used, owing to the fact that they were the most recent vertically oriented imagery data possessed. It was discovered that shoreline protection works, initiated by the NWA after Hurricane Ivan (circa 2005), were present on these images. Thus, the Google Earth images would give a good illustration of dune vegetation post- event.

Identifying characteristics were used to define features common to the type of conditions found on and behind the shoreline at the Tombolo. Additionally, the use of area analysis of the images lead to a determination of the distribution of these land-lifeforms on the tombolo.

5.2.2 Land Lifeform Assessments Methods – Ground Truthing

For land components, walking traverses were conducted as a means of confirming land-lifeform cover at areas where these were identified as being present on the aerial imagery. These walking traverses were also important because the aerial imagery used for mapping was 2 years older than present day conditions. If there were any significant changes in the positions or densities of the lifeforms in question, then these observations could then be used to update the imagery data.

The product of both photo assessments and ground truthing was the generation of a diagram outlining the spatial distribution of land lifeforms on the tombolo. Image interpretations were rendered on aerial images scaled to represent the same dimensions as the design plans for the development. This was done with MapMaker Pro.

5.2.3 Land Lifeform Status Assessment Methods

For land-lifeforms (in this case, dune vegetation) status was evaluated as a function of overall area covered by vegetation versus time. The manner in which this was done was through the evaluation of dune vegetation change over the periods 1961, 2003 and 2005.

To achieve this time series evaluation, all of the images outlined above were geo-referenced to the same scale and their respective areas of vegetation cover and vegetation footprints determined. In this way, both a numerical and spatial representation of vegetation change over time was obtained.

5.3 Water Quality Assessments

During the marine ground truthing phase, tests were made to determine the prevailing levels of suspended solids at the study area. This was done to provide a basis for the monitoring of sediment removal works from the Borrow area, once this was initiated.

Water and Secchi Disc[23] sampling were conducted at the sites defined on **Figure 9A –Appendix 1** with the collection of water samples for suspended solid analysis. Water samples for suspended solids analysis were taken within the vicinity of the sea bottom with the use of a Niskin Bottle[24]. Water samples at the shoreline sites outlined on **Figure 9A –Appendix 1** were collected by hand while wading at the water's edge. Water samples were analyzed using the SMEW 2540E Method[25] .

Initial Secchi disc sampling was done during February of 2007, during a period of very calm seas. Water sampling for total suspended solids was done in June of 2007, under sea conditions that could be regarded as being "normal" for the area, as illustrated at sample stations 1, 3 and 4 (see **Figures 9B-D –Appendix 1)**. These

[23] Tethered device lowered into water to be used to measure turbidity. www.reefed.edu.au/glossary/s.html
[24] Device used to collect water samples from below the surface.
[25] Standard Methods for the Examination of Waste and Waste Water – 20th Edition, 1998.

locations showed turbid water extending seaward from shore for distances of between 50 to 100 meters. Secchi disc readings were also taken at this time so as to provide a basis for comparison with readings taken in February.

Standards examined for suspended solids analysis were as determined by Dr. Caroline Rogers of the US Virgin Islands National Park Service[26]. Dr. Rogers cited sustained values of greater than **10 mg/l**[27], settling rates of greater than **10 mg/cm^2/day** and vertical visibilities of **less than 4 meters** (as measured by Secchi Disc), as being the limit beyond which detrimental impacts would occur to coral reef systems[28]. Additionally, Dr. Rogers, in her doctoral dissertation[29], indicated that single doses of sediments, amounting to a settling rate of **200 – 1000 mg/cm^2/day**, would kill corals. This would suggest a settling standard that would be immediately lethal to corals.

5.4 Ocean Currents and Sediment Transport Modeling:

This EIA document references a technical report prepared by CEAC Solutions Ltd, which was commissioned by the NWA to determine the manner in which sediments generated by dredging and dune creation would be transported by ocean currents (**see Appendix 3**).

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[26] **Rogers CS. (1983). Sublethal and Lethal Effects of Sediments Applied to Common Caribbean Reef Corals in the Field. *Mar Poll Bull*. 14:378-82.**
[27] Note that NEPA's proposed marine water quality standard for suspended solids were based on this literature.
[28] The assumption made is that TSS values of 10mg/l correspond to a visibility of 4 meters.
[29] University of Florida – August 1977

The modeled information was used for layering with biological resource information outlined in marine assessments to determine areas that may be at risk. It will be noted from a perusal of the appended report that the suspended solids limits of 10mg/l[30] was used as a modeling guide. Additionally, the recommendations outlined in the modeling report were also incorporated as mitigations in this EIA report.

5.5 Public Perception of the Public.

In order to ascertain the awareness and opinion of the public about the project, two meeting with stakeholders and the public were held. The first was held in May of 2007 and the second was held in January of 2008. The verbatim of both meetings are presented in appendix 5. The discussions suggest there are concerns among the public as to the environmental impact of the project and the measures to be used to reduce these impacts. There is however the realization that this is an important project which needs to be implemented.

A questionnaire was used in the second meeting to acertain a quantitative measure of the public's perception of the project. The questionnaire is presented in Appendix 5. Only 25% of the attendants did not know about the project before the meetings. Once they were enlighted 100% were in favour of the execution of project with 75% being strongly in favor. Everybody thought the project was

[30] Outlined in section 3.3.

beneficial with the protection of the road being the main benefit for 50% of the participants. Everybody was looking forward to the start of the project. A majority of the participants, 63% thought the project will affect the environment and these concerns are reflected in the verbatim. The verbatim and the results of the questionnaire indicate that the public is in favour of the project once the protection of the environment is taken into consideration during its execution.

6.0 Observations:

6.1 Marine Substrates

Figure 10A –Appendix 1 defines the locations of various substrates within the study area. Beach rock[31] (see illustration on **figure 10B – Appendix 1**) immediately adjoins the shoreline at the study area. This beach rock has apparently been deposited with successive relocations of the shoreline over the centuries, creating a layer of beach rock extending seaward from the shoreline for a distance of approximately 150 meters. The patterns illustrated on **Figure 10C – Appendix 1** suggest a progressive retreat of the shoreline to its current location, with subsequent deposition of beach rock in retreating layers.

Seaward of the beach rock layer is a fringing reef with characteristic spur and groove formations[32] and isolated shallow water coral pinnacles[33] (see Figure **11A & B – Appendix 1**). This substrate layer varies up to 200 meters in width where it ultimately encounters an expansive sediment plain. It is within this plain that the borrow area is located.

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[31] Formed from the cementation of beach sediments with calcareous materials

[32] formations reminiscent of corrugated roofs. This adaptation allows for wave energy to be dissipated through the reef. Also, sediments drain off the reef's spurs into its grooves, where it is deposited away from live reef substrate.

[33] Coral pinnacles are isolated areas of coral reef surrounded by sand.

Seaward of the sediment plain is a deeper area of reefs, with spur and groove formations characteristic of the shallower reef system. This reef system ultimately terminates at the Island shelf[34].

As indicated previously, both deep and shallow water reefs had spur and groove formations. These spurs and grooves are of low depth and relief and exhibit low rugosity[35]. The surface of the spurs was dominated by growths of fleshy green and brown algae with occasional heads of boulder corals being observed. **Figure 12A – Appendix 1** outlines examples of the corals observed at both deep and shallow coral sites. These are listed as follows:

1. Smooth Starlet Coral
2. Boulder Brain Coral
3. Mustard Hill Coral
4. Symmetrical Brain Coral
5. Cavernous Star Coral
6. Massive Starlet Coral

It was noted that all coral varieties were of the massive or boulder morphology. No branching corals were observed.

Coral / Algae percentage coverage estimates for the three sites assessed were summarized, as illustrated on **Figure 12B –Appendix 1.**

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[34] The island shelf is where the seafloor plummets to the abyss.

[35] Rugosity being defined as the level of complexity that a reef has, for example, the extent to which a reef area has holes, crevasses and overhangs within its substrate: Friedlander Allan & Parrish James 1998. Habitat characteristics affecting fish assemblages on a Hawaiian coral reef. Journal of Experimental Biology and Ecology 224:1-30.

6.2 Land Lifeforms

Thompson and Webber (2004)[36] characterized the tombolo as having dune vegetation on its southern shores and mangrove thickets on its northern shores.

Zonation was observed in the sand dune community of the Palisadoes and was defined as strand beach, strand dune and strand thorn-scrub vegetation. The term **Strand** here is used to describe "the narrow littoral marine zone including beach, fore-dune, and remaining sandy habitat up to the edge of stabilized dune or inland vegetation" [37]. A significant portion of this area is influenced by salt spray, mobile sand and surf and it is in an attempt to adapt to these conditions that zonations of plant vegetation occur.

The strand beach zone was characterized by ***Sporobolus sp***., ***Gomphrena sp*.** and ***Sesuvium sp***. The strand dune zone was characterized by the presence of ***Capparis sp*** and ***Calliandra sp*** while the landward strand thorn-scrub was characterized by the presence of ***Acacia sp***. (**see Figure 13 A-E –Appendix 1**).

[36] Heather P. Thompson and Dale F. Webber ***The sand dune ecology of the palisadoes, kingston harbour, jamaica Bulletin of Marine Science:*** **Vol. 73, No. 2, pp. 507–520.**

[37] http://www.botgard.ucla.edu/html/botanytextbooks/worldvegetation/strand/fulltextonly.html

Two endemic species, ***Calliandra pilosa*** and ***Opunitia jamaicensis***, were identified compared with five endemics observed in a 1953 report. The paper surmised that recent road realignments and widening/resurfacing development have increased the pressure on the rare and endemic species found in this sand dune community. Continued vegetation loss could affect dune stability and integrity of Palisadoes and associated communities within Kingston Harbour.

Most strand species are perennials[38]. Strand plants typically have either underground, creeping stems capable of forming new plants (like grass) or deep taproots, generally reaching several meters to wet sand at the water table.

The most salt-tolerant strand plants tend to be those found closest to the sea (strand beach) while species inhabiting unstabilized dune sands (strand dune) are adapted to being buried during strong winds.

Woody plants, such as trees, shrubs, and woody climbers, on beaches tend to occur far away from the water and near or only on stabilized dunes. In the dry tropics and subtropics, commonly thorn scrub may be the terrestrial vegetation adjacent to strand (Strand Thorn-scrub). Sea-grape and Sea-bean trees are commonly found behind the strand adjoining the Palisadoes roadway.
One of the major roles played by dune vegetation is that of stabilizing the sand reserves stored within the dune. This is achieved through the presence of the dense mats of vegetation, which act as an attenuator for storm waves.

[38] meaning that these plants that do not die after flowering, but live from year to year

Additionally, the roots of the vegetation serve as an anchorage mechanism, preserving the stability of the dune[39]***.***

The spatial distribution of the dune vegetation, as at 2005 (the most recent vertical aerial coverage possessed) is outlined on **Figure 14A –Appendix 1.** The area of dune vegetation existing on the windward (seaward) section of the Tombolo in 2005 was estimated at approximately 4.18 hectares. Dune vegetation area, estimated from aerial images taken in 2003 and 1961 were 7.9 and 6.97 hectares respectively. **Figure 14B –Appendix 1** further illustrates variations in the coverage of dune vegetation at the Tombolo, particularly at the groyne-field.

6.3 Fish Populations

Species lists were generated for fish observed at both deep and shallow sites examined within the study area. These are listed below and illustrated on **Figure 15A & B –Appendix**

[39] www.unesco.org/csi/pub/source/ero9.htm

Deep Reef Species List –

1. Red Banded Parrot Fish
2. Stoplight Parrotfish
3. Schoolmaster Snapper
4. Black Durgon
5. French Grunt
6. Creole Wrasse
7. Spiny Lobster
8. Mackerel
9. Spanish Hog Fish

Shallow Reef Species List –

1. Doctor Fish
2. Surgeon Fish
3. Blue Tang
4. Black Snapper
5. Barracuda
6. French Grunt
7. Sergeant Major Damselfish
8. Dusky Damselfish
9. Yellow Tail Damselfish
10. Stoplight Parrotfish
11. Striped Parrotfish
12. Lane Snapper (numerous numbers of juveniles)
13. Bluehead Wrasse
14. Yellowhead Wrasse
15. Spiny Lobster

AGRRA survey information collected for the three sites assessed were summarized in **Figure 15C- Appendix 1** and compared with AGRRA 2000 data for the north coast. Data was represented as numbers of fish observed belonging to the assessed fish categories per unit area of seafloor surveyed (100 square meters) and average lengths of fish observed.

6.4 Fisheries

Kingston Harbour and the Palisadoes area support approximately 3,115 registered fishermen operating from eight fishing beaches. These beaches are Greenwich Town, Port Henderson, Hunts Bay (Causeway), Hellshire, Port Royal, Harbour Head, Rae Town and Bull Bay. While about 50 percent of these fishers do not fish solely in the harbour or near the Palisadoes they are indirectly dependent on the area for the provision of bait for other types of fishing. The other half of fishers are directly dependent on the area in which all of their fishing activities occur. The fishery in the area include crustaceans (lobster, shrimp), molluscs, coastal pelagics (sprat) and reef fish (snappers, parrots).

The deeper areas of the Palisadoes fishery are frequently fished for Mutton and Land Snappers. Mutton snapper is caught in the day while lane snappers are caught at night with the aid of lights, which are used to attract the fish to the vessels. While these fish are caught year round, there are pronounced seasons for both, with Mutton Snapper being caught more frequently between December – January while the season for Lane Snapper is August to October.

The fishery is important as it provides employment for people from low income communities, who would otherwise have difficulty providing for themselves and their families.

The fishery has managed to survive despite the plethora of activities and developments that have occurred within the area. However, it has been established by the Fisheries Division that conflicting activities have had adverse effects on the fisheries, including sewage discharge from the harbour View Sewage Plant, discharges from the Hope, Cane, Chalky and Bull Park rivers. Overfishing also appears to be an issue at the site.

The fishing grounds identified were Windward Edge, Light House and Shipwreck (**see Figure 17 –Appendix 1**). Table 1 shows the number of fishers and fishing boats utilizing the Palisadoes area.

Table 1. Number of Fishers using the Palisadoes Fishing Grounds by Beach

Fishing Beach	Number of Fishers	Number of Boats
Bull Bay	42	21
Greenwich Town	38	28
Port Royal	10	5
Rae Town	40	20
Rockfort	10	5
Total	**140**	**79**

Source: Fisheries Division

Fishers harvest mainly finfish (such as snappers, parrots), coastal pelagics (such as sprats) and crustaceans (such as lobsters) within the Palisadoes fishing grounds. Due to the intensity of the waves or the general 'roughness' of the area, it is not a popular fishing ground for fishers.

The following gives an estimate of the value of fish caught in this area:

Estimated number of fishers using area - 140[40]
Estimated average catch[41] per day – 2kg
Estimated average value of catch per day – $807
Estimated average number of fishing days per year – 180
Total average value of catch per fisher per year – $ 145 260
Total average value of catch for 140 fishers – $ 20 336 400[42]
(Source: Fisheries Division)

By deduction from the above, it is estimated that the total catch for a day at the Palisadoes area would be 140 kg (two persons per boat at 2 kg per boat). This would be assuming that all persons are at the location fishing during a given day.

[40] Assuming 2 fishers per boat = 70 boats.
[41] Includes all species caught.
[42] This is based on the assumption that the fishers catch 2 kg of fish for every fishing event.

6.5 Marine Water Quality:

6.5.1. Total Suspended Solids:

Values for total suspended solids taken in June 2007 for sample stations outlined on **Figure 9 – Appendix 1** are outlined below in **Table 2**. and illustrated on **Figure 18A – Appendix 1**

Table 2 Total Suspended Solids values for stations at Palisadoes. Values in milligrams per litre.

Parameter Mg/l Standard = 10mg/l	**Stations**							
	1	2	3	4	5	6	7	8
	90	60	66	80	11	9	2	8

4.5.2. Turbidity Estimates:

Water visibility for sample stations examined during February 2007 outlined on **Figure 9 – Appendix 1**, as measured by secchi disc, has been outlined below in **table 3**. and illustrated on **Figure 18B – Appendix 1**

Table 3 Secchi Disc depth readings for stations at Palisadoes. Readings in meters[43].

Depth in meters Standard = >4m	Stations							
	1	2	3	4	5	6	7	8
	0.5m	0.5m	0.5m	0.5m	7m	8.5m	18m	7m

6.6 Prevailing Currents and Sediment Plume modeling:

Figure 18[44] -Appendix 1 suggests that the currents within the study area are predominantly oriented to the west-northwest, with a variation between this orientation and the south-southeast. The figure also suggests that the maximum current speeds measured ranged from 5-10 cm/sec.

The technical report also outlined that the currents observed were not influenced by tides.

Hence it was deduced that these currents were wind originated, which made sense, since the prevailing day and night wind directions correspond with the dominant orientations outlined on **Figure 18 – Appendix 1**.

[43] Sample stations 1-4 were at wading depth, stations 5-8 to seafloor

[44] Refer to report titled Palisadoes Protection And Rehabilitation Project, written by Authors Dr. José Luis Juanes Dr. Rafael Pérez M.Sc. Miguel Izquierdo and Eng. Vladimir Caballero

The CEAC Solutions Ltd. modeling report (see **Appendix 2**) made the following conclusions[45]:

1. Existing current meter data revealed that sub-surface and surface currents can be expected to move in both easterly as well as westerly shore parallel directions with a tidal signature. The resulting plumes can therefore be expected to extend to either sides of a discharge, depending on the stage of the tide and wind conditions.

2. Borrow area sediment plumes are not expected to have trajectories or concentrations that would result in any adverse ecological conditions to either offshore or nearshore reefs. These plumes are only expected to be some 300 to 500 metres in nominal dimension.

3. Accidental shoreline discharges of sediment plumes can extend 1,500 to 3,500 metres in longitudinal dimensions. These plumes could impact on ecologically important nearshore reefs. It is therefore very important to pay particular attention to the environmental considerations (such as turbidity barriers and sedimentation basins/berms) during the construction of the beach dunes when the sand is being pumped onto the shoreline.

[45] Quoted directly from document.

4. Important Kingston Harbour shelf reefs including South East Cay and others are not expected to be adversely impacted by the dredging operation.

6.7 Recreational Use.

Visual observations were made along the entire 5 km study area to determine the types of recreational activities that occurred within the areas to be re-stabilized. The most common activities observed (not necessarily arranged in order of significance were:

1. Line Fishing from shore
2. General fitness activities, including jogging and walking
3. Sight seeing
4. Wading (specifically near to Caribbean Terrace)

While a scientifically designed recreational use survey was not conducted, it was surmised over numerous traverses made during the week and on weekends that the activities cited above were most commonly conducted during early morning and late afternoon hours. Some fishing and sight seeing activities occurred late into the evening and during night hours.

The above-cited activities also appeared to peak in popularity during weekend periods.

7.0 Status Evaluations

7.1 Marine Resources

7.1.1 Marine Benthic Reef Resources: (include SE Cay data)

The Coral/Algae percentage cover results outlined in **Figure 12B – Appendix 1** suggest that deeper reef systems appearing to be in a better health condition (15% coral cover) than shallow systems (7% coral cover). Both results were slightly better than those obtained for South East Cay, over 5 kilometers southwest of the westernmost section of the study area (2% coral cover).

The disparity in deep-shallow water coral health could probably be explained by the possibility that sources of nutrients to the marine environment would be riverine based (Hope, Cane, Chalky and Bull Park Rivers). Additionally, the Harbour View Sewage Treatment Plant discharges close to the eastern extent of the reef coverage within the study area.

River and sewage discharges are of fresh water, which would float on top of the seawater and may not mix in deep water to the extent that it would in shallow water. Therefore, contaminants would have greater access to the seawater column in shallow water locations.

Why it is that a coral reef location closer to point source of pollutants would be slightly better than a location down current, but further distant from the sources, could not be explained.

When compared with the values outlined by Hughes (1991), it was concluded that all reef systems examined were in poor health due to algae overgrowth. However, the fact that coral resources were observed shows that there is potential for recovery, **if** the stresses being placed on the reef can be reduced.

7.1.2 Benthic Resources within the Borrow Area:

It was very quickly determined by the Cuban technical team (and confirmed by the EIA team) that there were no reef resources within the boundaries of the Borrow area. Additionally, it was outlined that there were very few observations made of burrowing filter-feeding organisms, such as Bivalve mollusks, within the sediment plain between both shallow and deep-water reef areas.

7.1.3 Fishery Resources

The results shown in **Figure 15C-Appendix 1** suggest that there was a lack of commercially important species of fish, with the exception of Lane Snappers, which appear to spend their juvenile lifecycles in the shallow reef areas near to the Tombolo (and particularly near to the groyne-field). There also appeared to be a population bias towards smaller, herbivorous fish and event the numbers of these types of fish were low.

The lack of top predators and the limited numbers and sizes of herbivorous fish observed, suggest an unhealthy fish population at the location.

Such a population would certainly not be helped with an extraction rate of over 25 metric tones of fish being harvested per year[46].

7.1.4 Water Quality

The results illustrated in Tables 2 and 3 (section 4.5.1-2) outline total suspended solids and turbidity values that were close to the 10mg/l limit for stations 6-8, slightly over the limit for station 5 and far exceeding the limits for stations 1-4. These observations were made under dry atmospheric conditions with wind speeds of 15 -20 knots and wave heights of up to 2 meters[47] and would probably be typical of these conditions.

The re-suspension of suspended solids inputs from river discharges through wave action may have contributed to the high sediment values obtained nearshore. Note, however, that there were no coral reef resources within the band of turbid water sampled nearshore on June 2007 (see Figures 9B-D – Appendix 1). The nearest examples of these resources were over 200 meters away from shore, with the reef sample station being closest to the area of re-suspension being sample station 5.

[46] Deduced from submitted Fisheries data.
[47] TVJ weather marine forcast observed for the day prior to the sampling and during the sampling.

Turbidity measurements (Secchi Disc) taken in February 2007 were obtained under dry conditions similar to those experienced in June 2007, but with wind speeds being less than 10 knots and wave heights being less than a meter. The seafloor was clearly visible from the sample boat at all stations during this period.

It was noted that the types of corals observed within the study area were of the massive (boulder) variety, which are known to be more tolerant of low visibility and elevated turbidity / TSS conditions. These observations may possibly be illustrating a reef that has, over time, adapted itself to these elevated conditions.

7.2 Tombolo Lifeforms:

There had clearly been a change in the area of dune vegetation existing in 2003 as opposed to 3005. Dune area coverage in 1961, 10 years after the onset of Hurricane Charley, was estimated at 6.97 hectares. In 2003, dune vegetation coverage was estimated at 7.9 hectares, as opposed to 4.18 Ha in 2005, one year after the onset of Hurricane Ivan (**see Figure 14A & B –Appendix 1**).

This information would suggest that there was vegetation loss at the Tombolo during Hurricane Charley. Some recovery may have occurred during the 10 year period between the onset of the Hurricane and the time of the capture of the 1961 image. It was clear that there was a sparcity of vegetation at the area defined as being critically affected, which was illustrated both on the 1961 and 2005 images. It is very likely that the same area was similarly affected during both storm events.

Visual evidence observed on the 2005 images suggested that the loss that occurred in 2005 was attributed to a combination of sediment removal and burial with wave-transported sediments.

8.0 Implications for Development – Negative and Positive Impacts:

8.1 – Negative Impacts:

As outlined in **section 1.1,** it was envisaged that several areas of impact could occur. These are elaborated on below:

8.1.1 Turbidity and sedimentation impacts:

Dredging of sediments from the borrow area will result in the generation of Turbidity and sedimentation at three locations. Firstly, the action of the dredge will generate turbidity and re-sedimentation at the borrow area. Secondly, the deposition of dredged material at the coastline could result in the generation of turbidity and sedimentation at the water's edge. Finally, the action of waves and currents could result in particulate transportation from the dredging and deposition areas down current.

The CEAC Solutions modeling points to the potential for sedimentation impacts in excess of the 10 mg/l limits (outlined under section 3.3) at sediment discharge areas along the shoreline.

8.1.2 Dune Vegetation Impacts:

Since offshore sand will be deposited on the existing shoreline to re-create the pre-existing dunes, it is clear that any existing vegetation within the footprint of the area to be filled will be threatened.

At a minimum, the Strand Beach and Strand Dune vegetation currently existing at the re-stabilization site will be impacted by burial. This will mean that a significant percentage of the 4.18 hectares of dune vegetation remaining after the onset of Hurricane Ivan will be lost.

8.1.3 Fisheries Impacts:

Table 2 summarizes the potential effects of dredging on the fish life and other marine organisms[48].

Table 2. Potential impacts of dredging on Fisheries

Nature of impact	Timing*	Area	Potential impact
Uptake (with sand and gravel	Short	In dredge track	Demise of sessile or poorly motile shellfish and crustacean
Noise	Short	Wide	Finfish and crustacean avoidance (esp. during migration and foraging)
Water quality	Short-medium	Plume high, Wide (re-suspension of	Finfish avoidance (during migration and foraging); shellfish

[48] Obtained from the Fisheries Division – Ministry of Agriculture.

		sand)	spat settlement and feeding.
Substrate type (nature and particle size)	Medium	In dredge track (gross change) Wide (surface covering)	Demise in benthic fauna, removal of eggs, destroy demersal habitat
Substrate topography	Medium – long	In dredge track	Change in tidal sound signature; physical obstruction and entrapment; loss of migratory trail indicators; loss of hiding places
Benthic community structure (species richness and abundance	Medium – long	In dredge track (gross change) Wide (surface covering)	Reduction in dietary choice and abundance; increase in predators, proliferation of competitors

* Short (<24 hours); medium (<1year); long (> 1year)

The dredging activities could produce considerable noise, which could frighten away fish species.

There is a strong possibility that the activities could inundate fishing areas with mud/sand and cover small fishes, eggs and other benthic organisms on which fishes depend. The turbidity of the water may also be detrimental to marine plants and other organisms that depend on clear sunlit water for survival. The digging of the seafloor also causes disturbance in the substrate and again this is detrimental to the benthic fauna on which fishes may depend. There is also some amount of belief that the dredging of the sea floor also causes the release of toxins that have been locked in the sediments. These toxins are also dangerous to fishes and other marine life.

With these possible impacts in mind, and based on the modeling work conducted by CEAC Solutions Ltd., it is anticipated that **the fisherys impact of greatest concern would be the negative impacts that could occur due to the exposure of prime nursery or adult fish habitats (such as the adjoining nearshore coral reefs) for fish near to sedimentation from dredge spoil deposition sites at the shoreline.**

While not an environmental issue, per se, the operation of the dredge at night could create a navigational hazard to fishers operating within the area.

8.1.4 Recreational Impacts:

Construction works on shore would curtail any availability of that location for recreational activities during the period of construction.

8.2 – Positive Impacts:

8.2.1 – Dune Recreation Impacts:

The completion of works along the Tombolo will result in the re-creation of the previously occurring dunes along the shoreline. **This will not only result in the re-stabilization of the area (reducing economic risks and social upheavals in the event of a breach of the Tombolo) but will also create a new substrate for the re-growth of dune vegetation at the site.**

8.2.2 Borrow Area Benthic Impacts:

Based on the lack of observations of benthic organisms within the borrow area, **It is unlikely that there will be any negative impacts emanating from the accessing of sediments from the borrow area**.

8.2.3 Deep water Coral Reef Impacts:

Based on current and sediment plume modeling, **it is unlikely that both the deep reefs located immediately south of the proposed restoration area and reef systems located in the vicinity of the Port Royal / Palisadoes reef systems, will be affected by the dredging and spoil disposal works proposed.**

8.2.4 Deep Water/Down – Current Fisheries Impacts:

Based on current and sediment plume modeling, **it is unlikely that both the deep reef fisheries located immediately south of the proposed restoration area and those fisheries located in the vicinity of the Port Royal / Palisadoes reef systems, will be affected by the dredging and spoil disposal works proposed.**

8.2.4 Recreational Impacts:

With proper management of the re-created dune areas, along with the implementation of works to facilitate and control recreational access, **the new dunes will contribute to an increase in the aesthetics and marketability of the area for recreation and sports.**

8.2.4 Sedimentation Impacts:

Monitoring work conducted during 18 days of dredging at Rackhams Cay in June of 2002 showed that while suspended solids values ranging between 36 - 110 mg/l were measured in the vicinity of the cutter head of the dredge, settling rates of 0.1 - 17.6 $mg/cm^2/day$ were measured on the reefs adjoining the dredge works. Aerial observations made 12 hours after dredging operations had ceased revealed vertical visibilities clear enough to define the orientation of the cut area on the Cay, while post dredging monitoring of both existing and relocated corals at the site showed no significant increases in mortality due to sedimentation[49].

[49] Peter M.C. Gayle, Peter Wilson-Kelly, Sean Green**:** *Transplantation of benthic species to mitigate impacts of coastal development in Jamaica..* **Revista de Biologica Tropical 2005.**

Therefore, though modeling work has shown that the suspended solid standards may be exceeded at dredge material discharge sites near to reef locations at Palisadoes, **reefs in these areas may either be geographically removed from these disturbances or may be able to tolerate such disturbances. This would be possible particularly if the periods of exposure to dredge spoil loading is finite.**

9.0 Proposed Mitigations:

The following list of mitigations are proposed to minimize any negative impacts that may emanate from the conducting of proposed re-stabilization works:

9.1 Sedimentation Mitigations:

The Cuban Technical report outlines the use of sediment berms to create retention ponds at the stabilization sites. These ponds will facilitate settling of sediments out of pumped dredge water, thus reducing the total suspended solid load to be returned to the marine environment once water is decanted.

In addition to the use of settling ponds, it would also be advantageous to use dredge pumping rates that will facilitate adequate retention time in the ponds, thus facilitating rates of settling that could result in discharges achieving the prescribed water quality standard of 10 mg/l.

Silt curtains should also be deployed at dredge spoil disposal to contain sediment movement at the shoreline. The use of the three measures outlined above **in combination**, will ensure that adequate protection is given to adjoining reef systems.

Having spoken to shoreline deposition works, it is also suggested that strict attention be paid to the prevention and immediate mitigation of leaks that may occur from the floating pipeline deployed between the dredge and the shoreline.

9.2 Fisheries Mitigations:

The implementation of the sedimentation control mitigations outlined in 7.1 will be the primary mechanism for avoiding negative impacts on fishing areas immediately adjoining shoreline construction sites. In addition to the use of these mitigations, the fishing public should be kept informed as to the operation plans for the dredge and the times at which it will be operation within defined locations. This will ensure that fishers have enough information to avoid being within the vicinity of the dredge, its floating pipeline and the shorelines at which re-stabilization works will be conducted.

Since popular fishing seasons for both Mutton and Lane Snappers are well known (December – January and August to October respectively), dredge timings should be planned to avoid these periods.

The fishers should be consulted and informed about the project ***in detail*** before start-up to garner their understanding and support. This might involve multiple meetings with the fishers. Additionally, it is proposed that a **Fishers Compensation Mechanism** be designed and implemented to deal with any claims for damages that can be properly substantiated. Such a mechanism could be based on a compensation mechanism promulgated through the Fisheries Division for seismic surveys recently conducted on the Pedro Banks (**see Appendix 4**).

9.3 Dune Vegetation Mitigations:

It is recommended that the technical advice of the Department of Life Sciences – UWI be sought to generate a landscaping plan for the dunes. This plan should incorporate a determination as to whether or not observed plant assemblages, or plant individuals known to commonly initiate re-growth on freshly bared sand, can be collected from the work areas **prior to dune construction**, with immediate replanting being done after stabilization had been achieved.

Such an implementation should be possible since shoreline re-stabilization works will be conducted in measured sections of approximately 100 meters length[50]. This plan should also include a landscape maintenance plan to ensure that re-growth is fostered to a point where natural forces can adequately proceed.

It is anticipated that, if plant collection and replanting can be done, then this will foster a situation of **no net loss of vegetation**. In a situation where increased dune surface is created, then a situation of **net gain will be achieved**, a most desirable condition.

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[50] Refer to report titled Palisadoes Protection And Rehabilitation Project, written by Authors Dr. José Luis Juanes Dr. Rafael Pérez M.Sc. Miguel Izquierdo and Eng. Vladimir Caballero.

9.4 Recreational Mitigations:

Re-stabilization work will not be conducted along the entire tombolo at one time. Non-construction areas will therefore, still be available for access to the public. The public will therefore have to be properly advised in advance of the intended progression of works at the Tombolo so that inconveniences can be avoided.

The re-stabilization process could easily be advertised as a comprehensive recreational package, with boardwalks, lay-bys, jogging trails and sitting / fishing areas incorporated. Such a package could enhance the attractiveness of development proposals for the area, such as the proposed 7th Harbour Development at Gunboat Beach, Palisadoes, Kingston. It must, however, be emphasized that human activities are one of the leading causes of dune destabilization. Any recreational designs for the tombolo must be sensitive to this fact.

10.0 Monitoring:

The proposed works will require careful monitoring to ensure that environmental impacts are either avoided or mitigated early. This document focuses on the implementation of **Short Term Monitoring,** required for environmental compliance during implementation. **Long Term Monitoring,** necessary in order to ensure that corrective works are properly maintained (with corrective works being conducted after tropical events) will have to be the purview of the National Works Agency.

Short term monitoring, in the context of this report, will be divided between monitoring for **Dredge operational quality control**[51] and **environmental monitoring**[52].

10.1 Monitoring – Dredge Activities:

The Cuban technical proposal outlines a detailed scheme of monitoring to evaluate the effectiveness of dredge and beach construction processes. These are outlined in Appendix 3 (Section VIII Execution of Works – Pages 77- 84.

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[51] As proposed in report titled Palisadoes Protection And Rehabilitation Project, written by Authors Dr. José Luis Juanes Dr. Rafael Pérez M.Sc. Miguel Izquierdo and Eng. Vladimir Caballero.

[52] As advocated in Section 7 of the EIA document.

10.2 Environmental Monitoring:

10.2.1 Marine Ecological Features:

Figure 8 - Appendix 1 defines the locations of both coral reef and fish population monitoring sites within the study area. Included with these sites would be a site at South East Cay outlines.
Thus a total of 4 coral and fish population monitoring stations will be examined during the construction phase of the project.

The Coral/Algae percentage cover results outlined in **Figure 12B – Appendix 1** will form the basis for the evaluation of any changes that may occur at these locations during the dredging operation **(**deep reef - 15% coral cover, shallow reef 7% coral cover, South East Cay –2% cover**).**

AGRRA fish population references outlined under section **4.3 – Figure 15C –Appendix 1** will form the reference around which the monitoring results of these resources at the marine sites examined can be compared.

Thus a total of 4 benthic assessment transects and 4 fish survey transects will be conducted during a typical marine ecological monitoring session. Information for both coral and fish resources will be obtained from fixed transects marked by both GPS coordinates and tethered surface / sub-surface floats. This will facilitate the ability to repeat visits to the sites so that true time series information for the same study areas can be obtained.

This will also facilitate the incorporation of data into a GIS for spatial mapping and presentation purposes.

10.2.2 Water Quality Monitoring:

The following water quality parameters will be measured during monitoring activities at the project site:

1. Total suspended solids with standard limits being **10 mg/l**
2. Suspended solids settling limits with standard limits being **10 mg/cm^2/day.**
3. Vertical water visibility (as determined by Secchi Disc readings) with standard limits exceeding **4 meters**.

Total suspended solids and visibility sampling will be conducted at the sites indicated on **figure 9 –Appendix 1 (also including the SE Cay site),** with sites 5-7 and the SE Cay sites being the same sites that marine ecological monitoring will be conducted at. Suspended Solids settling limits will be conducted at sites 5-7 and at the South East Cay site.

Additionally, on the days that sampling will be conducted at the afore mentioned sites, total suspended solids and visibility sampling will also be taken at locations where the dredge is actually working. Similar samples will also be taken at the locations on land where depositional work is being conducted.

Thus a total of 10 sub-surface total suspended solids samples and 4 suspended solids settling samples will be taken during a typical water quality monitoring session. Information for water quality will be obtained from stations marked by both GPS coordinates and tethered surface / sub-surface floats. This will facilitate the ability to repeat visits to the sites so that true time series information for the same study areas can be obtained. This will also facilitate the incorporation of data into a GIS for spatial mapping and presentation purposes.

10.2.3 Turbidity Plume Monitoring:

Plume tracking will be conducted to confirm the modeling predictions outlined by CEAC Solutions Ltd. This tracking will be conducted through the execution of aerial photo flights over the work area, using high altitude imagery (1000 meters) to establish a total picture of the study area and lower altitude imagery (500 meters) at the locations of each of the water quality and marine monitoring sites, along with the dredge and work area locations.

A time series photo presentation of the area will be generated, which will demonstrate the locations and fates of any plumes being generated by the proposed works. The “eye in the sky” presence will also allow for the detection of any plume movements that may be moving towards sensitive marine resources within the study area, leading to the execution of threat verification monitoring and, if needed, the execution of mitigation recommendations.

10.2.4 Fisheries Monitoring:

It is strongly recommended that the Fisheries Division be charged with the responsibility of generating a monitoring programme for both the welfare of its Fishers (as per the proposed Compensation Plan) and for catch change verification. The latter will be the only way in which impacts on the fishing trade within the area can be determined.

10.2.5 Dune Re-stabilization Progress monitoring:

Aerial photo monitoring of the dune construction process will be conducted during plume tracking photo flights. This tracking, like the plume monitoring will be conducted through the execution of aerial photo flights over the work area, using high altitude imagery (1000 meters) to establish a total picture of the study area and lower altitude imagery (500 meters) for more detailed imagery. A time series photo presentation of the area will be generated from these images, which will demonstrate the development changes at the site over time.

10.3 Monitoring Interval:

The following monitoring intervals are proposed:

1. Water quality monitoring (Total Suspended Solids and Settling suspended solids) will be conducted weekly.
2. Aerial Plume and development monitoring will be conducted weekly.
3. Marine Ecological assessments will be conducted monthly.
4. Fisheries catch and welfare monitoring – to be developed by the Fisheries Division.

11.0 Dune Maintenance:

The maintenance of the created dunes will be vital to the sustenance and security of the palisadoes Tombolo, main road and any recreational infrastructure placed at the site. It is envisaged that the stability of the works will be achieved through the following:

1. The cultivation and maintenance of dune vegetation, so as to stabilize the introduced sand.
2. Post tropical disturbance maintenance through the use of heavy equipment to not only clear the roadway, but also re-introducing the sand onto the dune in such a way as to re-establish its contour and integrity.

A post-event maintenance plan must be created to achieve these goals.

It is, however suggested that, where long term monitoring is concerned, considerations would have to be given to the examination of changes in the profile of the dunes over time. This is a task that the Survey Department would be adequately suited to conduct, having conducted profile work in support of the Cuban technical report.

AUTHOR'S CREDENTIALS:

PETER WILSON-KELLY:

PROFESSIONAL BACKGROUND

Peter Wilson-Kelly has worked in the fields of watershed management, coastal zone management, marine environmental science research and remote sensing for the past 19 years.

A Masters degree (Marine Sciences) graduate of the University of the West Indies (Mona Campus) and a former employee of the National Environment and Planning Agency and the Natural Resources Conservation Authority, he is currently the proprietor of a registered consultancy business which is involved in the generation of natural resources spatial, temporal and status information and in the analysis and monitoring of environmental change directly associated with human development intervention. His business seeks to facilitate the generation and transferral of information using geographical Information systems, remote sensing, modelling and multimedia to facilitate transparent information analysis and a simplified presentation process.

Mr. Wilson-Kelly ventured into the field of Marine Law Enforcement in 1999 and is currently a Lieutenant (junior grade) in the Jamaica Defence Force Coast Guard reserves. He serves the unit as its Marine Environment Pollution Officer, its Assistant Training Officer and its Assistant Diving Officer. Additionally, he is a Marine Navigator (Watch keeper) and is qualified to operate all of the Unit's small craft and Inshore Patrol Vessels.

Finally, Mr. Wilson-Kelly is currently developing a speciality in the field of diving, particularly in the areas of underwater videography/photography, search and recovery and marine ecological assessments. He has been certified as a PADI SCUBA Diver for 17 years and recently attained a PADI Enriched Air (NITROX) Diver, and a PADI equipment specialist certification. He also holds a Jamaica Defence Force equivalent of a US Navy Compressed Air Diver qualification.

WORK RELATED QUALIFICATIONS ATTAINED

- Swift Water Rescue Technician – June, 2005
- PADI Enriched Air (NITROX) Diver – March, 2005
- JDF Coast Guard Marine Navigation (Watch-Keeper) Qualification – February 2004
- HAZMAT Technician, US Environmental Protection Agency Certificate in Hazardous Materials Emergency Response, February 2003

- JDF Coast Guard /US Navy standard Compressed Air diving course – April 23-June 1, 2001
- JDF Coast Guard Basic Seamanship Qualification Training, October 2000-April 2001
- Proficiency in the Atlantic and Gulf of Mexico Reef Rapid Assessment Project monitoring methodology, August 2000
- Proficiency in the Caribbean Planning and Adaptation to Climate Change video-based coral reef monitoring and video capture techniques, 2000.
- Certificate of Competency – Fisheries Boarding Officers Training Course conducted by the US Coast Guard, February 2000
- Certificate of participation, Environmental Sensitivity Mapping Workshop, Trinidad. November 1999
- Certificate – Conservation and Sustainable management of Coral Reefs, Okinawa, Japan. May-July 1997
- Certificate – UNESCO sponsored training course in Underwater Videography, September 1995
- Certificate – Digital Remote Sensing and Geographical Information Systems for Coastal Zone Planning, Upsalla University, Sweden, May-June 1995
- Certificate – Coastal and Marine Pollution Prevention, Gothenburg, Sweden, April-May, 1994
- PADI Certification – Advanced Open Water Diver, May 1992
- PADI Certification – Open Water Diver, August 1990

PROJECT AFFILIATIONS

- Environmental Impact Assessment for Proposed Roadway Protection works at Palisadoes, St. Andrew for the National Works Agency – In preparation.
- Environmental Impact Assessment – Hotel, Condominium and Commercial Development at Sunset Avenue Montego Bay for Careif Ltd – In preparation.
- Marine Assessment, Marine Environmental Impact Evaluation and Mitigation for Proposed Marina Development at Negril, West End for Wedderburn Ltd. May, 2007.
- Marine Assessment, Proposed Villa, Hotel and Golf Course development at Coral Spring, Trelawney for Digibeat Ltd. February 2007
- Conch E-coli weekly monitoring at the Pedro Banks for the Veterinary Services Division -September 2006 to February 2007.
- Conch monitoring data GIS spatial analysis for Veterinary Services Division for European Union Certification - September 2006
- Beach design for Rose Hall Development Ltd at Lilliput, St. James – August 2006
- Canoe Valley (Manchester) Aerial Photo mission July 2006
- Port Royal/ Palisados Aerial Photo mission July 2006
- Beach enhancement assessment Proposal for Sandals Plantation Inn – June 2006.

- Finder Seismic Survey Fishers Compensation Programme development – May 2006
- Selection of Alternative Cable Route for Marine Fibre-optic Cable laid at Tower Isle, St. Mary: Prepared for Maritime and Transport Ltd - March 2006
- Canoe Valley Rapid Biophysical Assessment – February 2006
- Environmental Impact Assessment Team member – Proposed Airport Expansion at Basseterre, St. Kitts: Prepared for Environmental Management Consultants Co. Ltd - 2005
- Coastal Resources Description – Roslin Castle proposed development site – Prepared for Geomatrix Ltd. September 2005
- Planning Committee Member – Min of National Security National Security Strategy development – Concluded 2005.
- Post Hurricane Dennis Flood Damage Risk assessment – prepared for Management of Moy Hall Coffee Farm September 2005
- Beach design for 4 pocket beaches at Rose Hall, St. James: Prepared for Rose Hall Development Co. Ltd - 2005
- Design and Environmental Impact considerations for Boat Channel at San Souci Lido, Ocho Rios, St. Ann: Prepared for management of San Souci Lido Hotel June 2005
- Caribbean Terrace Post Hurricane Ivan mitigation assessment – Aerial Photography and Technical assistance to CEAC Solutions Ltd. March 2005

- Mapping and assessment of seafloor resources Proposed hotel development at Stewart Castle – Trelawney: Prepared for EIA report by TEMN Ltd - 2004
- Mapping and assessment of seafloor resources – proposed hotel development at Font Hill, St. Elizabeth: Prepared for EIA report by ESTECH Ltd - 2004
- Mapping and assessment of seafloor resources - proposed marine terminal expansion at JAMALCO Pier, Rocky Point, Clarendon: Prepared for EIA report by ESTECH Ltd - 2004
- Technical Assistance – The Nature Conservancy Pedro Banks Coral Reef Assessment reconnaissance – March 2005
- Team member, Jamaica Dolphin Population Aerial Assessment Project – March 2004
- Dive Team Leader, Caribbean Planning for Adaptation to Climate Change Coral Reef Monitoring exercises – Portland, Kingston and Discovery Bay. June 2004
- Dive Team Leader, Caribbean Planning for Adaptation to Climate Change Coral Reef Monitoring exercises – Portland, Kingston and Discovery Bay. June 2002
- Dive team Leader, Fisheries Division Conch Population Assessment Project, Pedro Banks, 2002
- Dive Team Leader, Caribbean Planning for Adaptation to Climate Change Coral Reef Monitoring exercises – Portland, Kingston and Discovery Bay. June 2001
- Technical/Diving support, Atlantic and Gulf of Mexico Reef Rapid Assessment Project, Discovery Bay – August 2000

- Dive Team Leader, Veterinary service Division Conch Sampling Exercise, Pedro Banks May-June 2000.
- Dive Team Leader, Caribbean Planning for Adaptation to Climate Change Coral Reef Monitoring exercises – Portland, Kingston and Discovery Bay. June 2000
- Team Leader, public presentation process – NRCA Green Paper Presentation Process – Proposed Policy document on Beach Use and Access in Jamaica. July- September 1998
- Project coordinating team member, Port Royal Environmental Protection Area project, 1998
- Technical assistant, Diver – Fisheries Division Conch Survey, Pedro Banks, 1997.
- Technical Assistant/Diver – Fisheries Division Reef Finfish Population Assessment Project, Alice Shoal, 1996
- Dive Team Leader, Caribbean Planning for Adaptation to Climate Change Coral Reef Monitoring exercises – Portland, Kingston and Discovery Bay. June 2000
- Team Leader, NRCA/University of Upsalla (Sweden) Jamaica Coastal Atlas Project (1995-1996)
- Technical assistant, Diver – Fisheries Division Conch Survey, Pedro Banks, 1994.
- Technical Assistant/Diver Benthic Resources Mapping Exercise, Montego Bay Marine Park, 1992

SCIENTIFIC PUBLICATIONS AND PAPERS

Peter M.C. Gayle, Peter Wilson-Kelly, Sean Green**:** *Transplantation of benthic species to mitigate impacts of coastal development in Jamaica..* **Revista de Biologica Tropical 2005.**

Peter H. Wilson-Kelly: *Characterization of the Fluvial Discharges to the Kingston Harbour and Recommendations for their management* **MPhil thesis, UWI Mona 2004**

Marcia M Chevannes Creary, Peter Wilson-Kelly, Sean Green Leslie Walling: *Coral Reef Monitoring for Climate Change Impact in the Caribbean.*
10th International Coral Reef Symposium (ICRS) July 2004

Peter E T EDWARDS*, George F WARNER, Peter H WILSON-KELLY, Marlon H HIBBERT
Evaluating the Success of a Major Coral Relocation Exercise at Rackhams Cay, Kingston Jamaica. **10th International Coral Reef Symposium (ICRS) July 2004**

Dale F. Webber and Peter Wilson-Kelly: *Characterization of Sources of Organic Pollution to Kingston Harbour, The extent of their influence and some rehabilitation recommendations* – **Bulletin of Marine Sciences, 73 (2): 257-271, 2003**

Peter M.C. Gayle, Peter Wilson-Kelly, Sean Green**:** *Case Study-Lessons Learned from the transplantation of benthic species as a strategy for mitigating the anthropogenic impacts of coastal development.* **31st Meeting of the Association of Marine Laboratories of the Caribbean (AMLC) Conference, Trinidad, 2003.**

Peter H. Wilson-Kelly, Roy Jones, Dr. Marcel Anderson: *Wetlands Management in Jamaica.* **Proceedings of the 5th meeting of Caribbean Foresters. Trinidad, 1991**

RICHARD O’KAR KELLY:

EDUCATION

2000-2001 - University of Hull (United Kingdom)
1997 - University School of Continuing Studies
1992-1995 – University of the West Indies (Mona Campus)
1985-1992 – Ardenne High School

QUALIFICATIONS

MSc. in Fisheries Science and Environmental Management concentrating in:

Environmental/Fisheries project development, planning and control.

This course looked at the conflicting nature of economic, scientific and environmental policies and their effect on environmental decisions and how to identify control and manage any project, methods of testing the soundness of projects and the project cycle.

Project systems management

This course highlights case studies of environmental projects financed by international funding agencies and the impact of project management in executing sound projects and write effective project proposals. Project systems management also looked at the concept of projects as a system and illustrates ways of identifying and correcting pitfalls in any project.

Data management

Coastal management (Integrated Management of Coastal Zones including mitigation measures of threats to this zone)

Inland fisheries and terrestrial natural resource management (including Environmental Impact Assessments (EIAs) and Aquatic Resource Management and applied management of natural resources),

Natural resource and fisheries (inland and marine) management

The Logical Project Framework for monitoring the progress of environmental and other projects, source and effects of pollution. The degree also focused on the importance and sustainable use of biodiversity in the terrestrial and marine environments and the crucial role of relevant agencies in multidisciplinary scientific management. The degree highlighted the integral role of applied science based technology in economic development.

BSc.(Hons) in Natural Sciences concentrating in Coastal Management, Ecology and Management of Terrestrial Environments, Data Management, Marine Science and Ecology, Chemistry, Natural Resource Management.

Minor in Geology concentrating in Earth Science, Caribbean Geology, Petrology, Palaeontology.

Supervisory Management

Other short courses include:

- World Bank Course on Environmental Impact Assessments
- Team Method Approach for Project Design and Implementation
- Introduction to Geographical Information Systems (GIS)
- CARICOM Fisheries Resource Assessment and Management Programme (CFRAMP) course on the use of Statistics in Natural Resource Management
- Deep Sea and Coastal Fishing Technology in South Korea, Lobster Casita training course in Mexico, Lobster Training Workshop in Cuba, Coastal Reef Assessment Training.
- World Bank Doing Business in 2006 (Important Country Indicators)
- The Role of Information Technology in Disaster Management

- Strategic Environment Assessment of Policies, Plans and Programmes
- System Dynamics (includes Vensim Modelling of Systems)

Workshops attended:

- Creating a Research and Innovation Park at the University of the West Indies
- Jamaica Country Strategy - Adaptation of the Sugar Industry
- Food & Nutrition Security and Vulnerability Profiling
- Natural Hazard Risk Assessment: Preventative Maintenance for Active Geological Processes and Hazards
- One-Day seminar on Jamaica's Response to the Rotterdam Convention
- Review of National Programme for Chemicals and Waste Management in Jamaica
- Review of various S&T related policies including the Science and Technology Policy
- The Importance of Public and Private Sector Partnerships in Advancing Science and Technology in Jamaica
- Review of the Agricultural, Science, Technology and Innovation System (ASTI) for the Sugar Industry with focus on Energy

A'levels: Biology, Chemistry and General Paper

O'level: Religious Knowledge

CXCs : Mathematics, English Language, Biology, Physics, Chemistry, French, Spanish

Research Papers and written works include:

- An Appraisal of the Recreational Fishery of Jamaica (MSc. thesis),
- An Appraisal of the Small Coastal Pelagics of Jamaica (paper presented at Small Coastal Pelagic Workshop in Grenada),
- National Report on the Lobster fishery in Jamaica (presented at the 2nd Workshop on Lobster Management in Cuba),

- The Socio-economic Importance of the Lobster Fishery in Jamaica (paper presented at the 2002 Scientific Research Council's (SRC) Science and Technology Conference
- An Appraisal of the Recreational Fishery of Jamaica (paper presented at the 4th World Recreational Fisheries Conference in Norway, 2000, currently working on paper highlighting the role of community organizations in the management of natural resources
- The Science and Technology Chapter in the Economic and Social Survey, Jamaica, 2005. Currently preparing the Chapter for 2006
- Jamaica's Innovation Infrastructure: A Comparative Analysis (paper presented at the SRC's Science and Technology Conference, 2006

Research Interest: Collecting data/information on a wide range of topics, assessing and analyzing the information and presenting the results, liaising with relevant agencies in incorporating the use of science and technology in creating a socio-economically prosperous Jamaica.

WORK EXPERIENCE

June 1995- November 30, 2005

Fisheries Officer, Ministry of Agriculture, Fisheries Division. Duties include Supervision of staff, training of staff. Design, coordinate and implement projects and programmes geared towards fisheries management. Budget design and writing, data collection and analyses, assist with bilateral agreements with other fishing nations in the region, report writing, beach inspection and management. Assist with the revision of fisheries regulations and policy, work with regional funding agencies such as the CARICOM Fisheries Unit. Work with international funding agencies such as Food and Agriculture Organization (FAO) and the Canadian International Development Agency (CIDA) on projects to enhance and develop the fisheries sector, investigate pollution impacting on the marine environment and recommending mitigating measures, assist with the preparation of national, regional and international workshops and seminars on fisheries management. Represent the Ministry of Agriculture and Jamaica at various international seminars, workshops and conventions. Job includes extensive data collection component and analyses of data. Liaise with various government and non-government agencies on various issues. Design, implement and supervise public awareness programmes. Coordinate the Lobster Enforcement activities annually.

October 2001, post upgraded to Senior Fisheries Officer. Duties similar to above but skewed towards more management related duties. Assistant Project manager, FAO funded project to develop Sustainable Development Framework and Policy for the Fisheries Sector. Project Manager, CIDA funded Post-Hurricane Ivan Rehabilitation Project for the Marine Fisheries Sector.

<u>January 1999 to June 2000</u>

Part time Spanish teacher at Quest Preparatory School.

January 2004 – present

Part-time lecturer in Environmental Studies for the Bachelor of Environmental Technology Programme at the College of Agriculture, Science and Education (CASE).

December, 2005 to present

Science and Technology Planner at the Planning Institute of Jamaica (PIOJ). In addition to executing research and monitor various areas in science, technology and innovation (STI), the core function of the position is to facilitate the integration of STI imperatives into broad national development planning as a response to the changes in the global economy and to Jamaica's need to adapt to these. Key areas of focus are: energy and waste management, development of a herbal and neutraceutical industry, development of STI database (includes monitoring of STI indicators), food and nutrition security, biodiversity, trade standards (such as ISO and HACCP), natural and man-made hazard and risk management and information and communications technology (ICT).

The job entails monitoring the STI portfolio for the Institute and includes intensive contact and collaboration with a wide range of ministries, academic institutions and agencies both locally and internationally including the Ministry of Industry, Technology, Energy and Commerce (MITEC), the National Commission on Science and Technology (NCST), the Scientific Research Council (SRC) and UNESCO. Reviewing various S&T related policies including the S&T policy and providing technical advice where necessary is also an integral component of the position. I am also involve in the review of the Energy Policy and is currently preparing a technical package on the impact of the proposed policy on the environment. I also act as Technical Coordinator for the STI Task Force, which is one of the 28 task forces sect up to assist in the development of a comprehensive, long-tem national development plan for Jamaica.

SPECIAL ABILITIES

Computer literate with competency in Microsoft Office, Internet, Vensim Modelling,
Underwater Diver.

SPECIAL AWARDS

- Jamaican delegate for the UNICEF Caribbean Summit for Children held in Barbados in 1991.
- Nominated for Headboy at Ardenne High School.
- Recipient of the Proxy Parents Scholarship in 1992 and 1994.
- Recipient of the European Union/CARIFORUM Scholarship in 2000.
- Short-listed for the Fulbright Scholarship, 2004
- Elected as a S&T Specialist for the Review and Selection of priority Science and Technology Programmes and Projects for Latin America and the Caribbean for 2007 to be funded by the

Organization of American States (OAS). The Workshop is to be held at the OAS Headquarters in Washington DC, USA in February 2007.

HOBBIES

Reading, diving, snorkeling, surfing the internet, playing football.

MEMBERSHIPS

Member of Steering Committee for the Replanting of Mangroves in Kingston Harbour
Member of Regional Working Group for Lobster Management
Various other committees including the Committees on the conservation of Jamaica's biodiversity and Hazardous Waste Management.
Currently seeking membership in the Jamaica Society for Scientists and Technologists
Technical Secretary for the Jamaica/UNESCO Commission for Science and Technology

REFERENCES

Available upon request.

Appendices

APPENDIX -1

FIGURES PRESENTED IN

A MARINE AND SHORELINE ENVIRONMENTAL IMPACT ASSESSMENT REPORT FOR PROPOSED NATIONAL WORKS AGENCY SHORELINE STABILIZATION WORKS – PALISADOES, KINGSTON

Prepared by Peter Wilson- Kelly & Associates

May 2007

FIGURE 1A Aerial Photo of the Sidney Makepeace Wood designed groynes (1) at Palisadoes in Kingston (Image 2002)

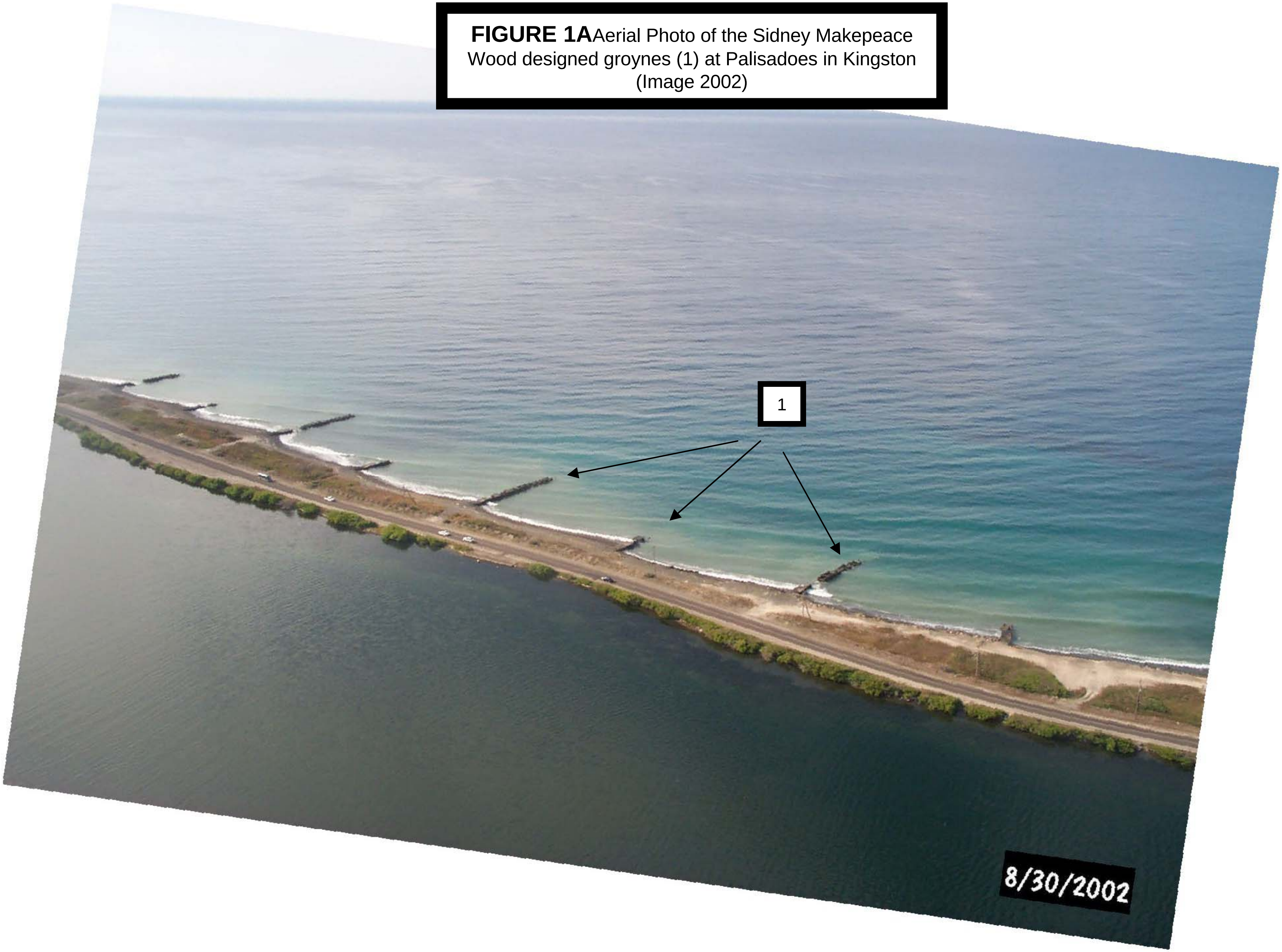


FIGURE 1B Ground-based Photo of the Sidney Makepeace Wood designed groynes at Palisadoes in Kingston (Image 2007)

FIGURE 2 The Location of the Proposed Borrow Area South of Palisadoes – As represented in the Cuban Technical Document

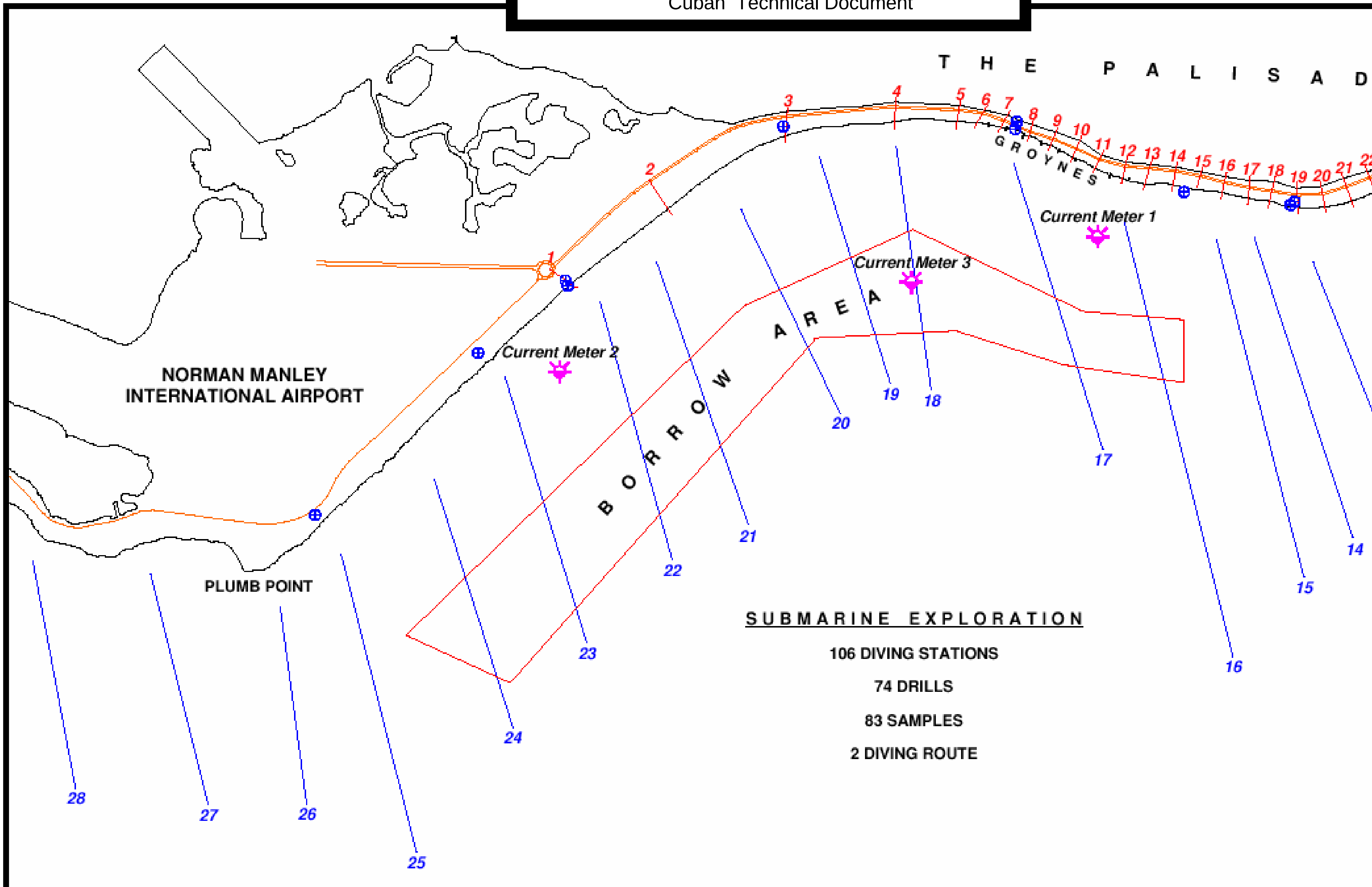
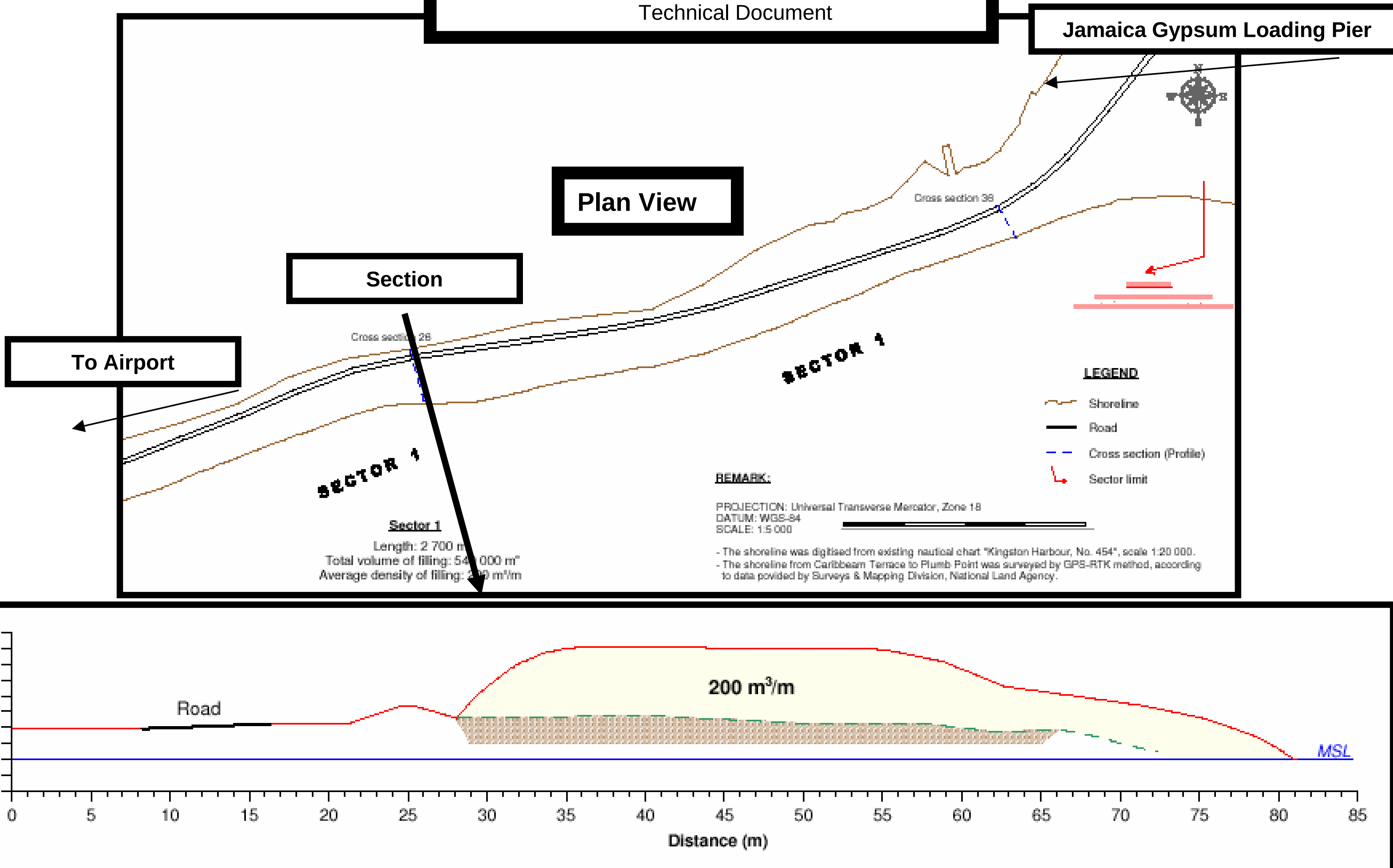


FIGURE 3A Example of the Location and Crossection of Dune Re-Nourishment Design at Palisadoes – As represented in Cuban Technical Document



Crossection View

FIGURE 3B Crossection and Plan of Revetment and Dune Design at Makepeace Wood Groynefield– As represented in Cuban Technical Document

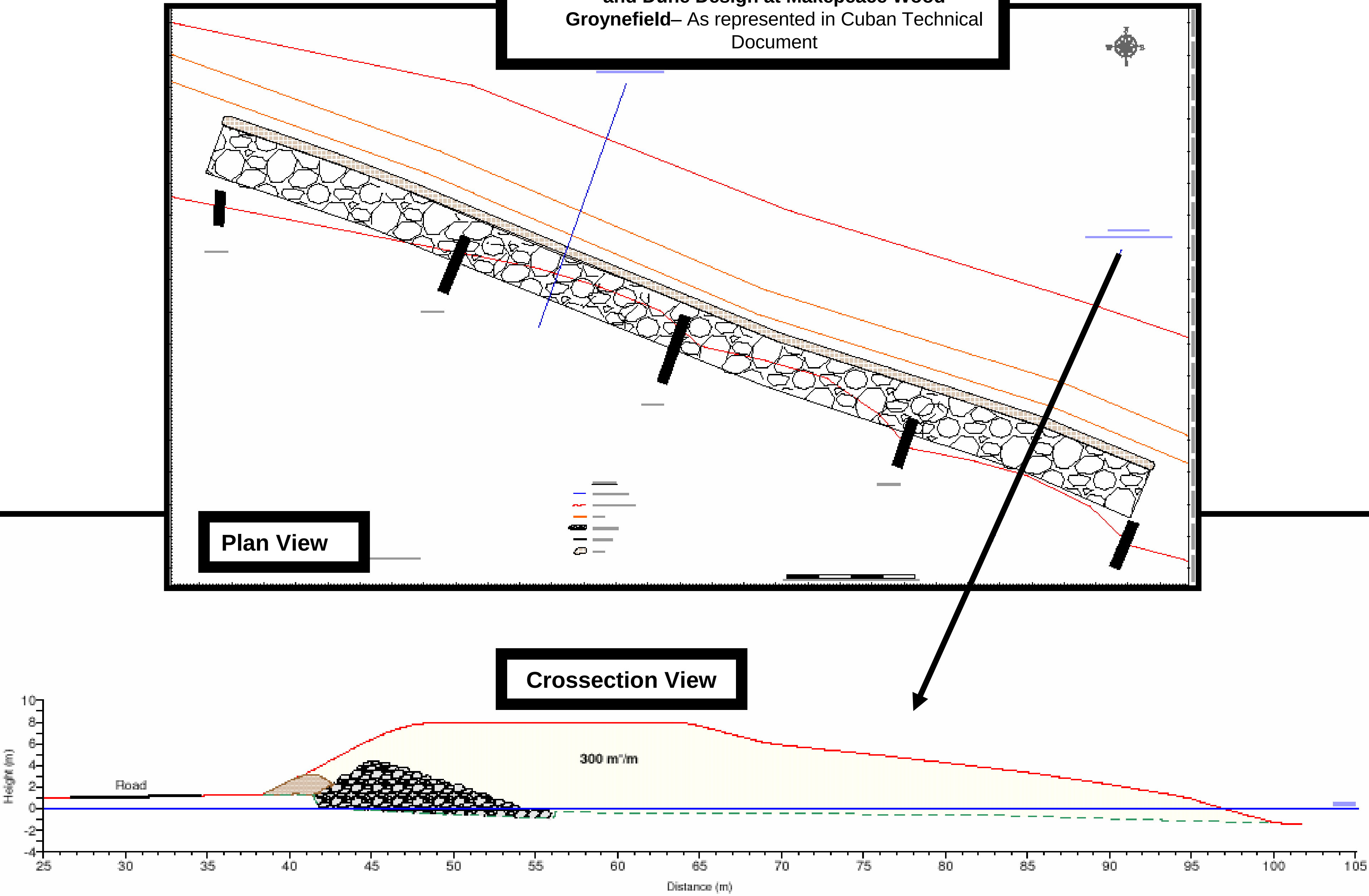
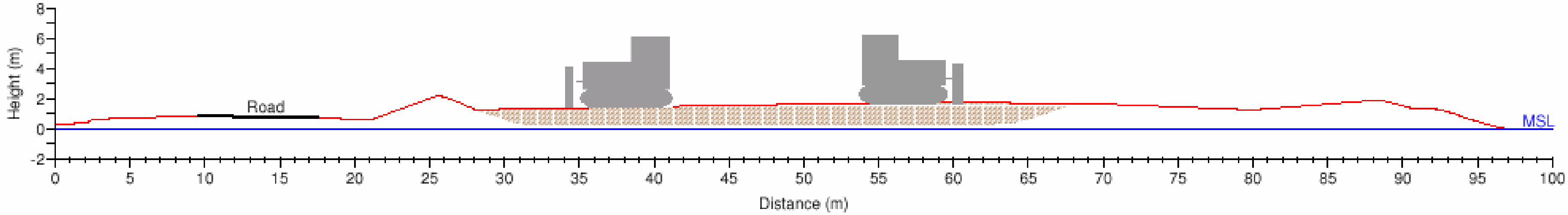
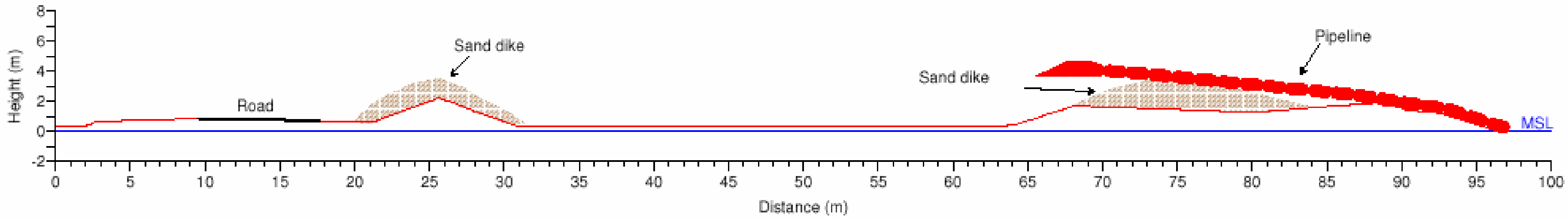


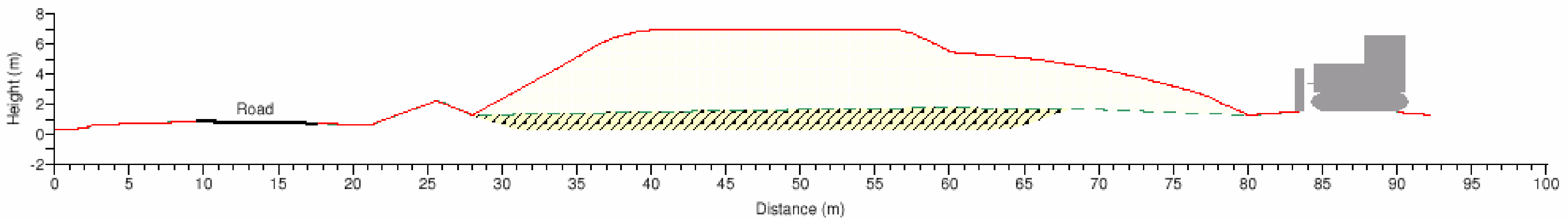
FIGURE 3C Plan for the Deposition of Sediments to create new Dunes at Palisadoes



Step 1. Preparation of the sand dike to confine the sand filled in the dune area.



Step 2. Sand fill



Step 3. Execution of the design profile.

FIGURE 3D Picture of Proposed Trailing Suction Hopper Dredge

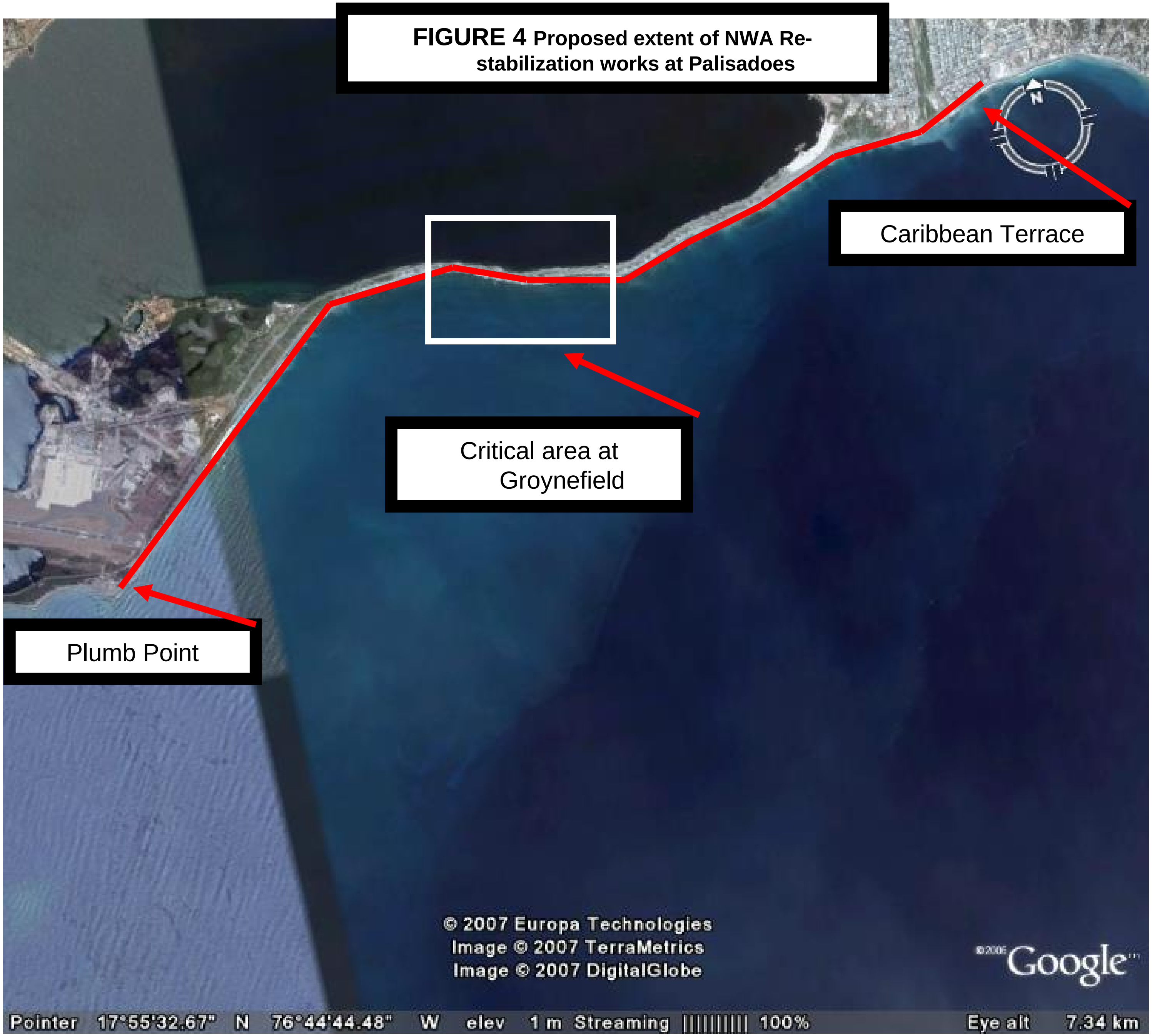


FIGURE 4 Proposed extent of NWA Re-stabilization works at Palisadoes
Caribbean Terrace
Critical area at Groynefield
Plumb Point
© 2007 Europa Technologies
Image © 2007 TerraMetrics
Image © 2007 DigitalGlobe
©2006 Google
Pointer 17°55'32.67" N 76°44'44.48" W elev 1 m Streaming |||||||||| 100%
Eye alt 7.34 km

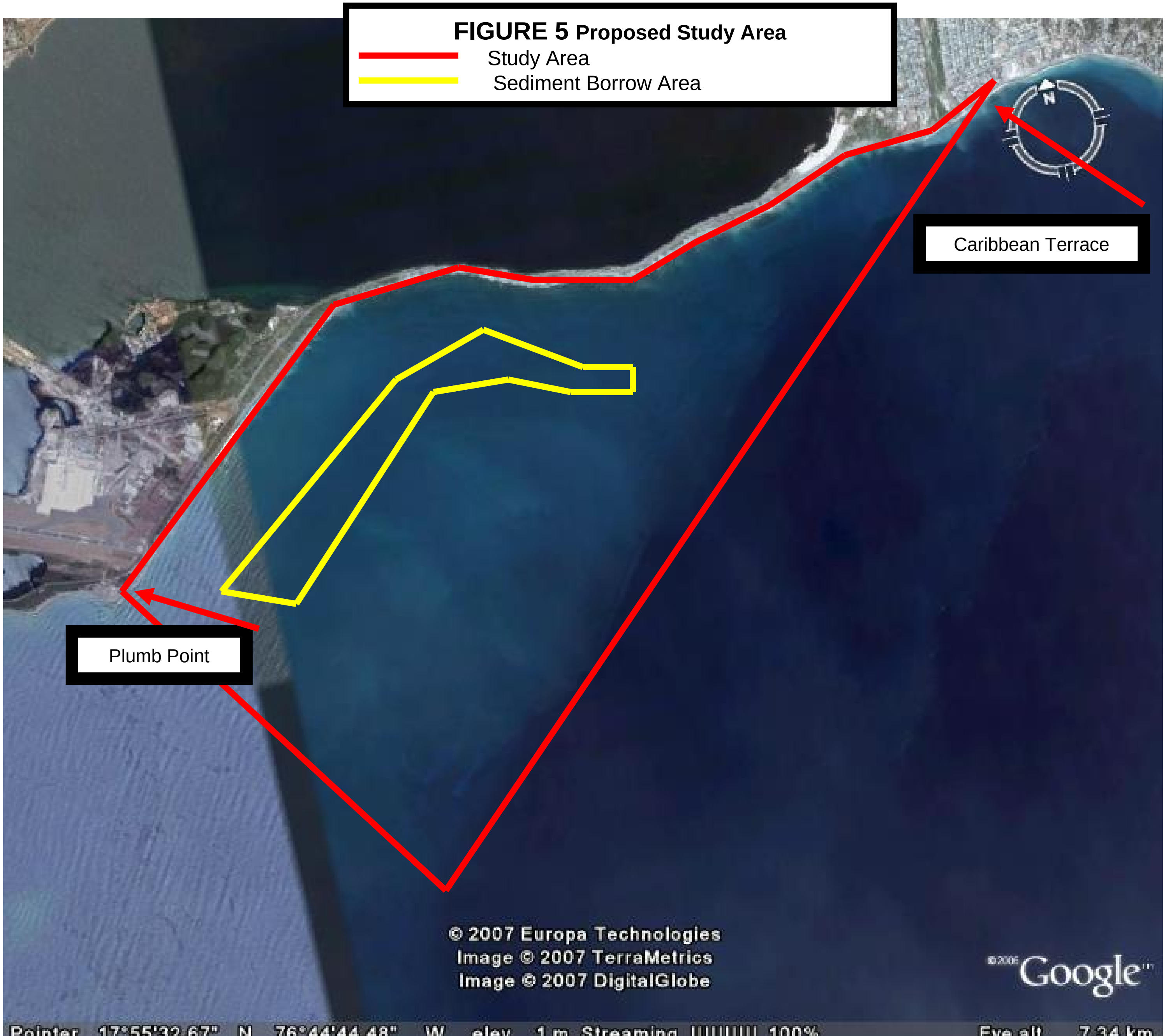


FIGURE 5 Proposed Study Area

FIGURE 6 **Extent of Turbidity Plume over Study Area at Palisadoes Re-nourishment area**

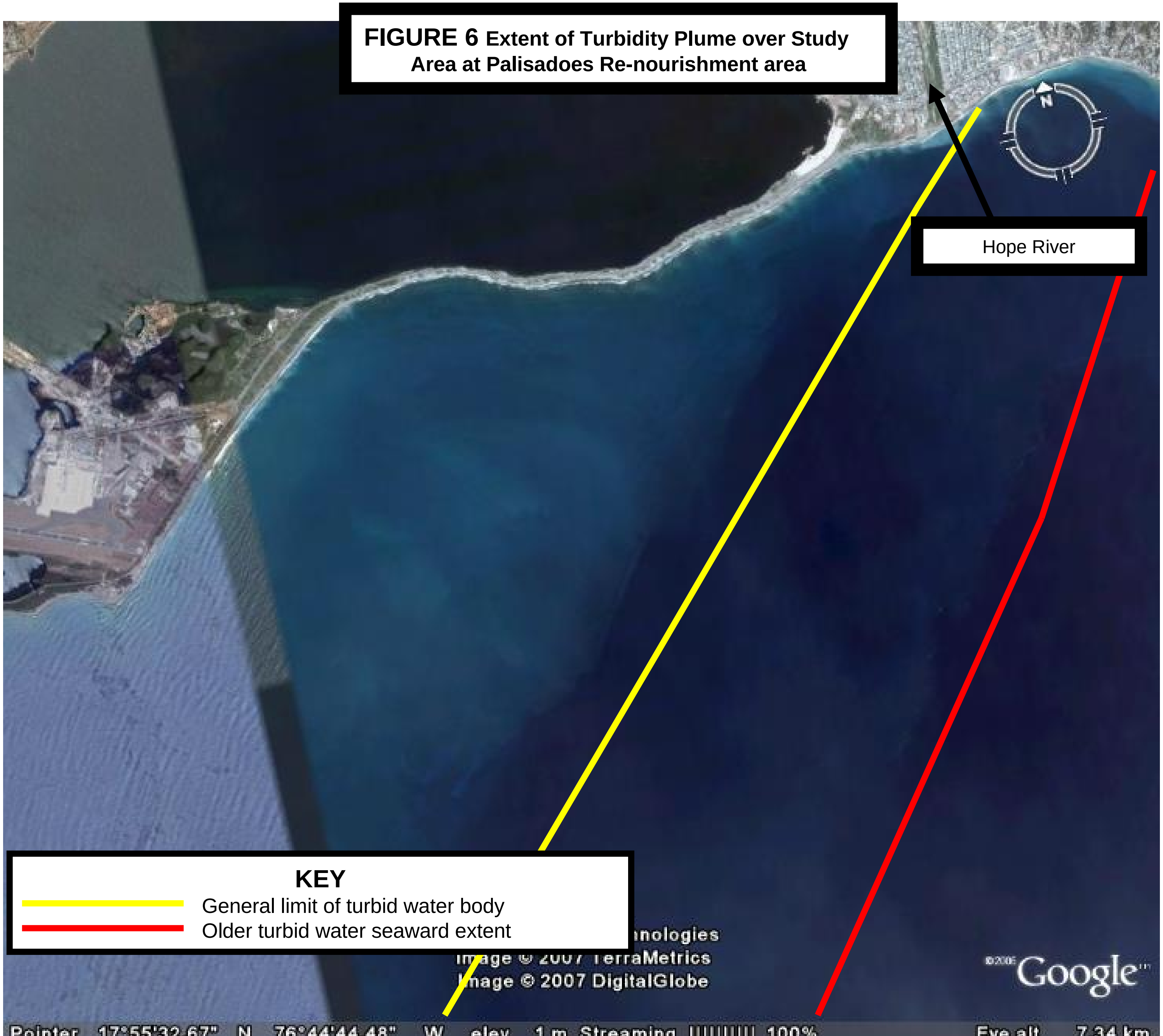


FIGURE 7 **Marine Assessment Site at South East Cay (in relation to study area)**

FIGURE 8 **Marine Groundtruthing Sites at Palisadoes Re-nourishment area**

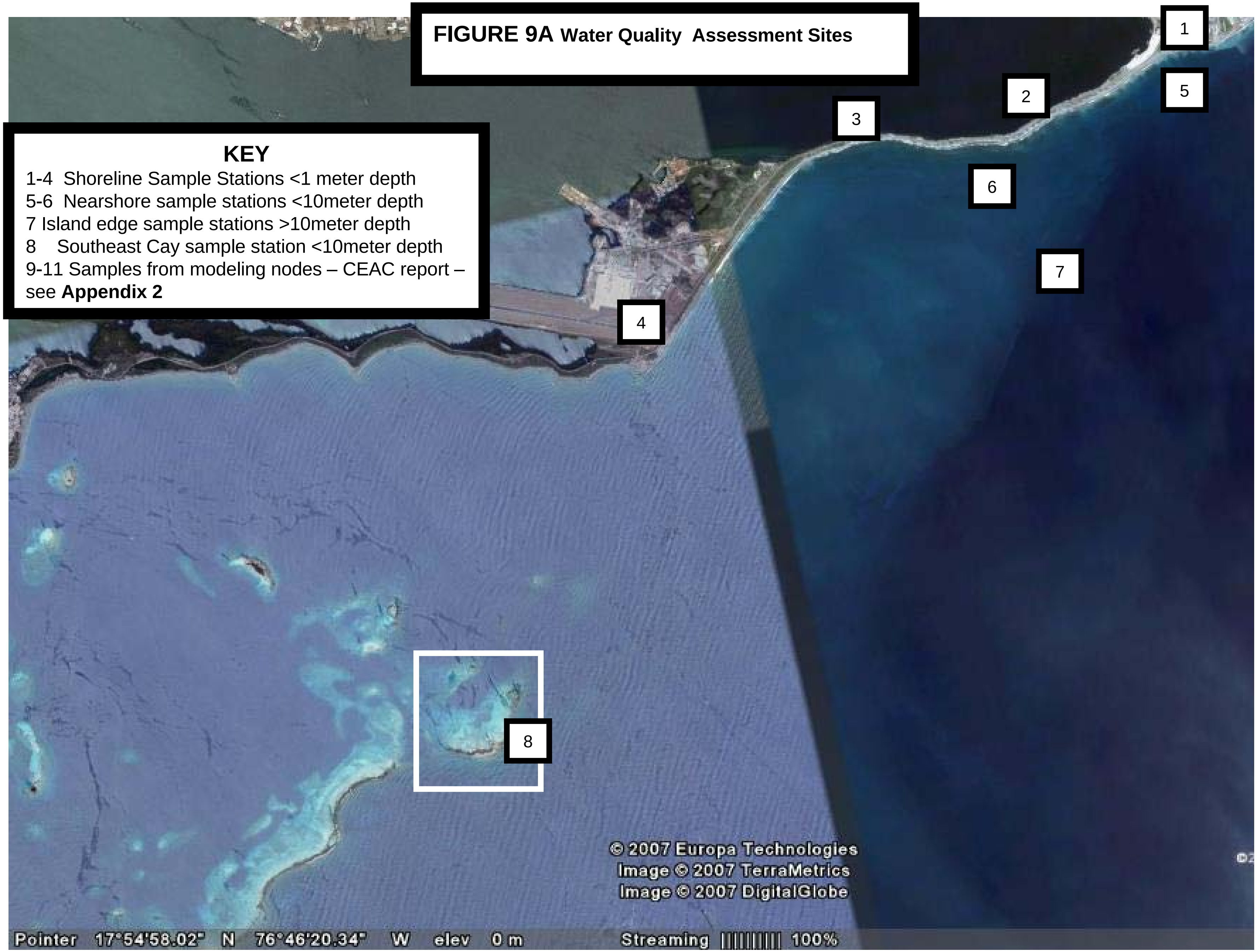


FIGURE 9A **Water Quality Assessment Sites**

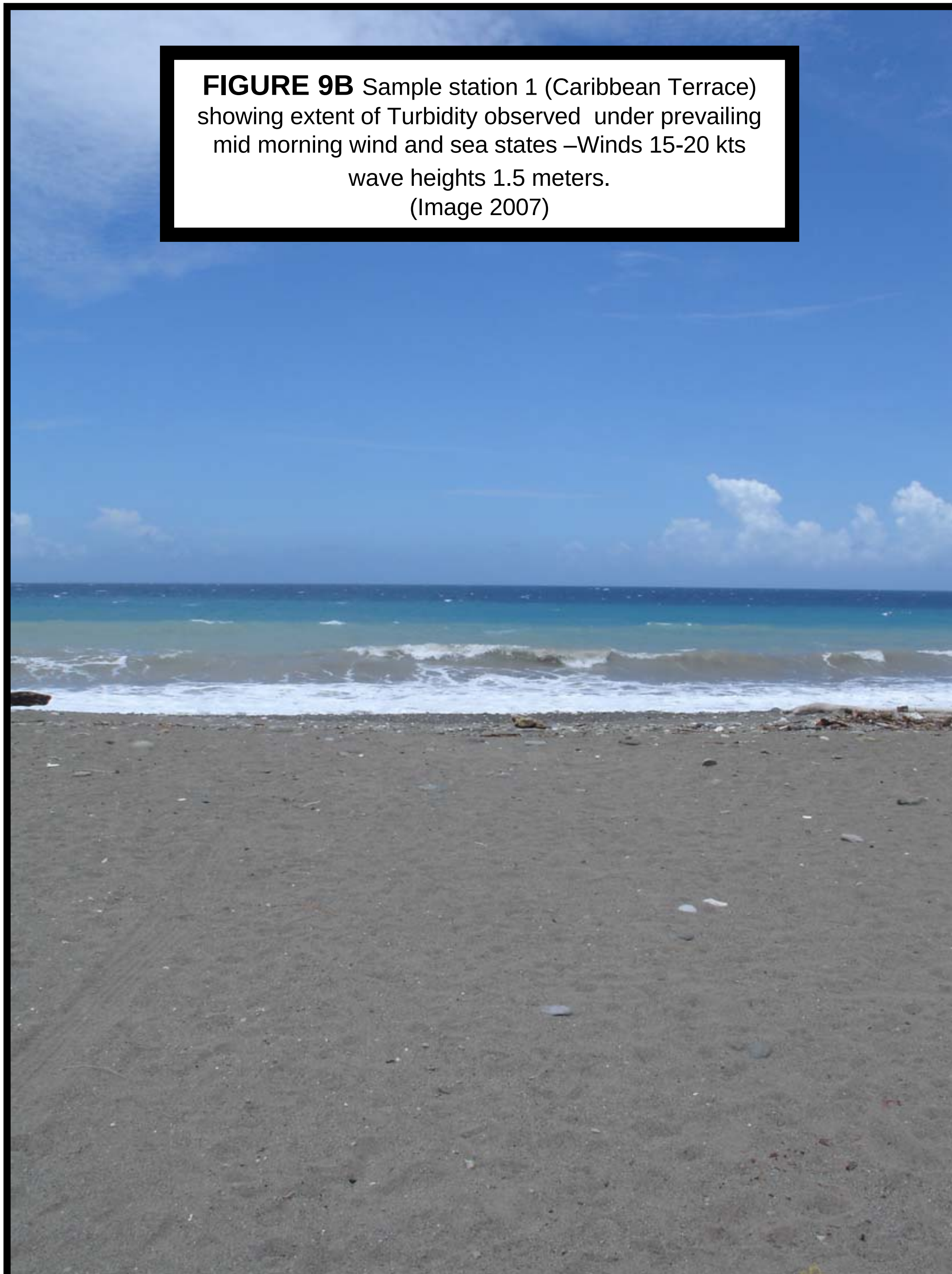


FIGURE 9B Sample station 1 (Caribbean Terrace) showing extent of Turbidity observed under prevailing mid morning wind and sea states –Winds 15-20 kts wave heights 1.5 meters.
(Image 2007)

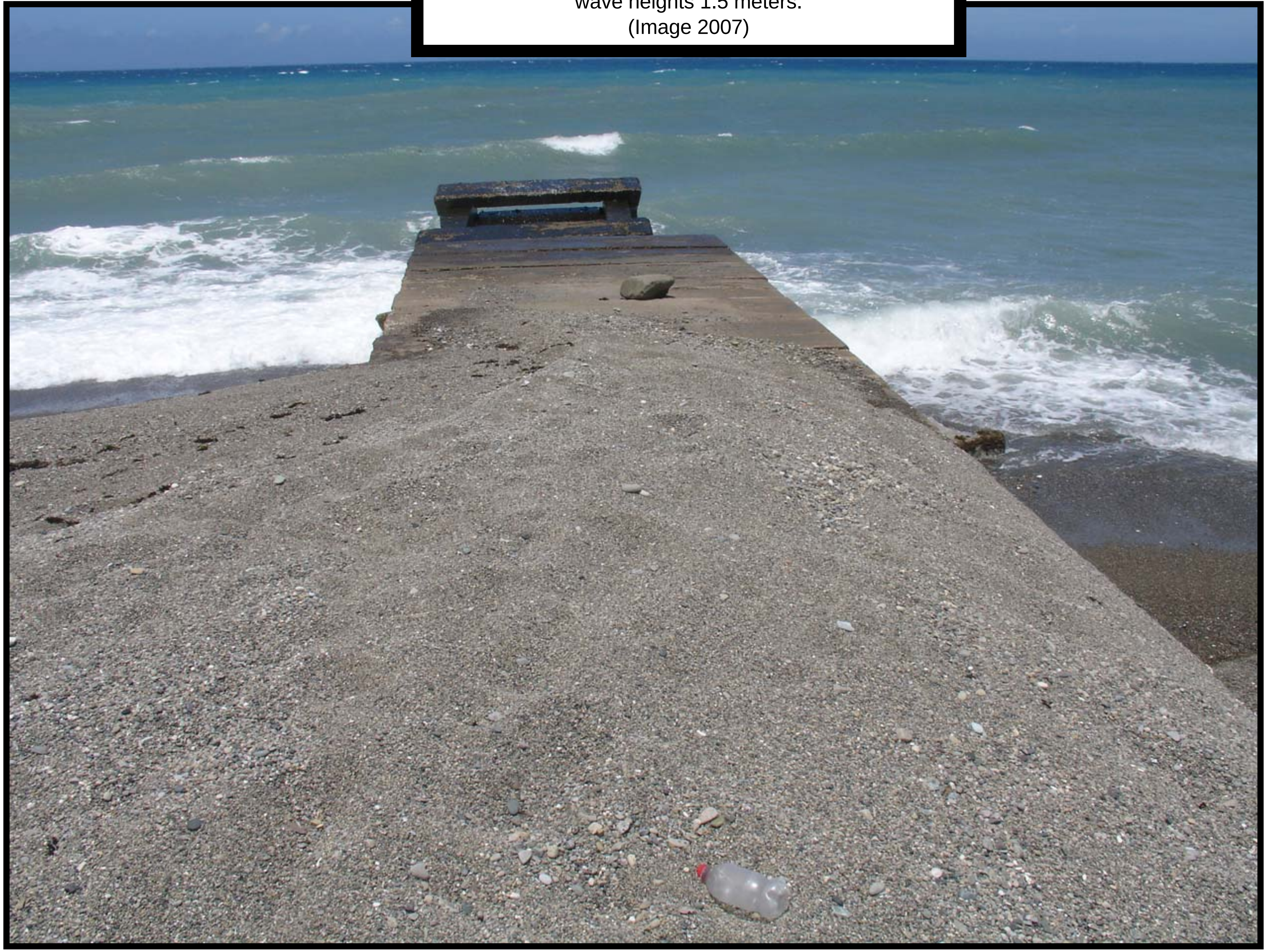


FIGURE 9C Sample station 3 (Groune Field) showing extent of Turbidity observed under prevailing mid morning wind and sea states –Winds 15-20 kts wave heights 1.5 meters.
(Image 2007)

FIGURE 9D Sample station 4 (near Plumb Point) showing extent of Turbidity observed under prevailing mid morning wind and sea states –Winds 15-20 kts wave heights 1.5 meters.
(Image 2007)

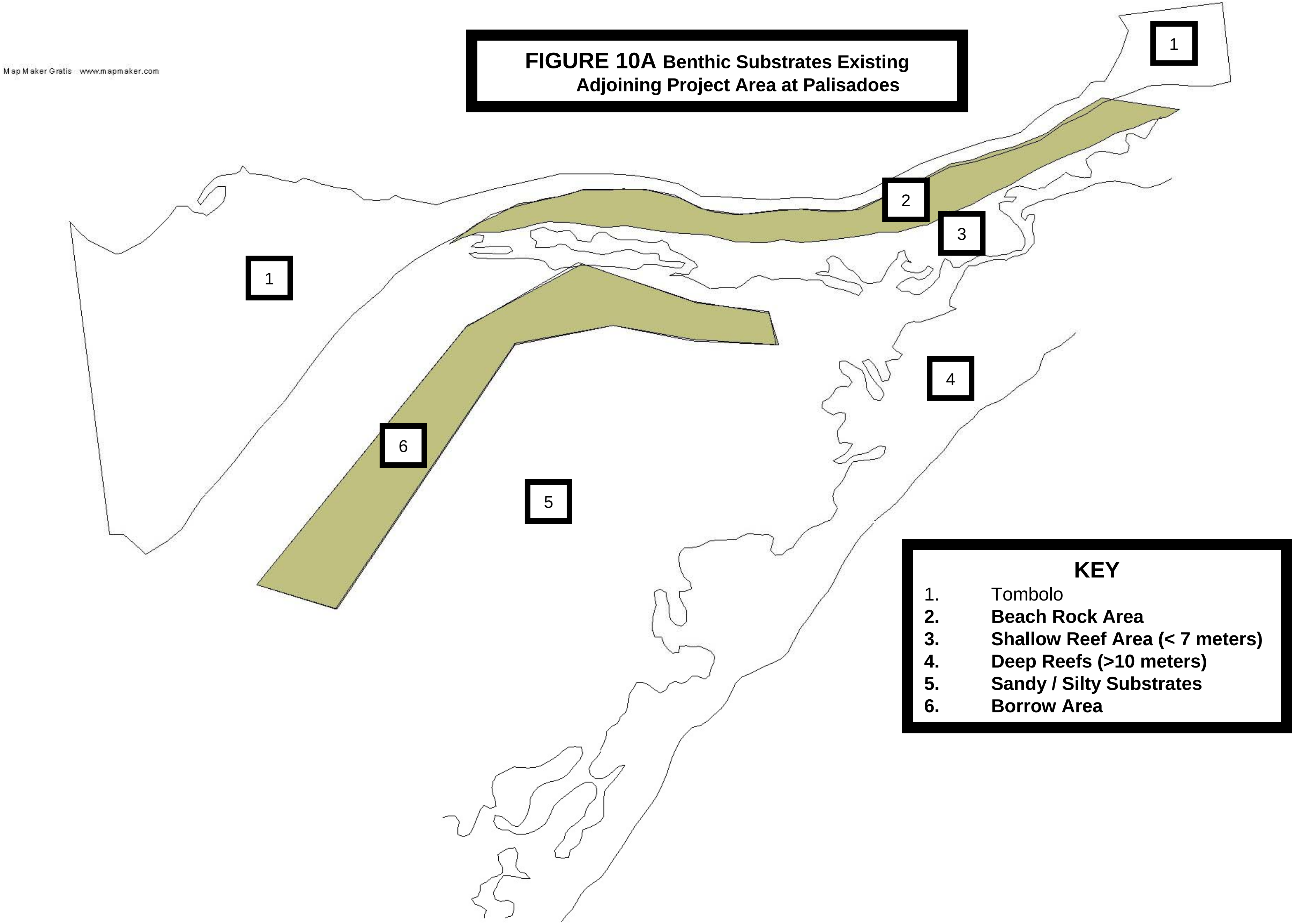


FIGURE 10A Benthic Substrates Existing Adjoining Project Area at Palisadoes

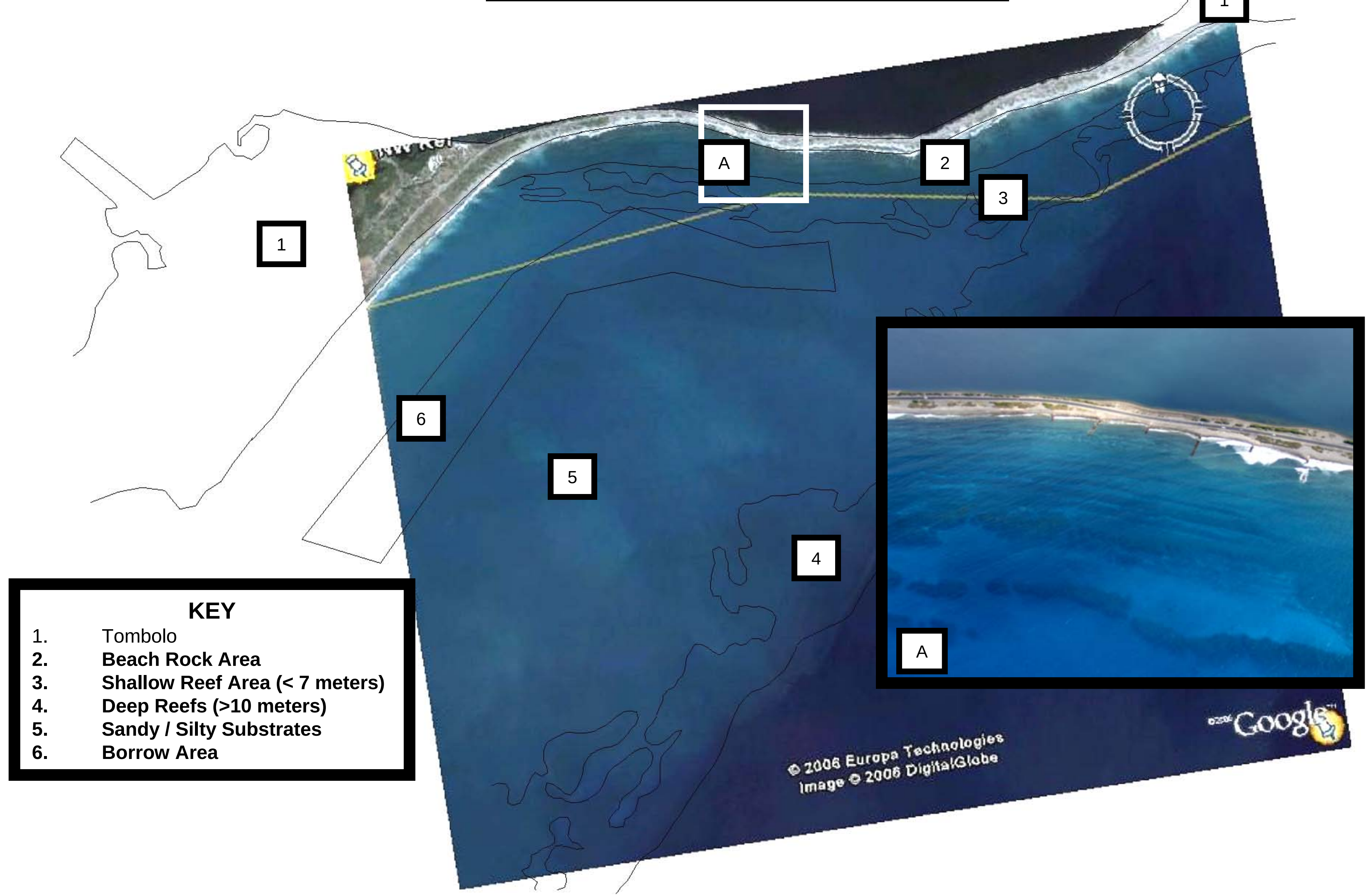


FIGURE 10B Aerial Illustration of Submerged Beach Rock and contact with reef area at Palisadoes (A)

FIGURE 10C **Aerial Illustration of Successive Submerged Beach Rock Deposition (A) near Groyne Field (B) at** Palisadoes

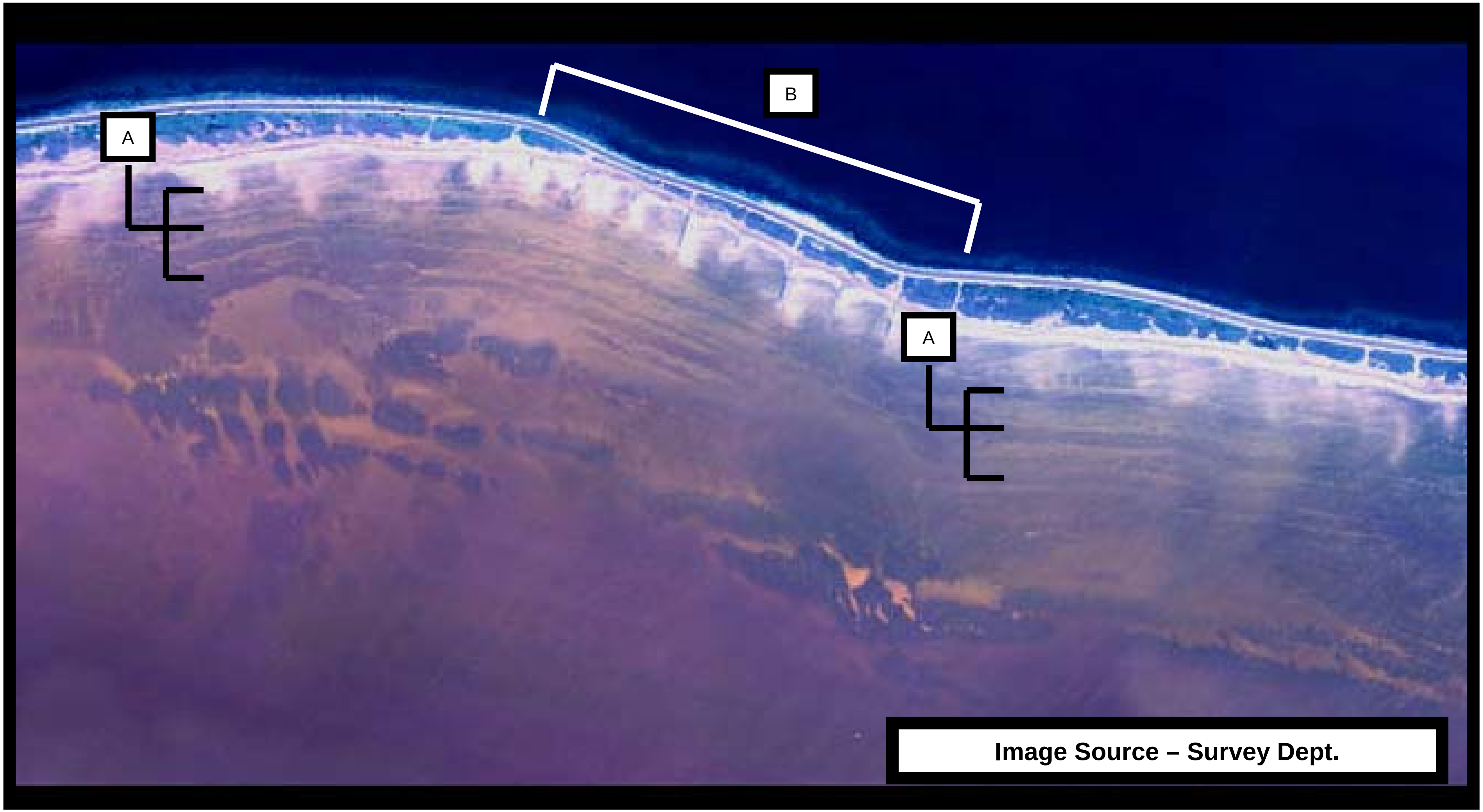
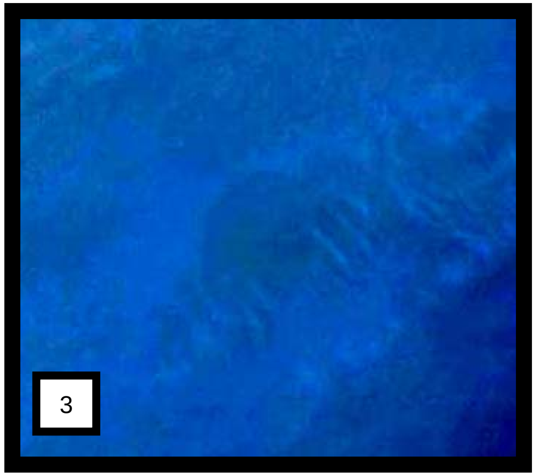
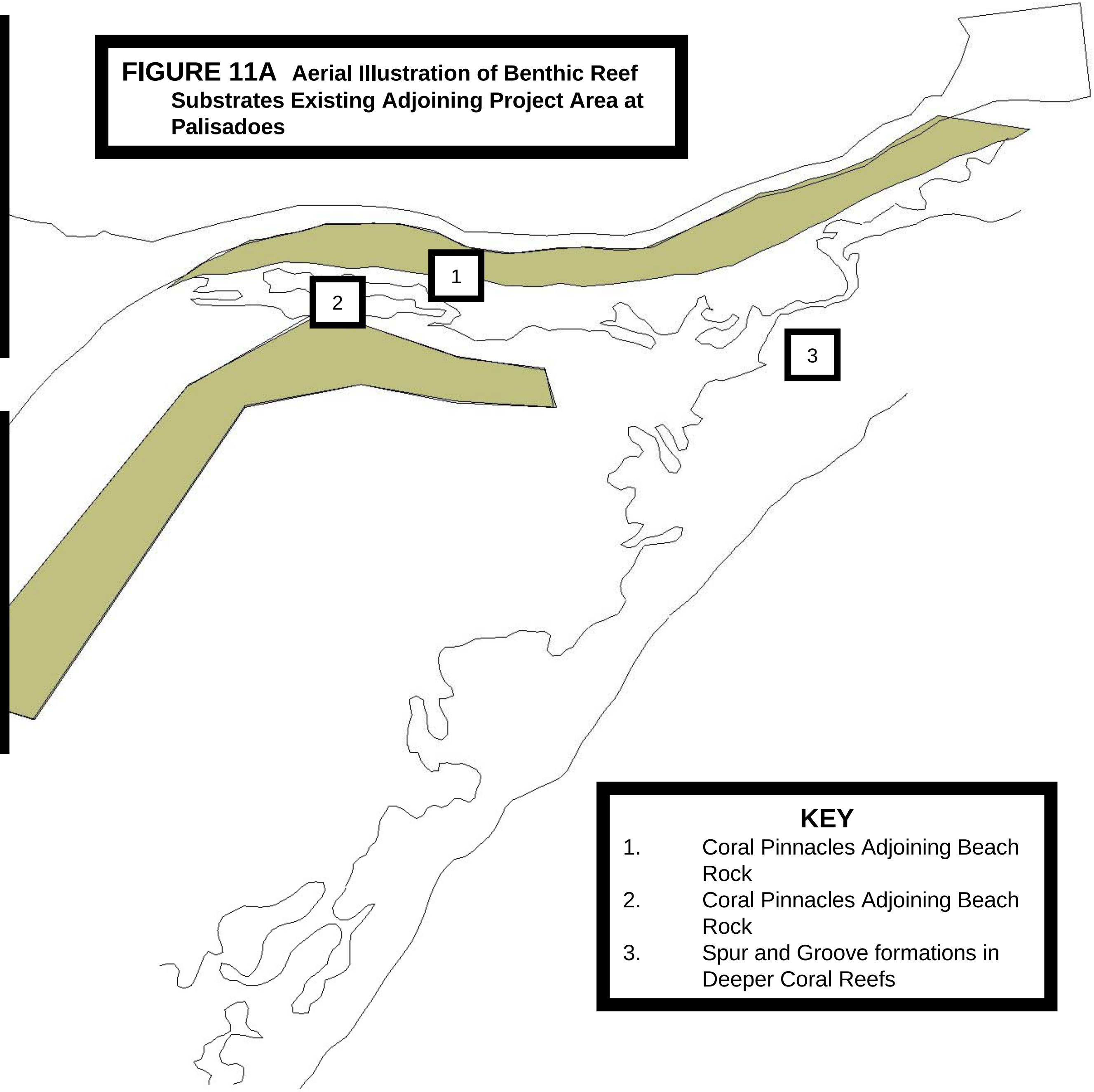


FIGURE 11A **Aerial Illustration of Benthic Reef Substrates Existing Adjoining Project Area at Palisadoes**





KEY

1. Coral Pinnacles Adjoining Beach Rock
2. Coral Pinnacles Adjoining Beach Rock
3. Spur and Groove formations in Deeper Coral Reefs

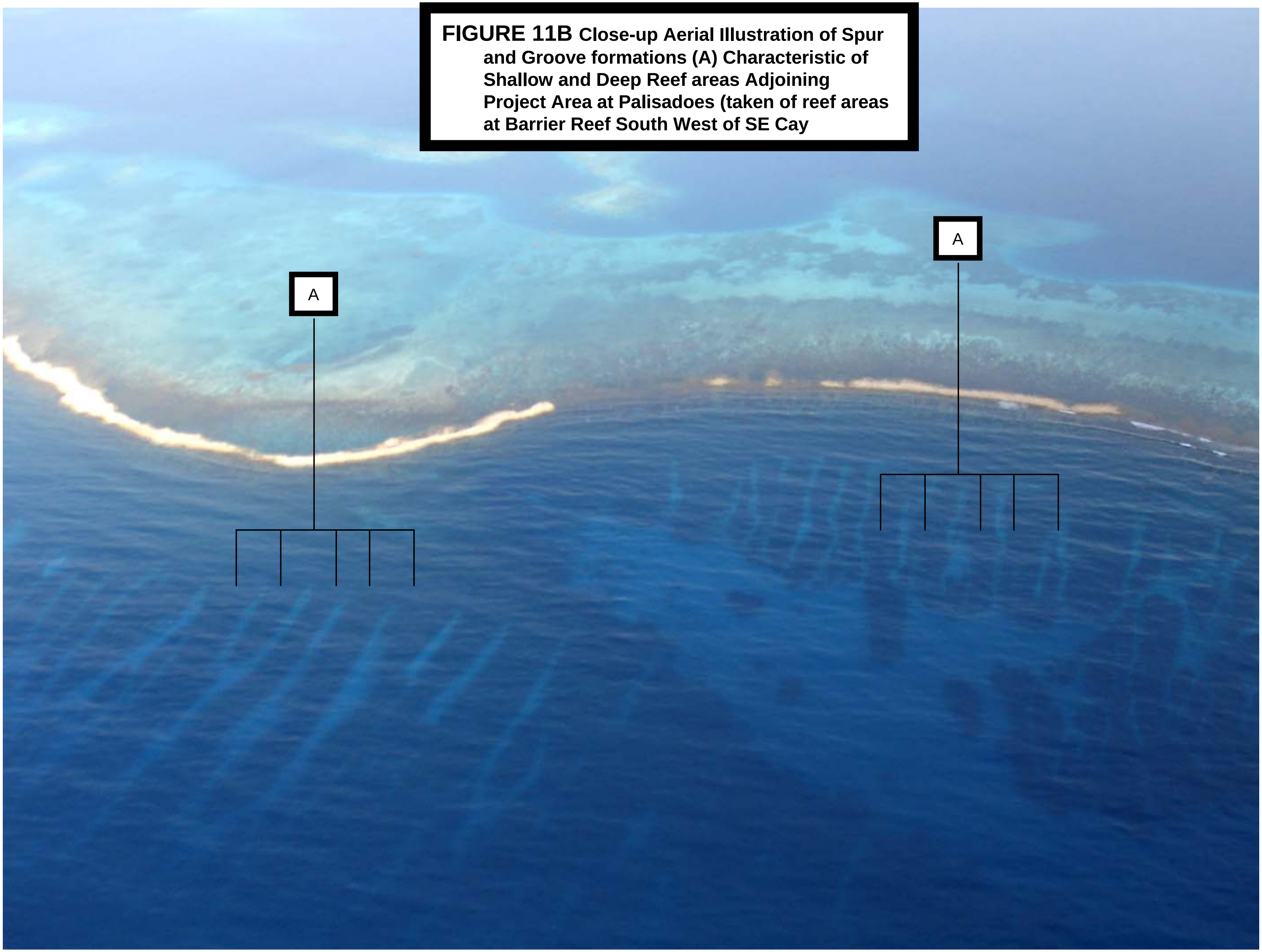
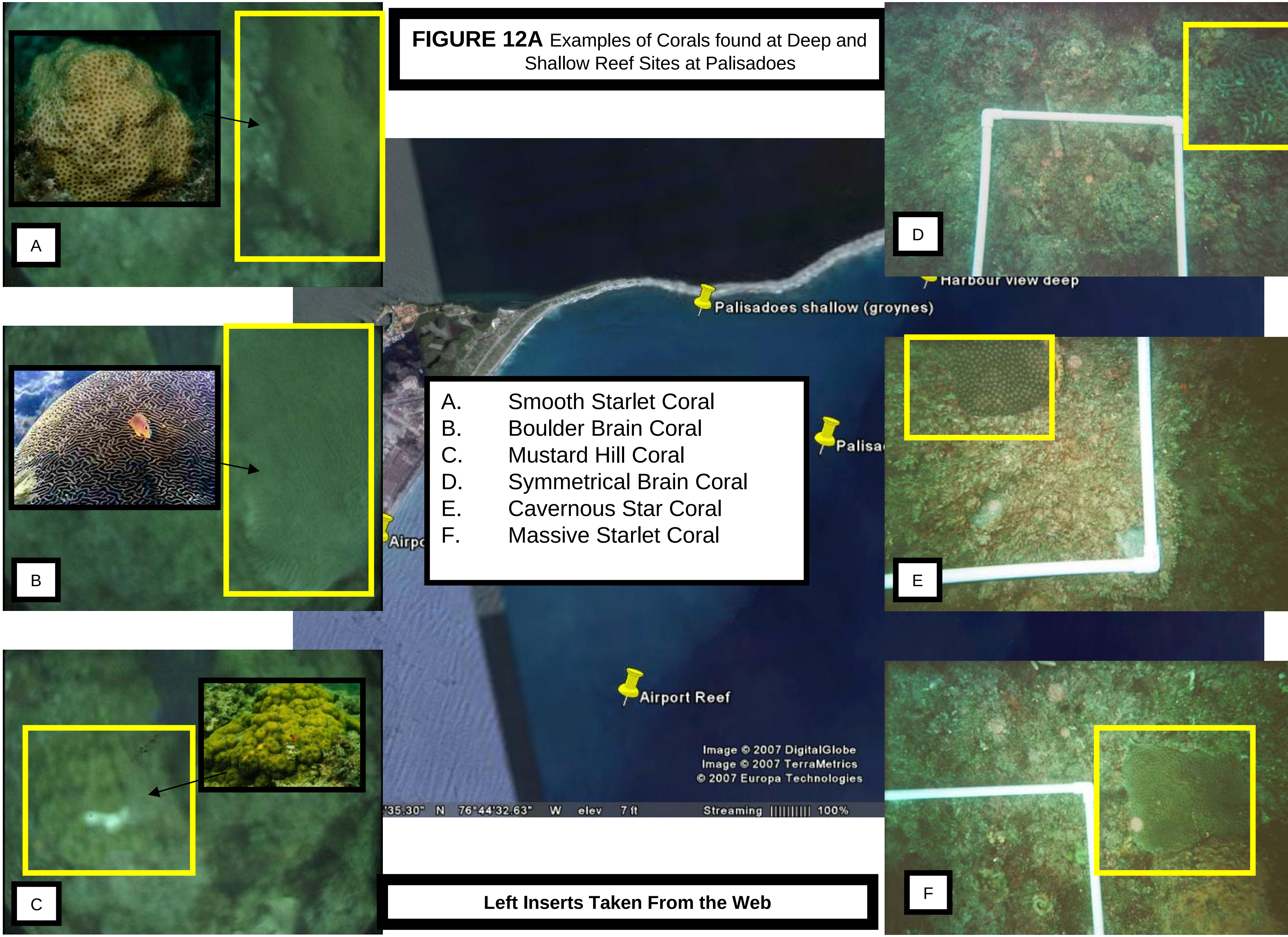


FIGURE 11B Close-up Aerial Illustration of Spur and Groove formations (A) Characteristic of Shallow and Deep Reef areas Adjoining Project Area at Palisadoes (taken of reef areas at Barrier Reef South West of SE Cay

FIGURE 12A Examples of Corals found at Deep and Shallow Reef Sites at Palisadoes



Left Inserts Taken From the Web

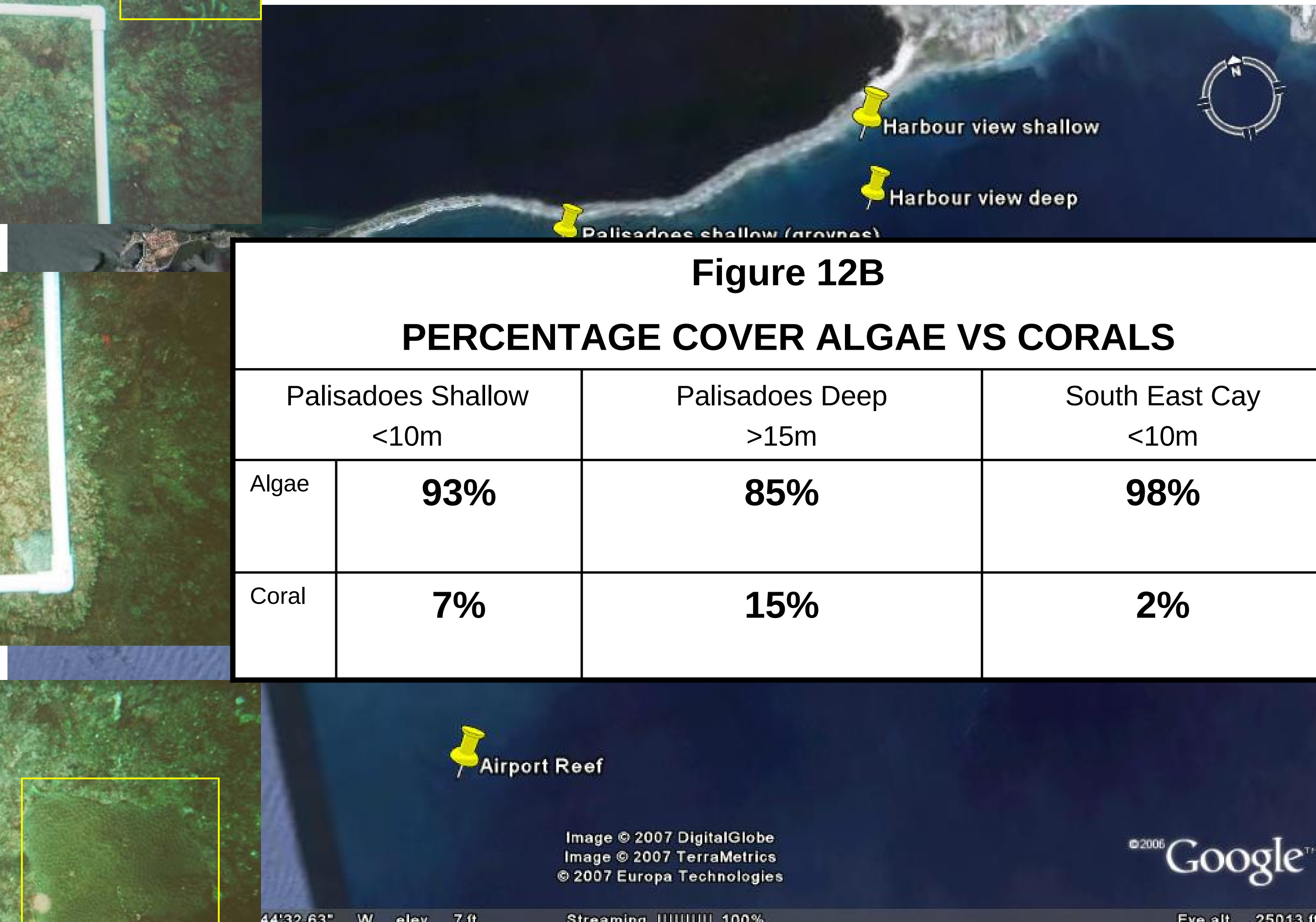
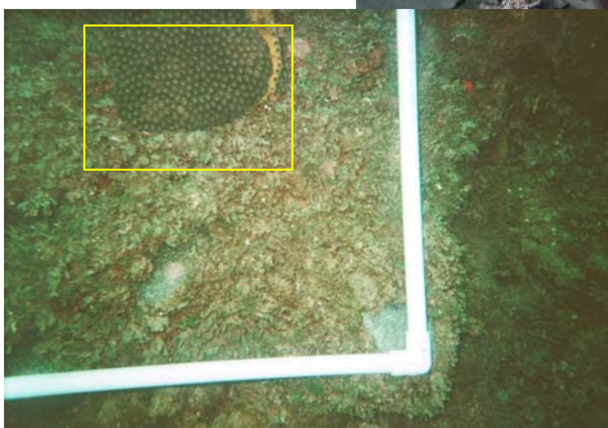


Figure 12B

PERCENTAGE COVER ALGAE VS CORALS

	Palisadoes Shallow <10m	Palisadoes Deep >15m	South East Cay <10m
Algae	**93%**	**85%**	**98%**
Coral	**7%**	**15%**	**2%**



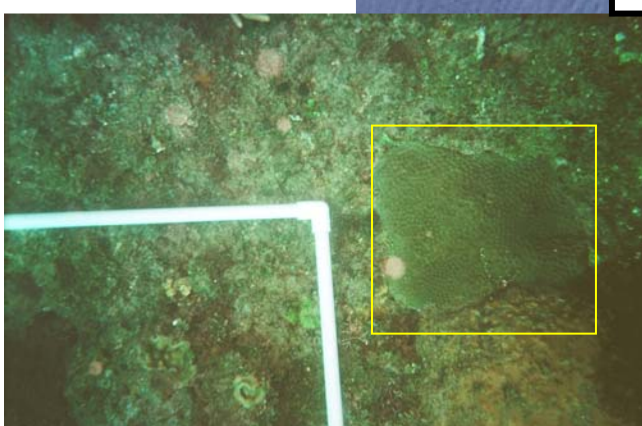


FIGURE 13A Illustrations of Strand Beach Vegetation Cover at Palisadoes

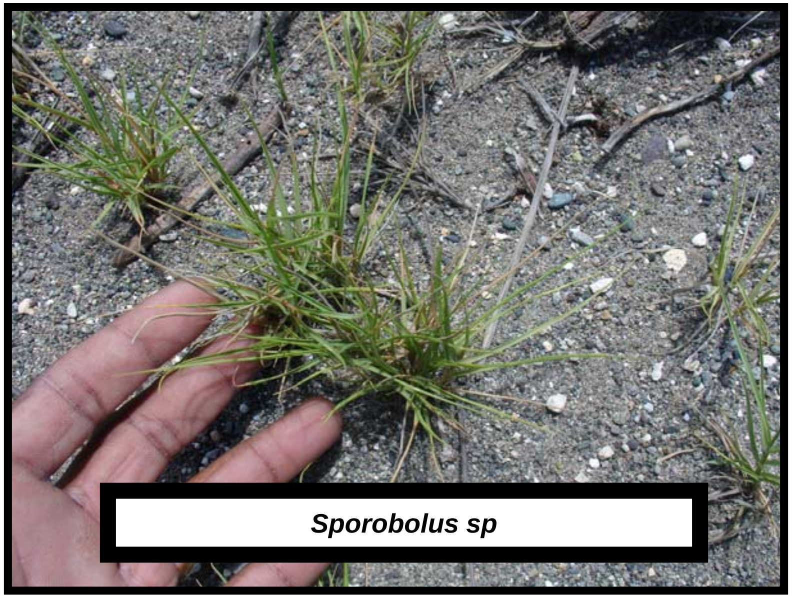
Sesuvium sp

Gomphrena sp

FIGURE 13B Illustration of Strand Dune Vegetation Cover at Palisadoes

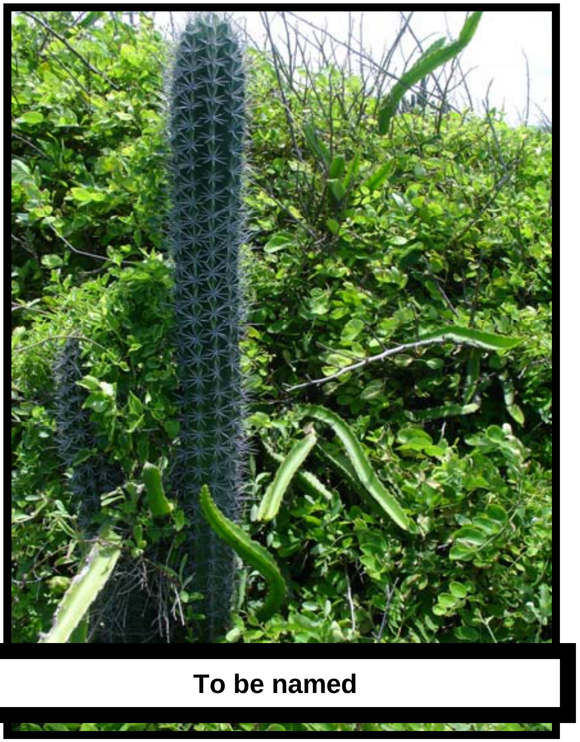
To be named

To be named



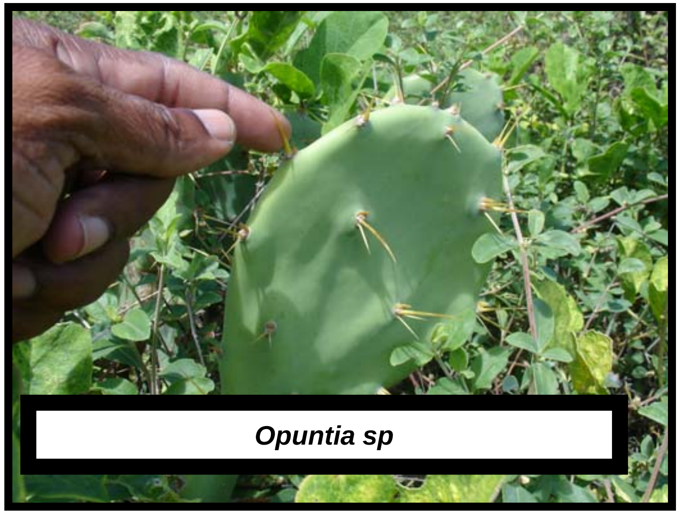
Sporobolus sp

FIGURE 13C Illustration of Strand Thorn-Scrub Vegetation at Palisadoes



To be named

Acacia sp



Opuntia sp

To be named

FIGURE 14A Illustration of Change in Dune Vegetation Cover at Palisadoes over the period 1961-2005

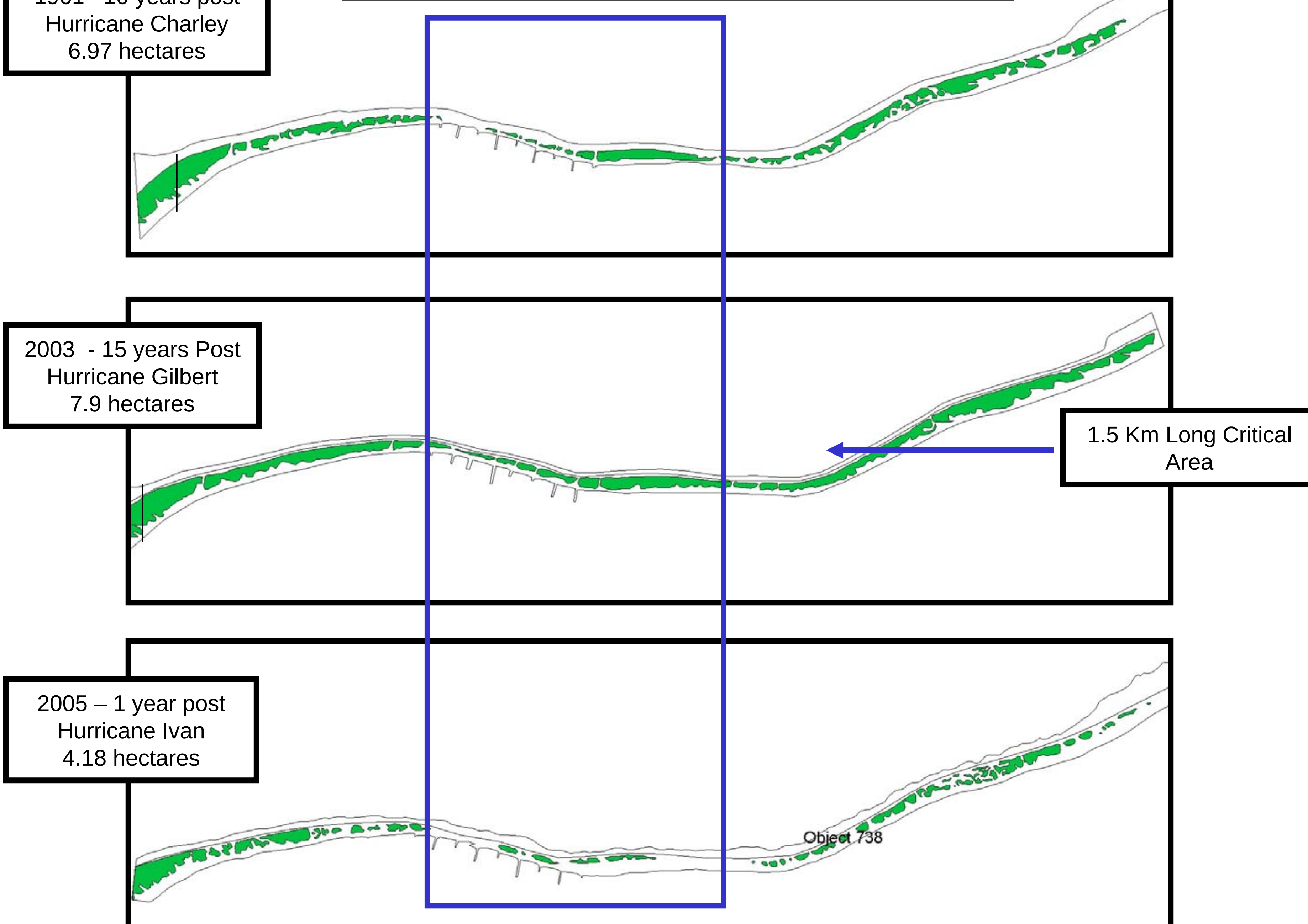


FIGURE 14B **Aerial Illustration of Change in Dune Vegetation Cover at Groyne Field Palisadoes over the period 2002-2007**

NOTE

Areas of low-lying to moderately dense vegetation coverage in 2002 – A dominated by grey sand coverage in 2007 - B

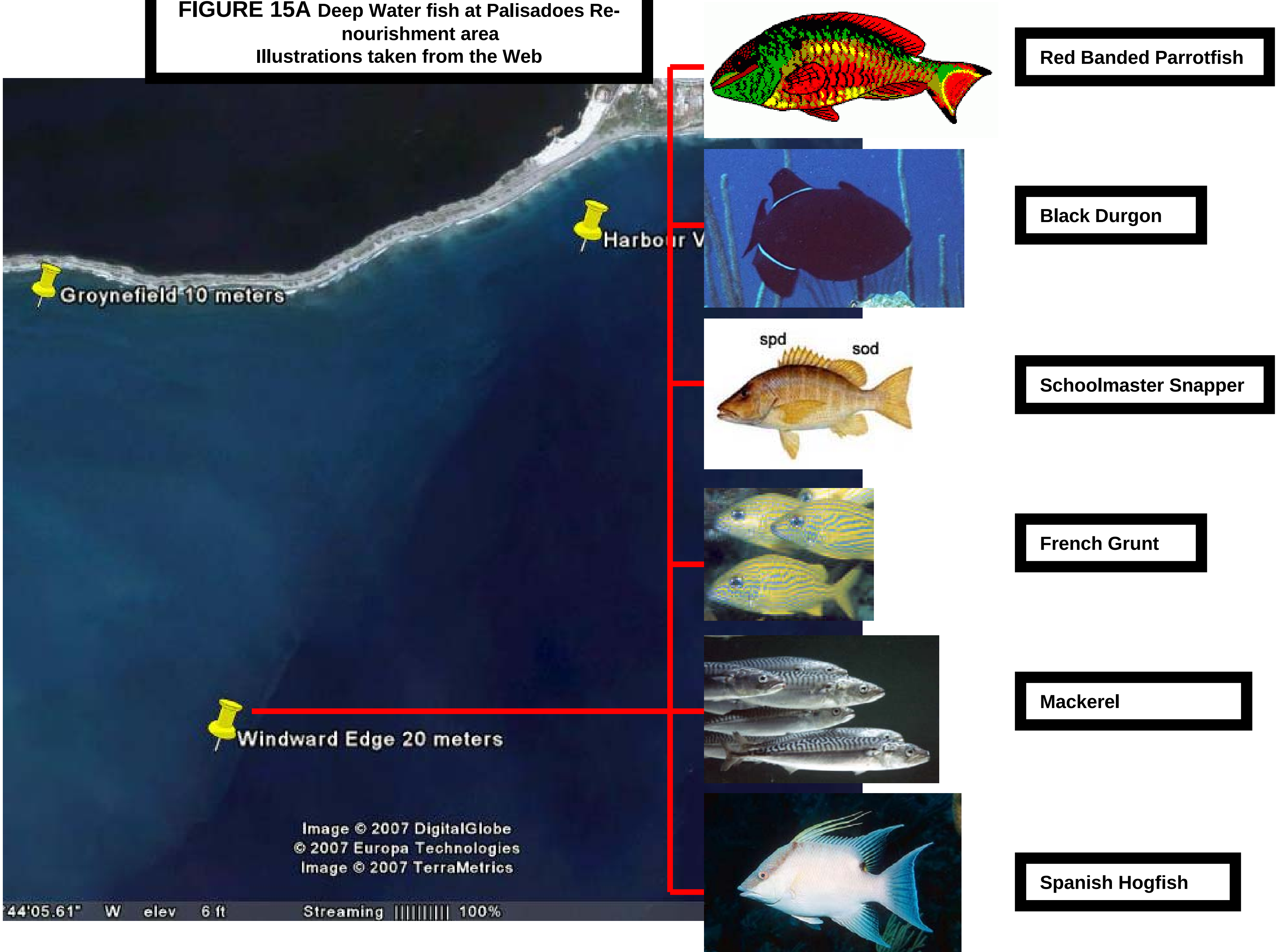


FIGURE 15A Deep Water fish at Palisadoes Re-nourishment area
Illustrations taken from the Web

FIGURE 15B Examples of shallow Water fish at Palisadoes Re-nourishment area
Illustrations taken from the Web

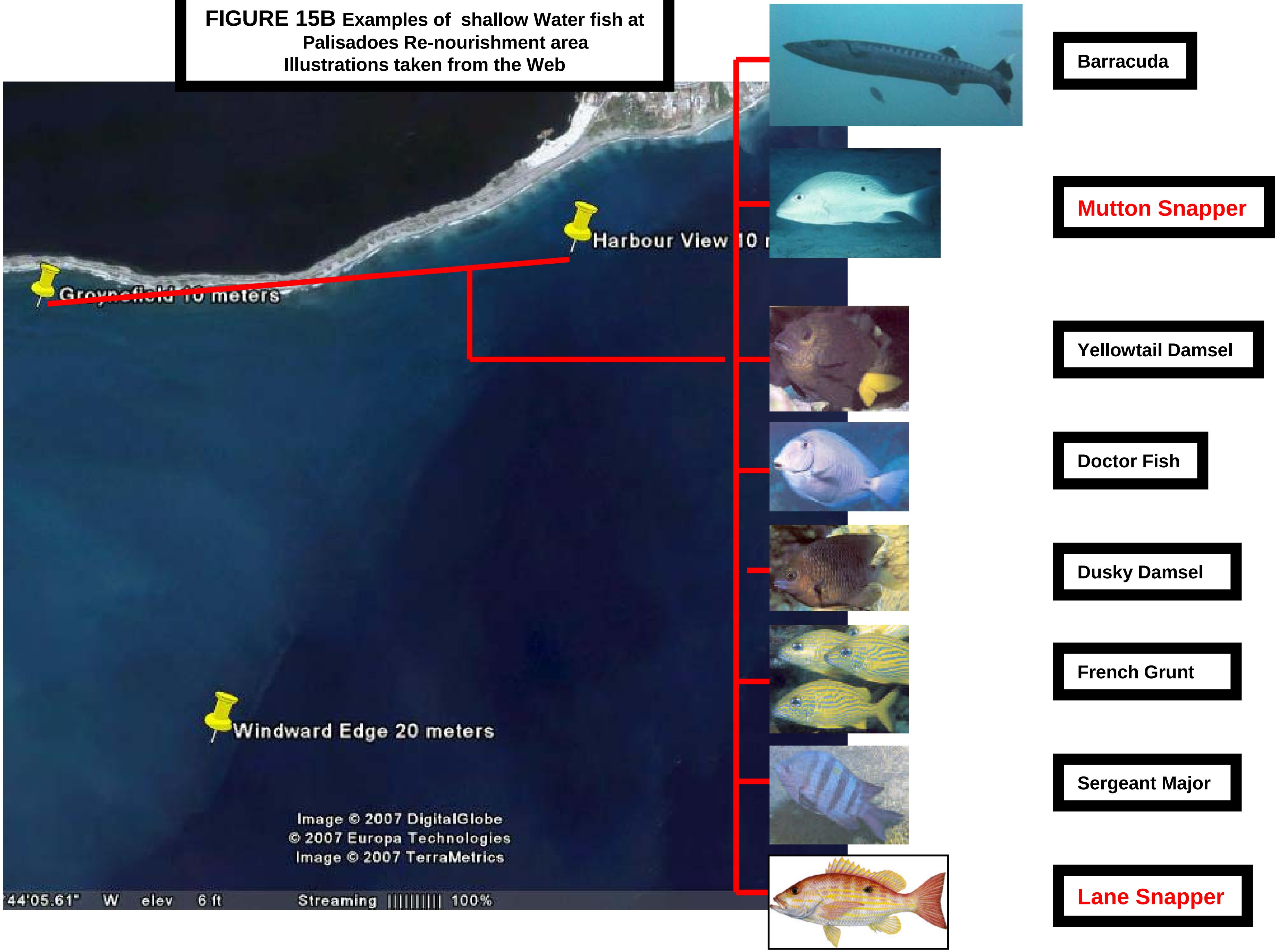


FIG 15C

AGRRA Data for Transects conducted in study area for proposed Palisadoes Re-stabilization project.

Transects surveyed 4x30 meters – 2 shallow and 1 deep

Harbour View Reef
Palisadoes Reef
Windward Edge
AGRRA 2000 AVEGAGES

Surgeon Fish		Parrot Fish		Grunts		Snappers		Groupers	
#/100 m^2	Length cm	#/100 m^2	Length	#/100m^2	Length	#/100 m^2	Length	#/100 m^2	Length
13	**<10**	**12**	**<10**	**0**	**0**	**0**	**0**	**0**	**0**
8	**<10**	**9**	**<10**	**8**	**<20**	**>100**	**<5**	**0**	**0**
0	**0**	**5**	**<20**	**7**	**<20**	**1**	**<15**	**0**	**0**
5.5	***10.3***	***16.7***	***12.5***	***2***	***15.6***	***0.2***	***17.4***	***1***	***15.6***

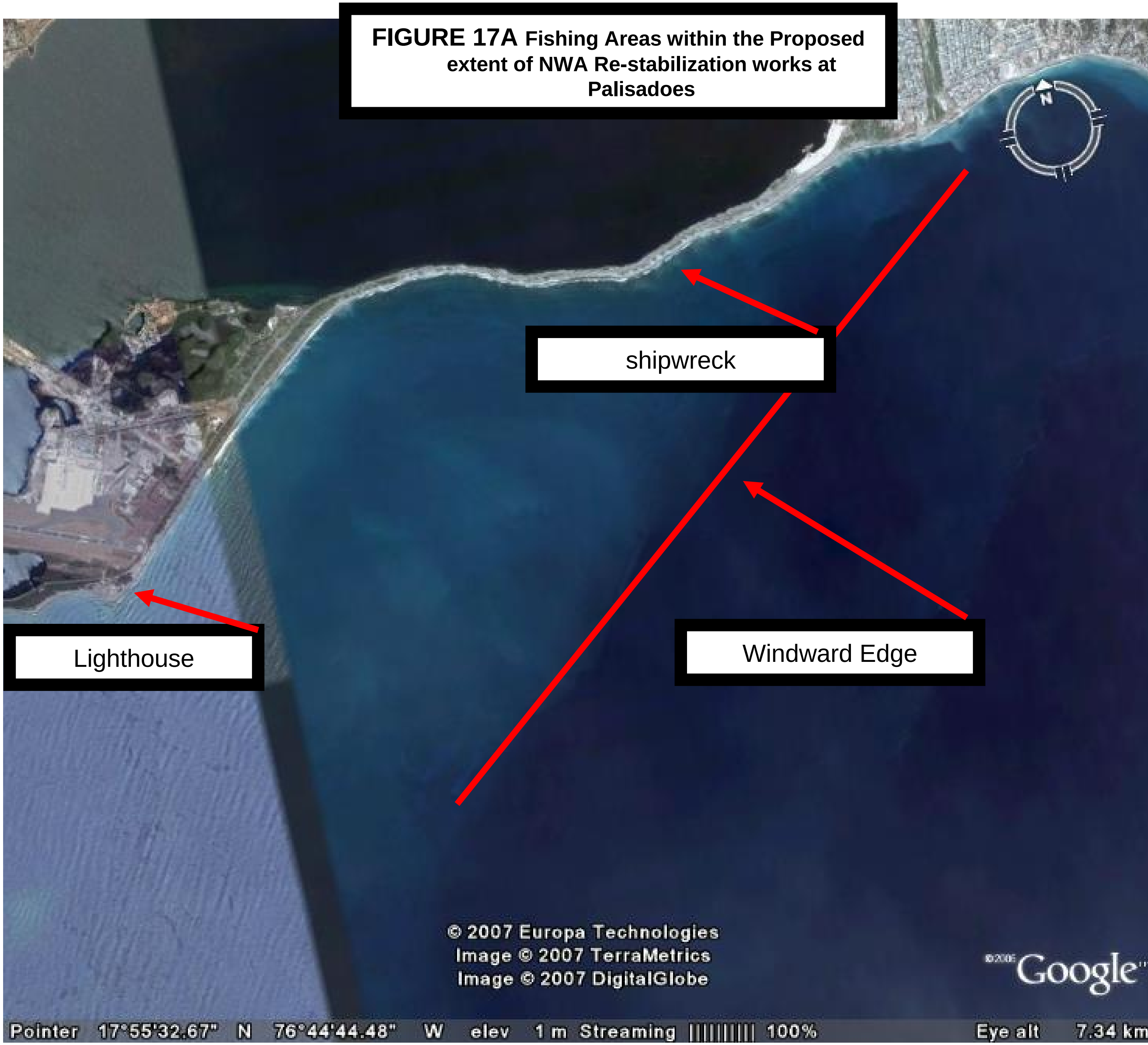


FIGURE 17A Fishing Areas within the Proposed extent of NWA Re-stabilization works at Palisadoes

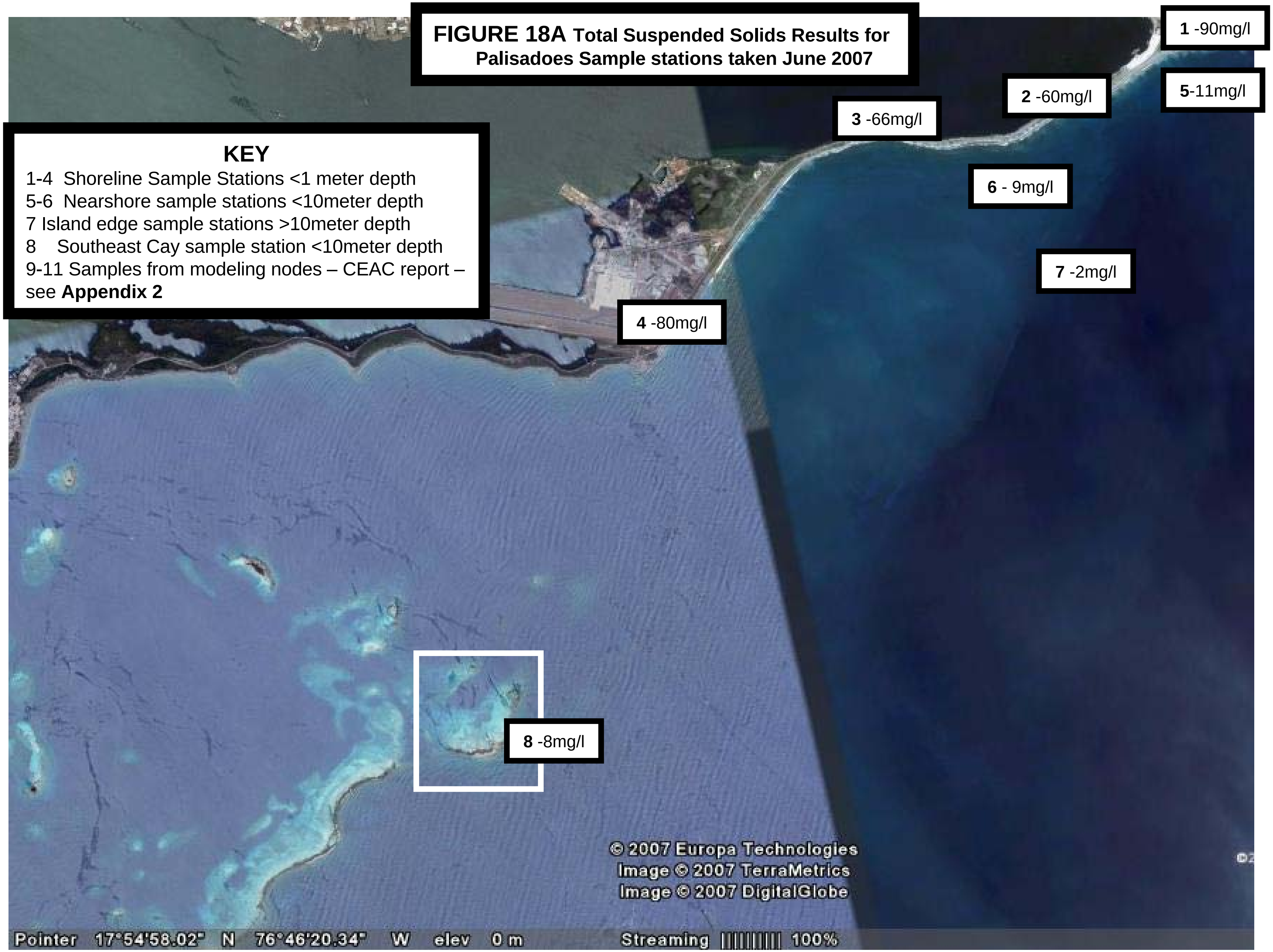


FIGURE 18A Total Suspended Solids Results for Palisadoes Sample stations taken June 2007

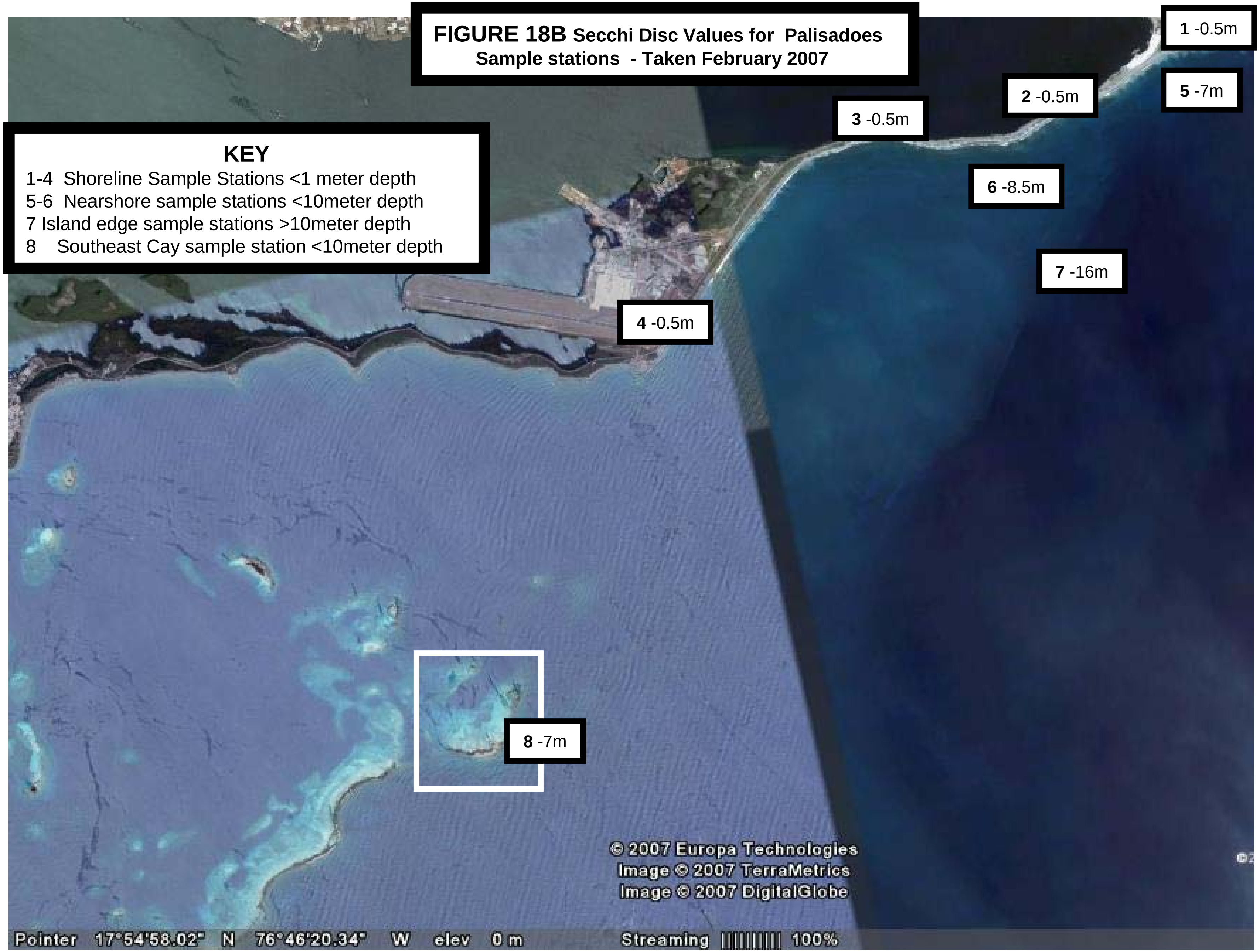


FIGURE 18B Secchi Disc Values for Palisadoes Sample stations - Taken February 2007
KEY
1-4 Shoreline Sample Stations <1 meter depth
5-6 Nearshore sample stations <10meter depth
7 Island edge sample stations >10meter depth
8 Southeast Cay sample station <10meter depth
1 -0.5m
2 -0.5m
3 -0.5m
4 -0.5m
5 -7m
6 -8.5m
7 -16m
8 -7m
© 2007 Europa Technologies
Image © 2007 TerraMetrics
Image © 2007 DigitalGlobe
Pointer 17°54'58.02" N 76°46'20.34" W elev 0 m
Streaming |||||||||| 100%

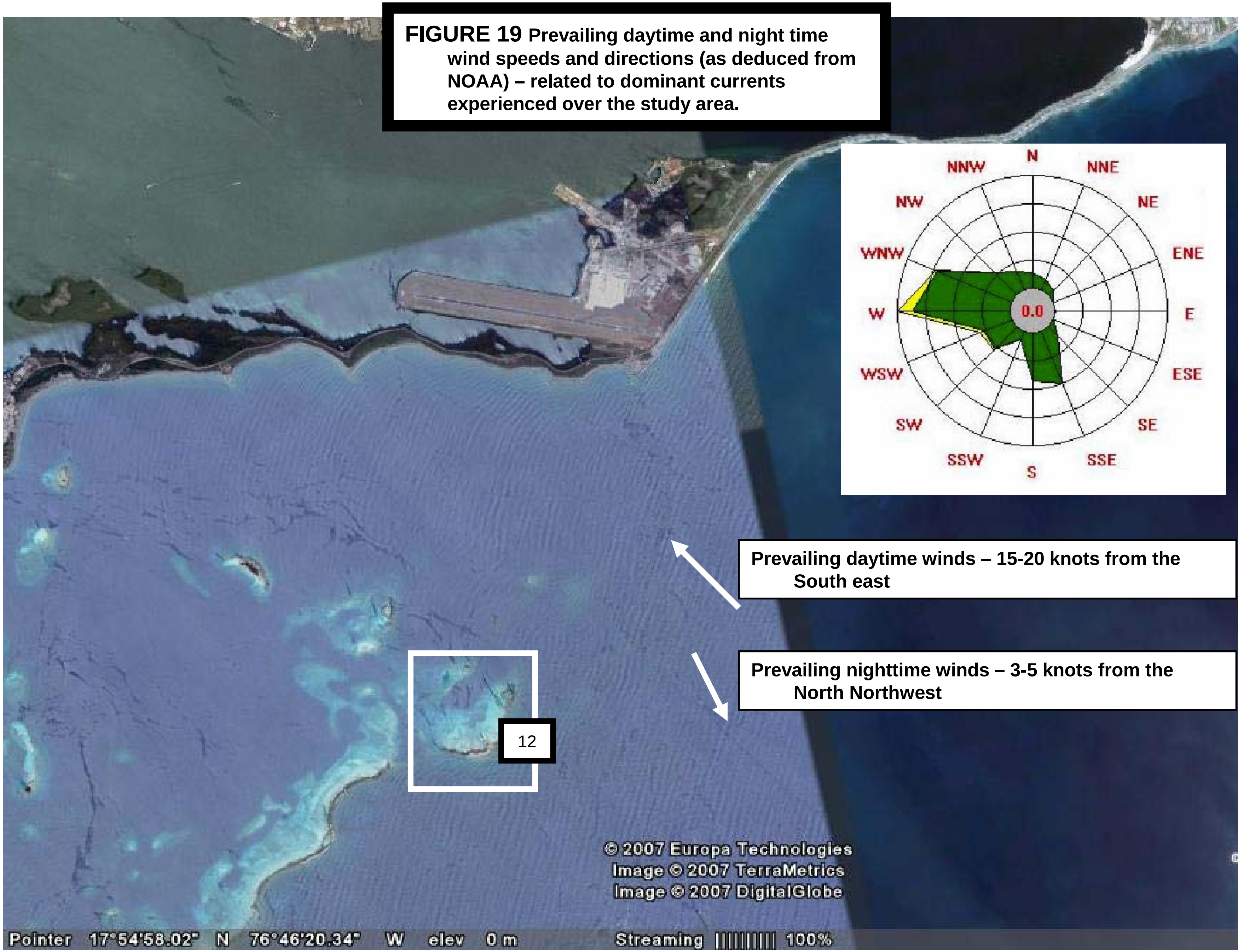
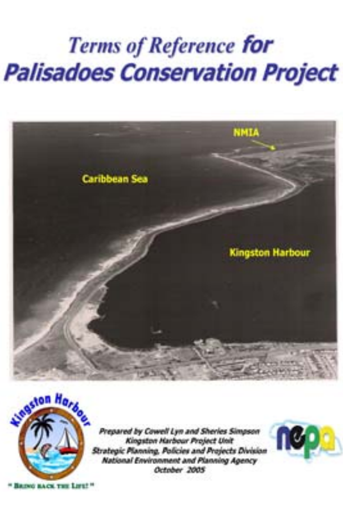


FIGURE 19 Prevailing daytime and night time wind speeds and directions (as deduced from NOAA) – related to dominant currents experienced over the study area.

Appendix 2

Cuban Technical Report



GAMMA S.A.

Instituto de OCEANOLOGIA

PALISADOES PROTECTION AND REHABILITATION PROJECT

February 2007

PALISADOES PROTECTION AND REHABILITATION PROJECT

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Institute of Oceanology
Institute of Meteorology
Ministry of Science, Technology and Environment of Cuba.
Inversiones GAMMA S. A.

February 2007

Project Participants:

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- Mr. Adrián Niévares Pérez, Oceanographer, Specialist Technician.*
- Mr. Alexis Morales Villalba, Specialist Diver.*
- Mr. Jorge Oliva Duarte, Specialist Diver.*
- Mr. Yohannes Acosta Díaz, Specialist Diver.*
- Mr. Richard Walker, Quantity Surveyor, Technical Services Department.**
- Mr. Leroy Osbourne Williams, Driver.**

* Institute of Oceanology, CITMA, Cuba.

** National Works Agency, Ministry of Housing, Transport, Water & Works, Jamaica.

Collaborating Jamaican Institutions:

- National Works Agency, Ministry of Housing, Transport, Water & Works.
- Land Agency, Ministry of Housing, Transport, Water & Works.
- The Marine Geology Unit, UWI, Mona.
- Meteorological Services, Ministry of Local Government & Environment.
- National Environment and Planning Agency, Ministry of Local Government & Environment.
- Jamaican Coast Guards.

Acknowledgements:

From its beginnings, Palisadoes Protection and Rehabilitation Project has received the permanent supervision of the Steering Committee through weekly meetings that were fundamental to the successful development of the Project. We would like to express our deepest thankfulness to the members of this Committee, and particularly to:

- Mr. Calvin Thompson, National Land Agency.
- Mr. Jeffrey Spooner, Meteorological Services.
- Mr. Cowell Lyn, Airports Authority of Jamaica.
- Mr. David Smith, Smith-Warner International.
- Mr. Chris Burgess, CEAC.
- Mr. Sean Green, NEPA.
- Mr. Kapleton Hall, NEPA.
- Mr. Anthony McKenzie, NEPA.
- Prof. Ted Robinson, The Marine Geology Unit, UWI, Mona.
- Miss. Shakira Khan, The Marine Geology Unit, UWI, Mona.
- Dr. Rafi Ahmad, UWI, Mona.
- Mr. Peter Wilson-Kelly, Consultant/JDFCG.

We would also like to convey special thanks to the National Works Agency, the Ministry of Local Government and Environment, and the United Nations Environment Program in the persons of:

- Mr. Milton Hodelin, CEO, NWA.
- Mr. Earl Patterson, NWA.
- Mr. Lynval Ramdial, NWA.
- Mrs. Maureen Hendricks, NWA.
- Mr. Philbert Brown, Ministry of Local Government and Environment.
- Mr. Joseph Shako, Ministry of Local Government and Environment.
- Mr. Franklyn McDonald, UNEP.

Very special appreciation deserve the persons from the Jamaican Coast Guards involved in supporting our project during field work operations.

PALISADOES PROTECTION AND REHABILITATION PROJECT

CONTENT **Page**

I. INTRODUCTION.

On an invitation of the Ministry of Land and Environment of Jamaica and with the collaboration of UNEP Regional Office, three specialists from the Ministry of Science, Technology and Environment of Cuba (CITMA), participated in November 2005 in the presentation and discussion of the Terms of Reference for Palisadoes Conservation Project, elaborated by Cowell Lyn and Sheries Simpson in October 2005.

As a result of that visit, the Cuban specialists presented in January 2006, a Technical Proposal directed to develop the investigation works identified in the Terms of Reference and to define the engineering actions required for the protection of Palisadoes.

In March 2006 a mission integrated by technicians and officials of the Jamaican Government visits Havana with the objective of specifying the scope of the technical proposal elaborated by CITMA specialists, and evaluating with the Cuban authorities the logistics aspects for the development of the project.

During the work sessions held in that occasion, it was defined the necessity to concentrate the attention on the protection of a prioritized 5-Km sector with emphasis on a tract of 1.5 km where the erosion process threatens to destroy the only road that provides access to Port Royal and to Norman Manley Airport from Kingston City.

The meetings also permitted to specify the need to involve Jamaican institutions in fundamental project tasks, and the definition of a Technical Committee that supervises field work progress and the elaboration of the project report.

The project negotiation phase began in August 2006, between the National Works Agency (NWA), from the Ministry of Housing, Transport, Water and Works, and the company Inversiones Gamma S. A. belonging to CITMA. The Contract for the Procurement of Consulting Services for Palisadoes Protection and Reahabilitation Project was signed in December 2006.

The first stage of the project, developed from December 1st to 21, was directed to the study of the marine climate and its objective was to define the design parameters for coastal protection works. The study included the analysis of the database on tropical hurricanes that have affected the area during the last 100 years, establishing the return period for the different categories and applying numeric models to evaluate the storm surge and wave height parameters corresponding to extreme erosive events, such as hurricane Ivan. The works were developed by Dr. Rafael Pérez Parrado from the Institute of Meteorology of the Ministry of Science, Technology and Environment of Cuba, and specialists from the Meteorological Service of Jamaica. This stage concluded with the presentation of a preliminary report on December 20, 2006.

The second stage of the project took place between November 30 and December 30, and it corresponded to field works required for the physical characterization of the study area, and for the evaluation of engineering alternatives to protect the prioritized sector.

Starting from the hypothesis that the reconstruction of the dune and beach is an appropriate alternative for the protection of 5 km of coast, during the field works special attention was paid to the localization and evaluation of submarine sand deposits with appropriate conditions to be used as borrow areas.

Works on land were directed to the morphological and sedimentological characterization of the coastal sector object of study, and they included excavations to determine the rock layer depth in the most critical tract of the prioritized sector.

The analyses of grain size and composition of the sediment samples were carried out in the laboratory of the Marine Geology Unit of the West Indies University, Mona; and most of the topographical information was obtained by the Survey Department from the National Land Agency.

At the end of the second stage, a second report was presented with a synthesis of the results obtained in each of the tasks conceived for the field work. The confirmation of the existence of a sand deposit in the submarine slope with appropriate conditions to be used as borrow area, was an essential result to sustain the proposal to reconstruct Palisadoes natural dune, not only as a coastal protection work, but also as an action for the environmental rehabilitation of the tombolo.

For the protection of the road in the most critical sector of Palisadoes, it had been conceived the construction of a structure of geotubes filled with sand, taking into account the advantages of this technique regarding time of execution and economy of the materials required. However, keeping in mind the results of the excavations carried out in the critical sector, it was proven that the water level and the continuous impact of the wave in the place where the structure should be make its construction extremely difficult. This brought about the decision of using quarry stone instead of the geotubes.

In the third stage developed between January 1st and 31, the team proceeded to complete the processing of the field information and to the elaboration of the planes, models and calculations that substantiate the design for dune reconstruction and for road protection in the critical sector, which was done according to both engineering and environmental approaches.

In the fourth stage, developed between February 1st and 15, it was elaborated the English version of the project for its final delivery.

It should be highlighted that from the first stage, the Palisadoes Conservation Steering Committee carried out weekly meetings with the objective of evaluating the progress of the project. The recommendations issued from these meetings were very useful for planning the actions and for the definition of solutions and design approaches.

With the presentation of this document, the company Inversiones Gamma S. A. fulfils the commitment assumed with the Ministry of Local Government and Environment and the Ministry of Housing, Transport, Water and Works, National Works Agency, as it is established in the contract No. DC-2006-CITMA-JM-01. Primary information obtained during field works, and information reached in laboratory and cabinet works, are included in attached charts and figures.

II. JUSTIFICATION OF THE PROJECT

The Palisadoes Peninsula constitutes the extension of land of about 14 Km in length, with an East-West projection, that protects Kingston Harbour from the open waters of the Caribbean Sea.

The need for the protection of Palisadoes Peninsula from earthquakes and from the impact of tropical hurricanes is very well documented in the Terms of Reference for Palisadoes Conservation Project, elaborated by Cowell Lyn and Sheries Simpson in October 2005.

Taking as reference the work: “A Study of Earthquake Risk in Jamaica” (Shepherd, 1971), the authors argue that between 1880 and 1960, Kingston and St. Andrew experienced a total of 155 damaging earthquakes. Of this total, 16 events were of intensity VI, one was intensity VII and another was intensity IX. In relation to the Palisadoes and Port Royal, Shepherd estimated that “the probability of failure on the scale of 1692 in any 50-years period is of the order of 16%, and the probability of ground failure on a smaller scale is 44%”. The map of the Frequency of Damaging Earthquakes for Each Parish of Jamaica presented by Shepard, identifies the Palisadoes as the most threatened area in the country.

It is evident that any planning conceived for the use and development of Palisadoes has to pay prioritized attention to the danger implied by the occurrence of an earthquake. This risk element should be evaluated even for the coastal defence works that are conceived for the protection of Palisadoes from the impact of tropical hurricanes.

With regard to the impact of hurricanes, the information extracted by Lyn and Simpson (2005), from ODP's CATALOGUE of JAMAICAN DISASTERS, and a list presented by Stanley (1967), demonstrate that numerous events have severely affected Palisadoes and Kingston Harbour since 1712.

According to information facilitated by Professor Robinson from Geology and Geography Unit, WIU, Gascoigne's map of 1728 shows the formation of 5 breaches in the eastern sector of Palisadoes as a consequence of the hurricane occurred in 1722, which, with an estimated storm surge height of 5 m, has been the most severe hurricane that has affected Palisadoes since the first hurricane records available.

Starting from that event, moments of intense erosion caused by hurricanes (probably also by some earthquake), are alternated with moments of sand accumulation and partial recovery of the dune and beach as a consequence of the input of new material to the coast through the rivers located due East of the Peninsula.

With the occurrence of hurricane Ivan in September 2004, an intense process of sand migration from Palisadoes external side toward the Kingston Harbour side took place, which had never before been observed since the event in 1722.

The degree of dune destruction caused by this sand transport process has left the Palisadoes Peninsula in a high degree of vulnerability to future erosive events, even of a much lower category than that of hurricane Ivan, and it evidences the inability of the Coastal System to recover itself in a natural way.

As it is well described in the Terms of Reference (Lyn and Simpsom, 2005), the transformation process of Palisadoes constitutes an imminent threat to economic and social objectives of high significance for the country.

The document stands out the importance of the road as the only access to the historical town of Port Royal, as well as to Norman Manley International Airport, the Quarantine Complex of the Ministry of Agriculture in Plumb Point, Caribbean Maritime Institute, Royal Jamaica Yacht Club, Buccaneer Beach and Gunboat Beach. Particularly, it is very well identified the breakwater function of the Peninsula before storm waves, constituting the indispensable natural defence for the protection of Kingston Harbour and its urban areas located on the coast.

In fact, the Terms of Reference for Palisadoes Conservation Project had as main objective to offer the basic guidelines for the program of investigations indispensable for proper decision making within an Integral Program for the Management of Palisadoes Peninsula.

Keeping in mind the guidelines of the Terms of Reference, the Ministry of Local Government and Environment, and the Ministry of Housing, Transport, Water and Work, decided to begin the execution of a project that guarantees the protection of the most critical sector in the peninsula with urgent character.

The solutions proposed and designed in this project respond to that objective and have been conceived under the premise that they do not compromise the application of future works that require a higher degree of concurrence and technical and financial preparation.

III. MATERIALS AND METHODS

Field Works.

The field works were carried out between December 1st and December 30th, 2006. During this period it was executed the land and sea works corresponding to tasks 6, 7, 8, 9, 10, 11, 12, 13 and 14 enclosed in Annex II to the Contract No. CC-2006-CITMA-JM-01.

Task 6. Bathymetric Survey.

Equipment

Acoustic System DT-5000, BIOSONICS Co.

GPS Garmin 76. System WASS.

From Cane River to Little Plumb Point, 37 survey lines perpendicular to shore were executed between 5 m and 30 m deep. The main goal of this survey was to characterize the submarine slope to find a sandy basin useful as borrow area. The survey demonstrated the existence of an appropriate basin. The survey was also useful to verify the updating of the bathymetric Map 1:10 000 edited by the Survey Department in 1999. Both the survey lines and the sampling stations of all the field works were georeferenced using the GPS Garmin 76 with WASS antenna, guaranteeing a precision of 3 m.

The profiles are included in Annex 1 and their location on site is shown in Map Sheet 1 that includes the location of all the executed field works.

Task 7. Determination of sand thickness.

Equipment

Manual driller with 2 sections of 1.65 m.

In the submarine exploration to locate and evaluate the borrow area, 74 drills were executed using a manual driller, 58 of which correspond to the area finally selected to obtain the sand for the project. The results of these measurements are included in the Map Sheet 3.

Task 8. Sedimentary Survey.
Task 13. Sedimentary sampling in rivers and beaches.

The laboratory analysis was executed by the Marine Geology Unit, UWI, Mona

A total of 97 sediment samples were taken, 82 of which correspond to the submarine exploration to locate the borrow area, 1 to East Channel, and 14 to dune and beach.

The submarine samples were taken from the sandy cone formed during the manual drilling operation. This sample characterizes the sediment column that will be dredged and introduced in the coast. The samples in dune and beach were taken in the same profile to characterize the native sand.

Sample splits of 100-130 g were placed through a nest of thirteen (13) sieves, decreasing in half phi (½ Φ) intervals from - 2.0 Φ (4 mm) to 4.0 Φ (62 µm). The nest was placed on a mechanical shaker for 10 minutes. The initial weight of each sample was recorded prior to sieving and the weight of each fraction of the sediment retained in each sieve was weighed, using a digital balance with precision of 0.01 g. The raw data obtained was used to plot frequency distribution curves and calculate statistical parameters of mean, sorting and skewness. Laboratory results were included in Annex 2 and their location on site is shown in Map Sheets 1 and 3.

Task 9. Current measurements
in the near-shore zone and borrow area

Equipment
Current meter SD 6000
AANDERAA Co.

Two stations were established to measure the near shore currents and another to measure currents in the borrow area. The equipment recorded during 11 days with 15 minute intervals. The location of the current meter stations is shown in Map Sheets 1 and 3.

Station 1 corresponded to a rocky bottom and a depth of 7.2 m, and station 2 with a sandy bottom and 7.3 m of depth, separated 2.5 m from the bottom in both cases. Station 3 was established in the central part of the borrow area in a sandy bottom at a depth of 16 m and separated 3 m from the bottom. The digital records were processed by means of the software of the SD 6000.

Task 10. Diving description of the submarine slope.

Equipment
The boat and the diving tanks were facilitated by the Coast Guard.

The description of the submarine slope was executed in 106 diving stations and along two submarine routes of 300 m. These descriptions are complementary information to evaluate the characteristics of the borrow area. Simultaneously to the realization of each station, it is visually corroborated the sandy composition of the bottom, the cover of benthic organisms, and the existence of natural or artificial irregularities that may affect the operation of the dredger. The results of the descriptions are included in Annex 2.

Task 11. Topographic survey.

Task 12. Levelling of beach and dune profiles as indicators of morphological changes.

These tasks were executed by the National Land Agency (NLA), and the Cuban team.

Equipment

The instruments used by the National Land Agency in the execution of the surveys were:

- **TRIMBLE 5700 dual frequency GPS receivers**
- **LEICA TC 600 Total Stations**
- **LEICA NA 2000 automatic level**

The instruments used by the Cuban team in the execution of the surveys were:

- **SOKKIA DT 510A Digital Theodolit**
- **GPS Garmin 76. System WASS**

Along Palisadoes study sector, 49 cross sections of the Peninsula were done by the National Land Agency (NLA). The coastline was surveyed by GPS – RTK method using GPS.. Additionally, the Cuban specialists did two profiles in the critical sector to emphasize the morphological and sedimentary characteristics of this sector and to design the protection works. In the critical sector it was included an excavation using a backhoe with the objective of measuring the level of the rocky surface.

Pairs of inter-visible control marks consisting of concrete monuments cast in concrete foundation at a depth of approximately one (1) metre and fixed by DGPS survey were established at the Harbour View round-a-bout, the round-a-bout at the intersection of Palisadoes Road with the road to Norman Manley International Airport, and on Palisadoes Road, approximately midway between the two round-a-bouts. These control monuments were also heighted by spirit levelling referenced to four (4) benchmarks located along the same section of Palisadoes Road.

The points from which the Cross Sections were observed were selected and marked at intervals of approximately one hundred metres (100 m), with the exception of the first three (3) cross sections, which were spaced at longer intervals. These points were fixed by Total Station traversing, tied to the previously established control stations and heighted by spirit levelling. They were also checked by GPS – RTK observations.

The cross sections were observed by Trig-Heighting survey method referenced to the previously selected traverse points. All points representing noticeable change in elevation along the section were measured.

The positions surveyed, both during the coastline survey and the observation of the cross sections, represent the waterline as defined by the almost continuous wind driven surf and should not be interpreted as the "normal tidal coastline". It should also be noted that the elevation of the data points observed during the coastline survey do not necessarily indicate ground level.

The software used in the data processing and draughting were: TRIMBLE Geomatics Office, AUTODESK 2007, TERAMODEL 9.6, MICROSO

Task 14. Hydrological description of river basins.

Equipment

GPS Garmin 76. System WASS

Two routes around the Hope River mouth and Caribbean Terrace were executed to verify the morphologic and sedimentary characteristics of the littoral near that area.

The cartographic basis of the project has been the 1999 bathymetric map 1:10 000 and the 1984 topographic maps 1: 50 000 elaborated by the Survey Department.

Cabinet Works.

Understanding that the surge and wave generated during the occurrence of tropical hurricanes constitute the main erosive agents that affect Palisadoes, chapter IV of the project comprises a study specifically on that theme, including its methodological aspects. Other studies and mathematical models used as regards hydrodynamic characteristics and sediment transport are also included in this chapter.

Criteria considered for revetment construction and dune design are explained in chapters VI and VII, to achieve a better understanding.

IV. PHYSICAL-GEOGRAPHICAL CHARACTERISTICS OF THE PALISADOES

As pointed out in the Justification of the Project, Palisadoes constitutes a land extension of about 14 Km in length, with an East-West projection, that separates Kingston Harbour from the open waters of the Caribbean Sea.

In the paper “The Formation of the Palisadoes” that is one of the results of the Environmental Foundation of Jamaica Project No. 03/09/431 –PL480 led by the Marine Geology Unit of the University of the West Indies, Professor Ted Robinson presents a description of Palisadoes evolution process.

According to that description, Palisadoes’s current shape seems to have originated about 4000 years ago, when sea level was more or less established and several small islands were connected among themselves and to the mainland through the formation of successive spits extended westward from Hope River mouth by long shore transport. Taking into account the characteristics of this process, scientists have preferred to consider that the formation of Palisadoes responds more to the genesis of a tombolo than to that of a peninsula.

The hypothesis of Palisadoes tombolo formation process is strongly supported in several papers reviewed and discussed by Malcolm Hendry, as part of his Ph.D. thesis “A Study of Coastline Evolution and Sedimentology: Palisadoes, Jamaica”, (1979).

In any case, it is clearly established in all the papers that the supply material that gave origin to Palisadoes was mainly produced by means of the longshore transport coming from the sediments that reach the coast through Hope River.

IV.1. Morphodynamic and Sedimentologic Characteristics

Regarding the present dynamics of Palisadoes, Hendry (1979) demonstrated by means of a study of historical information that in the 1728 Gascoigne map, 5 breaches appear in the narrow area of the eastern part of Palisadoes, which were produced by a severe hurricane that affected the area in 1722, causing a sea level rise of about 16 feet above normal in Port Royal.

The reviewed information shows that starting from 1728 the breaches were closed at some times and then reopened as a consequence of other hurricanes, until they were definitely closed in 1788 up to the present. Some indications suggest that the closures were in a certain extent caused by man-made actions.

The coastline evolution trend between 1876 and 1970 is represented by a diagram prepared by Hendry (1979) on the basis of maps and field measurements. It is concluded that by this period, the southward migration of the narrowest sector in the eastern part of Palisadoes, the retreat in up to 100 m between Plumb Point and Little Plumb Point, and a considerable accretion in Port Royal have already occurred.

On the other hand, the results of the coastline change assessment carried out by Professor Robinson using aerial photographs of flights in 1949 and 1961, and 2002 IKONOS images, show a similar trend to that proposed by Hendry for the coastal sector between Plumb Point and Port Royal, but it points out only small changes in the narrowest sector of the eastern part of Palisadoes.

By means of network of 13 monitoring points distributed along the tombolo on its seaward side, Hendry (1979), studies in more detail the monthly and daily morphological variations of the beach profile between July 1976 and June 1978. Among his results, the author synthesizes:

"Beach erosion and accretion at the Palisadoes is a diurnal phenomenon, resulting from changes in wave form in response to the sea-land breeze regime. When onshore (sea breeze) winds occur, the steep, destructive wind waves generated at these times initiate erosion on the foreshore. When offshore (land breeze) winds occur, constructive, trade-wind generated swell waves return the sediment that was lost from the beaches during the daytime. However, the effect of aspect appears to be important for some sections of the Palisadoes shoreline with winds from certain directions, resulting in either fetch restriction, and/or sheltering from wind wave approach. The causative influence behind this coastal-process response system is the local variation in barometric pressure."

"A limit is placed on the volume of sediment removed from some of the beaches over the short-time by the presence of a layer of beachrock and/or boulders under the mobile beach sediments."

"The boulders, which have been placed as a beach protection measure, are neither bound together, nor constructed as a self-supporting revetment. As a result, the boulders are liable to move alongshore under the normal wave conditions, and will be of no value for beach protection under storm or hurricane conditions."

"Trends of erosion or accretion were difficult to define on most of the Palisadoes beaches that were surveyed over a two-year period. Therefore, the value of short-term surveying for assessing such trends appears to be limited."

As it may be inferred from Hendry's results, beach morphodynamics in Palisadoes is conditioned to the daily breeze regime that causes mainly a daily redistribution of material from the berm to the submarine slope and vice versa, without important change in the sand volume of the beach profile.

This beach profile behaviour has been maintained even after the pass of Hurricane Ivan in 2004. As it may appreciated in Picture 1 taken shortly after the pass of Hurricane Ivan and Picture 2, taken during the field works in December 2006, for most of the eastern part of Palisadoes the beach profile recovered rapidly adopting a typical conformation of cumulative coast, with a wide and well-defined berm with diurnal variation like that explained by Hendry, (1979).

Picture 1. (Left). After Hurricane Ivan. (Provided by Professor Ted Robinson). Notice the rapid conformation of the berm and the beach profile after the pass of Hurricane Ivan.
Picture 2. (Right). December 2006. Notice that the characteristics of the profile are maintained.

However, pictures 3 and 4 corresponding to the most critical sector in Palisadoes, show how Hurricane Ivan caused the widening of beachrock and the recovery of the beach profile did not reach this area in the same way, thus confirming that the volume of material required for the profile restoration does not exist in the submarine slope, and no new inputs are reaching the sector through the longshore transport.

Picture 3. (Left). After Hurricane Ivan. (Provided by Professor Ted Robinson). Widening of the beachrock outcrop after the pass of Ivan.
Picture 4. (Right). December 2006. Notice that the beachrock outcrop is maintained.

Both, Hendry and Professor Robinson, highlight in their papers the current beachrock outcrop and destruction along several sectors in Palisadoes, as a clear sign of the erosive process that is affecting the tombolo.

During the time period in which Hendry's paper, (1979), was prepared, no hurricane affected the Palisadoes directly, and the impact of an event of such nature on the tombolo's morphology was limited to the historical assessment of the changes in the coastline and the identification of the breaches that had been formed, as well as to alert on how destructive the wave and surge caused by such events would be.

The pass of Hurricane Ivan in 2004 has provided the possibility to evaluate with more evidence the main morphological changes that a hurricane produces, and to identify the risk factors that this represents from the socioeconomic point of view.

While pictures 1 and 2 were useful to demonstrate the rapid process of profile recovery and the little changes produced in the coastline; pictures 5 and 6, also taken shortly after the pass of Hurricane Ivan and during the field trips in December 2006 respectively, show the impact of the surge and wave associated to a hurricane on Palisadoes natural dune.

Picture 5. (Left). After Hurricane Ivan. (Provided by Professor Ted Robinson). Destruction of the dune at the pass of Ivan.
Picture 6. (Right). December 2006. Notice that the dune has not recovered.

Although topographic levelings of before and after the hurricane were not available, which could have been useful to quantify the magnitude of the sand volume removed from the dune to the North side of the road, pictures 7 and 8 evidence the transfer of a considerable volume of material.


Pictures 7 and 8. Sand transfer toward the inner part of Kingston Harbour as a consequence of the surge and wave generated by Hurricane Ivan. (Provided by Professor Ted Robinson)

The magnitude of dune erosion and sand accumulation in the inner side of Palisadoes during the 18-hour effect, while Hurricane Ivan was impacting the area, demonstrate that the development process of a coastal area essentially takes place under the occurrence of events of such nature.

It must be pointed out that, as part of this project, the Survey Department of the Land Agency carried out 49 cross-sections, properly referenced, of Palisadoes from Caribbean Terrace to the round-a-bout of the road to the airport. The cross-sections were used to define the design of the profiles corresponding to dune reconstruction and will be useful as reference for the future monitoring of morphological variations of the beach and dune profile, (Annex 3).

As regards the structure of the submarine shelf in front of Palisadoes, Hendry (1979), emphasizes on the complexity of the processes that shaped the present relief, in which abrasion-accumulation processes of ancient fluvial terraces are combined with tectonic events and the formation of reef structures. Both, the analysis of the bathymetric map and the sounding profiles carried out during the field work in December 2006, allow to detect the existence of a sedimentary basin, projected almost parallel to Palisadoes and widening westward, acting as a trap for the sediments transported by the offshore currents that generate during storms.

The hypothesis used to search for the sand borrow area for the dune reconstruction in Palisadoes was based on these considerations on the morphology of the submarine shelf, and it was confirmed with the location of the borrow area in that basin.

Sediment composition was studied through the samples obtained in the beach and the dune, from Plumb Point to Caribbean Terrace, as well as in the submarine basin identified as borrow area. The results of the analysis are comprised in Annex 2.

The results of the grain size analysis and sand composition are further explained in chapter VI, in function of the evaluation of the composition of the material to carry out the dune reconstruction works.

Even without a thorough analysis of results obtained in the laboratory, it may be underlined that as refers to both grain size and mineral composition, the results are very similar to those reported by Hendry, (1979).

According to the analysis of thin sections, the highest weight percent in dune and beach sand samples corresponds to quartz, and carbonate percents are lower than 10 %. (See Chapter VI, sand composition).

Samples obtained in the submarine basin present a very similar composition to that of dune and beach samples; although an increase is observed in the percent of carbonate components that is probably resulting from the input of calcareous skeletons of benthic organisms contributed by the impact of Hurricane Ivan on reefs.

Taking into account the obtained results, it may be stated that fluvial inputs continue being the main source of sediment for the coastal system; though current erosion of the dune, beachrock, and biogenic inputs increase their contribution to the sedimentary balance of the coastal system at present. Besides, it may be noticed that, to a lesser degree, the material coming from protection works destroyed by wave have become part of the beach natural sediment supply.

IV. 2. Hydrodynamic characteristics

Hendry, (1979) synthesises his analysis regarding the hydrodynamic characteristics by stating:

¨There are two main influences for the propagation of waves arriving at the shoreline of the Palisadoes on a day-to-day basis. These are the trade winds, which generate swell waves year-round, and the sea breeze, which generates wind waves in the approaches to the Palisadoes on a year-round diurnal basis¨.

¨Both swell and wind waves approach from a predominantly southeasterly direction. This is reflection of two major influences: firstly, the consistency in the direction of the wave-generating wind regimes, and secondly, the controlling influence of offshore bathymetry, coastal configuration and regional topography on wave generation and approach¨.

In the report prepared by Mr. Jeffrey Spooner, from the Meteorological Services (Annex 4), the results of Hendry, (1979) are confirmed, and a characterization of the land and sea breeze regime, as well as of the trade winds.

From the analysis of wind rose data for Palisadoes, the following results, of particular practical interest for this project, may be synthesised:

At Palisadoes, the Sea Breeze (trades plus local thermal sea breeze) is evident year round but is strongest in June, with a predominant direction from East-Southeast (105 to 125 degrees). (See Table 3-1, Annex4).

East Direction, (075 - 105 degrees) represents days when the magnitude of the trade is relatively greater than normal, directions South-East (125 - 145 degrees) represents days when the magnitude of the local sea breeze is greater than normal, (Table 3-2(a), Annex4).

Winds from the East-Southeast are strongest all months even though North (345 to 015 degrees) winds have a higher frequency of occurrence in November, December and January. An interesting point to note is that winds from the North occur in June (Fig. 3-2f, Annex4). But June has the lowest frequency of winds occurring from the North. The four months- May, June, July and August- record 48% of the occurrences from East-Southeast and 19% from North, while November, December and January record 12% from East-Southeast and 36% from North.

Table 3-2, (Met. Service. Annex 4)

		E.S.E.	N
May, June, July, August	-	48%	19%
November, December, January	-	12%	36%

Which seems to mean that in summer the trades as well as local sea breeze are more persistent. In winter the average duration of the sea breeze is less, resulting in a higher frequency of North winds.

Very light winds (1-3 Knots and Calms), occur most nights from North West through North (305-010 degrees). (Figure 3-2m) shows that 4328 of 8586 occasions or 50.5% of the times when light winds were reported, they were from these directions. Calms also occur mainly at nights and in April and November. (Table 3-2 (last column), Annex 4).

In June the sea breeze persists until late evenings or sometimes throughout the night, thus reducing or cancelling the influence of the mountain wind. April and November then represent the transition months between persistent cool night winds from the hills and warm sea breeze from the East-Southeast.

Taking into consideration the correspondence between the occurrence of trade winds and the generation of swell waves, and using information from the SSMO Jamaica South area, Hendry (1979) shows periods between 6 and 9 sec, although they may occasionally be longer.

"Wimpey Laboratorios Ltd. (1973), presented data only on the higher waves that were recorded at Cow Bay. These had periods ranking between 5 and 9 seconds, in an area where refraction effects are felt. Frequent observations of swell at the section of the Palisadoes which is closest to deep water (Hope River area) has shown that the most common swell wave period is one of 8 seconds (measured visually, using a wrist watch with timing attachment)".

"Swell wave height cannot be separated from the Cow Bay or SSMO data with any reliability. However, visual observations show that swell waves in deep water are low, from approximately 0.2 m to 0.8 m high".

Hendry (1979), emphasises that ¨the swell waves period increased during growth of the sea breeze, decreased slightly as the wind speed weakened, and remained nearly constant as the wind speed normal to the coast continued to fall¨. He suggests that the swell waves at the Palisadoes may respond to the sea breeze in a similar fashion.

It should be pointed out that during the 26 days of work at sea of the field trip in December 2006, it was corroborated the diurnal occurrence of the sea breeze. It was object of special observation that in 10 occasions when the work began in swell wave conditions, the sea breeze increased its speed in a short time, causing the increase in wave height without essentially changing its direction of approach; even in some days when swell wave direction was between East-Northeast and East, and the breeze came clearly from East-Southeast.

The currents roses represented in figures 1 and 2 correspond to the records of the current meters placed in stations 1 and 2, near shore at 7.2 m and 7.3 m deep respectively, at a 2.5-m separation from the bottom (See location in sheet 1).

In both stations it is observed the formation of two fields of directions that are predominant and opposite, oriented almost parallel to the coast, in correspondence with a typical regime of currents induced by the tide flow and ebb.

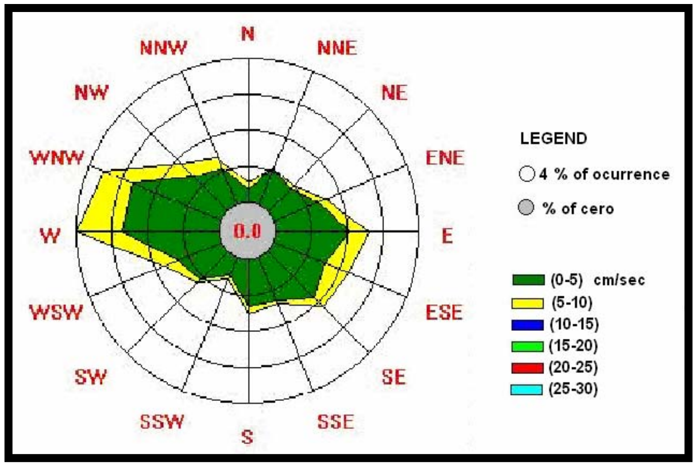


Figure 1. Currents rose for station 1 located near shore.

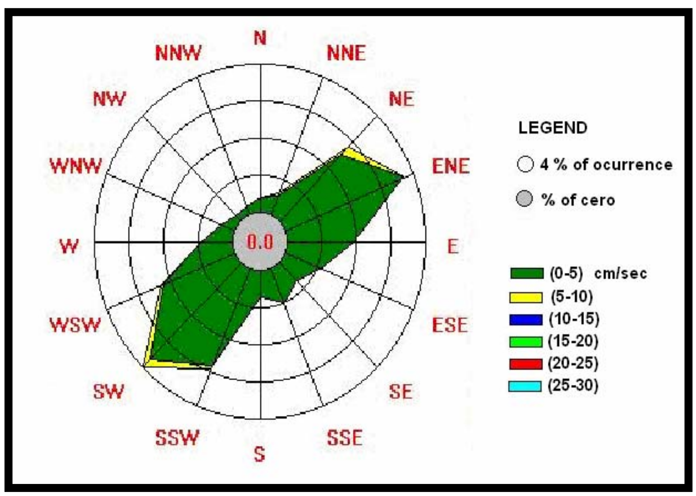


Figure 2. Currents rose for station 2 located near shore.

However, in station 1 it may be observed that West and West-North-West directions appear with a frequency of occurrence somehow higher than those of the opposite directions from East and East-Southeast, probably indicating the influence of the current strengthening westward, influenced by the breeze.

In the case of station 2, it is also noticed the strengthening of the occurrence of directions with the West component, but it is less significant. In both cases the recorded speeds were mostly in the range of 0-5 cm/sec, and only in the case of station 1 the records between 5-10 cm/sec reached 25%; thus proving that, in spite of the strong breeze generated during those days, the current speed turned out to be relatively low.

As explained above, the influence of Palisadoes habitual regime of trade winds and breezes on the morphodynamics of the beach profile causes the continuous sediment exchange between the submarine slope and the berm, but significant long-term morphological changes are not observed.

Nevertheless, historical evidence, and particularly those provided by Hurricane Ivan, support the statement that tropical cyclones cause sever transformations in the tombolo, mainly the formation of breaches.

Keeping in mind the particular significance of cyclones in the evolution of the Palisadoes, a study is included on the surge and wave that an event of such nature may unleash.

IV. 3. Storm surge and waves caused by tropical hurricanes

Countries and states affected by Atlantic tropical systems ranging from depressions and tropical storms to category five hurricanes (Saffir-Simpson scale) include the US Gulf States, the Caribbean Islands, and Gulf and Caribbean coasts of Mexico.

Impact of hurricanes on these countries may be enormous especially on the economy of small islands like Jamaica.

Jamaica is located in the hurricane belt, and the official hurricane season runs from June 1 to November 30, with August and September being the peak months.

Hurricane-related severe phenomena are strong winds, rain, waves and storm surge, the last two producing frequent coastal floods everywhere when hurricanes strike, especially in low coastal areas.

Wind wave effect is important in deep water and decreases in shallow water, while storm surges become fundamental in shallow water.

Storm surge is simply water that is pushed toward the shore by the force of winds swirling around the storm. This advancing surge combines with the normal tides to create the hurricane storm tide, which can increase the mean water level in 4 meters or more.

In addition, wind driven waves are superimposed on the storm tide. This rise in water level can cause severe flooding in coastal areas, particularly when the storm tide coincides with the normal high tides. Due to the fact that much of the Caribbean coastlines south of Palisadoes Peninsula lie less than 3 meters above mean sea level, the danger from storm tides may be tremendous.

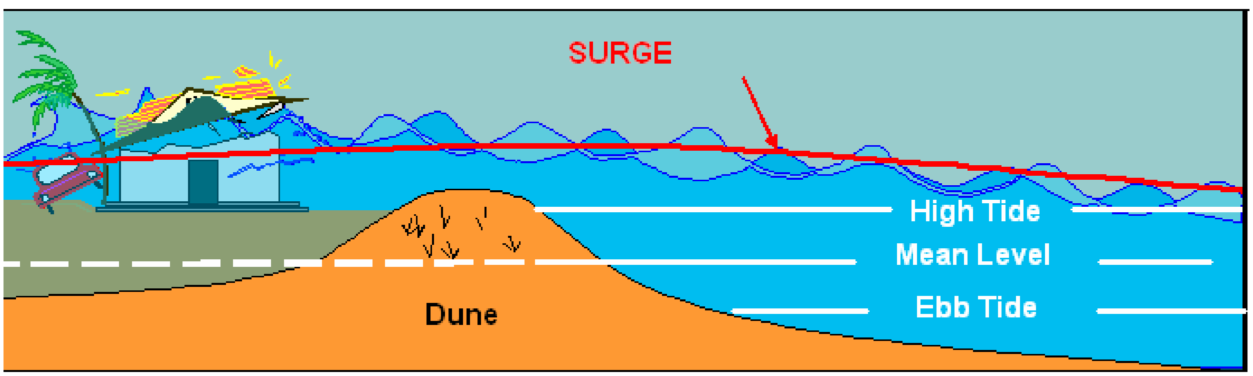


Figure 3. Schematic representation of the storm surge.

Surge level in a particular area is also determined by the submarine slope of the shelf. A shallow slope off the coast will allow a greater surge to inundate coastal communities.

Communities with a steeper submarine shelf will not see as much surge inundation, although large breaking waves can still present major problems. Storm tides, waves, and currents in confined harbours severely damage ships, marinas, and pleasure boats.

Storm surge is an abnormal rise in sea level accompanying a hurricane or other intense storm, and whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the cyclone. This dome of water (often 50-100 miles wide) sweeps the coastline near where the hurricanes eye makes landfall, or when hurricanes move parallel to the coastal line.

Storm surge is usually estimated by subtracting the normal or astronomic high tide from the observed storm tide. When storm surge is combined with a normal astronomical high tide, a storm tide is created. With the added effect of battering waves, the storm surge causes 9 out of 10 hurricane fatalities, but because of improvements in forecasting, the spread of information and timely evacuations (all coupled with a little luck), the number of fatalities from hurricane storm surge has been drastically reduced over the past 30 years. However, the element of risk is always there.

With the enormous increase in world coastal populations, it is more critical than ever to understand the risks from hurricane storm surge; and more importantly, heed the warnings and evacuation orders given by local emergency management officials.

The rise in water, coupled with the battering waves on top of the elevated water level is the reason that sometimes millions of people are urged to evacuate their coastal homes. Storm surge and wave action is shown in figure 3.

Storm Surge Return Period — Definitions and procedure

Storm surge return periods are useful to land use planners and emergency managers for assessing the likelihood of extreme water depths associated to tropical cyclones. At a given location, it is desirable to determine sound statistical estimates of return periods (typically for 10, 25, 50 and 100 year periods). The goal is to determine statistical estimates that provide the best scientific prediction of return period. Uncertainties include both limitations in the historical record and effects of parameter estimation. The corresponding standard error embodies uncertainties associated to limitations in the historical record and parameter estimation. In this report, MONSAC model (Pérez

Parrado, (2003)) is used for estimating maximum storm surges. This general approach is illustrated with 4 points in Jamaica's Palisadoes Peninsula.

It starts from the notion of an "N-year return period," recognizing that descriptions and definitions should be adaptable to other time horizons. At a given site, X meters is assumed to be the storm surge height of N-year return period. The following represents a potential interpretation of X meters, and hence, suggest the potential definition.

1. It is expected to see in the next N years at least one storm that produces an X meter storm surge.

The goal of this study is to use the historical storm data set (HURDAT), in conjunction with MONSAC model to predict the storm surge height distribution for given time frames. HURDAT is a database of historical tropical storms in the Atlantic Ocean developed by the US National Hurricane Centre. MONSAC is a computer-based numerical model that produces estimates of storm surge height at the coastline for any coastal area. This general approach is illustrated for 4 points in Jamaica's Palisadoes Peninsula (Figure 4), for different time periods of the year.

Steps of the procedure:

1. Extract relevant historical storm information from HURDAT covering the 1851-2005 period (a total of 1318 storms over 155 years).
2. Extract relevant historical storm information from HURDAT covering the 1851-2005 period (total of storms impacting the selected point in Jamaica over 155 years).
3. Compute in descendent storm intensity the historical information to determine preliminary probabilities.
4. Fit the data set to Weibull distribution function to estimate return periods for tropical cyclones.
5. Run the MONSAC model for storm surge calculations and record the observed storm surge at the selected site.

Figure 4. View of the four points chosen for modelling in Palisadoes Peninsula.

Once storm surge values have been computed and the statistical analysis performed, it will be possible to estimate the storm surge corresponding to a variety of return periods. It is used the Peak Over Threshold Method, which requires the identification of storms passing within a user-specified distance from the location of interest. In this study it was defined a radius of 100 km for calculations.

The data set was subjected to fits by a number of different probability distributions, using the Curve Expert Fit package (Hyams, 2005), by means of which a variety of distributions was obtained. Among the distributions considered, Curve Expert suggested that the Weibull distribution provided the most reasonable representation of the data. The Weibull density function is given by:

$$f(x) = a - b * \exp(-c * x^d)$$

in which a, b and c are related to scale, shape and location parameters.

The case study was carried out for the Palisadoes Peninsula (four points), and in particular at Gunboat-Terrace sector. Storm surge computing was carried out using both MONSAC model with a long-term maxima approach, and the generic model, with a peak-over-threshold approach.

From this representation, we have the following maximum likelihood estimates (MLE) for storm surges in the Palisadoes Peninsula (see Tables 2, 4, 6 and 8).

MLE value is in the centre or middle of the distribution of future extremes. Using table 2 as a guide, a structural design engineer could propose that an asset located at this site ought to be built to survive a 4.49 meter storm surge for a 50-year return period to achieve a 95% prediction limit level. Building to survive a 3.59 meter storm surge has about a 50-50 chance of being inadequate. The difference between the 3.59 and 4.49 meter surge values reflect the inherent uncertainty in predicting return period values.

Case 1: Airport (Near Plumb Point) 17.91N-76.77W

Table 1. MLE Storm surge return periods for tropical cyclones from TT to category 5 Saffir-Simpson scale.

Category	Return Periods (Years)
TT	3.9
C1	7.1
C2	12.9
C3	21.2
C4	40.3
C5	130

Table 2. Storm surge results (meters): Maximum Likelihood Estimates and Upper Prediction Limits for 10, 25, 50 and 100 year return periods

Return Period	Storm Surge based on MLE Estimates	Storm Surge, Upper Prediction Limit (95%)
10 years	1.23 m	1.73 m
25 years	2.24 m	3.07 m
50 years	3.12 m	4.03 m
100 years	3.76 m	4.78 m

Case 2 (Palisadoes) 17.93 N-76.75 W

Table 3. Return periods by hurricane category

Category	Return Periods (Years)
TT	3.95
C1	7.09
C2	12.94
C3	21.24
C4	40.3
C5	130

Table 4. Surge by return period

Return Period	Storm Surge based on MLE Estimates	Storm Surge, Upper Prediction Limit (95%)
10 year	1.25 m	1.74 m
25 year	2.45 m	3.28 m
50 year	3.49 m	4.39 m
100 year	4.19 m	5.22 m

Case 3. (Palisadoes) 17.93 N-76.73 W

Table 5. Return periods by hurricane category

Category	Return Periods (Years)
TT	3.75
C1	6.74
C2	12.31
C3	20.2
C4	38.4
C5	124

Table 6. Surge by return period

Return Period	Storm Surge based on MLE Estimates	Storm Surge, Upper Prediction Limit (95%)
10 year	1.15 m	1.64 m
25 year	2.19 m	3.01 m
50 year	3.02 m	3.92 m
100 year	3.59 m	4.72 m

Case 4. Caribbean Terrace 17.93 N-76.71 W

Table 7. Return periods by hurricane category

Category	Return Periods (Years)
TT	3.75
C1	6.74
C2	12.31
C3	20.2
C4	38.4
C5	124

Table 8. Surge by return period

Return Period	Storm Surge based on MLE Estimates	Storm Surge, Upper Prediction Limit (95%)
10 year	0.95 m	1.44 m
25 year	1.96 m	2.86 m
50 year	2.88 m	3.69 m
100 year	3.47 m	4.60 m

As explained above, storm tides are storm surge plus astronomical tides, thus being obvious that when high astronomical tide coincides with storm surge the effects on coastal areas are worse.

Maximum Astronomical tides in Palisadoes appear to be around 30 cm and must be included in the final sea level estimates.

Jamaica's experience with Hurricane Ivan:

Hurricane Ivan was a powerful hurricane category four in the Saffir-Simpson scale. Although not making landfall in Jamaica, Ivan resulted in fourteen deaths, and caused damage across the island, with southern parishes suffering the greatest damage. One of the more significant destructive aspects of Ivan was the storm surge generated along the South coast of the island. Storm surges of 2-4 meters in some locations caused extensive damage to natural coastal systems and housing, and were responsible for several deaths. Wind damage to vegetation and roofs was also severe, particularly at higher elevations.

Ivan modelling shows that the storm surge rose up to (2.32)- (2.40)- (2.50) m when it crossed South of Palisadoes, and (2,25) m for Caribbean Terrace. The estimated return period for a hurricane like Ivan based on wind data is 90 years. Initial data were:
Date 09/11/06 GMT
Category 4 SS scale
Location 17.4 N-77.4 W
Winds 230 km/h

Pressure 926 hPa

Motion speed 19 km/h

Caribbean Terrace to Gunboat Wind Wave Modelling

Wind Driven Waves superimposed on the storm tide may aggravate the situation in the selected site. Surge and battering waves can cause severe damage in coastal zones, the analysis of wind waves produced by hurricanes is shown in figure 5. Modelling hurricane waves using SWAN model with 6-meter wave in shallow–deep water boundery shows that the wave attenuation is substantial and waves of less than 1.5 meters arrive at the peninsula (Figure 5), but they reach 2.5 meters near Caribbean Terrace.

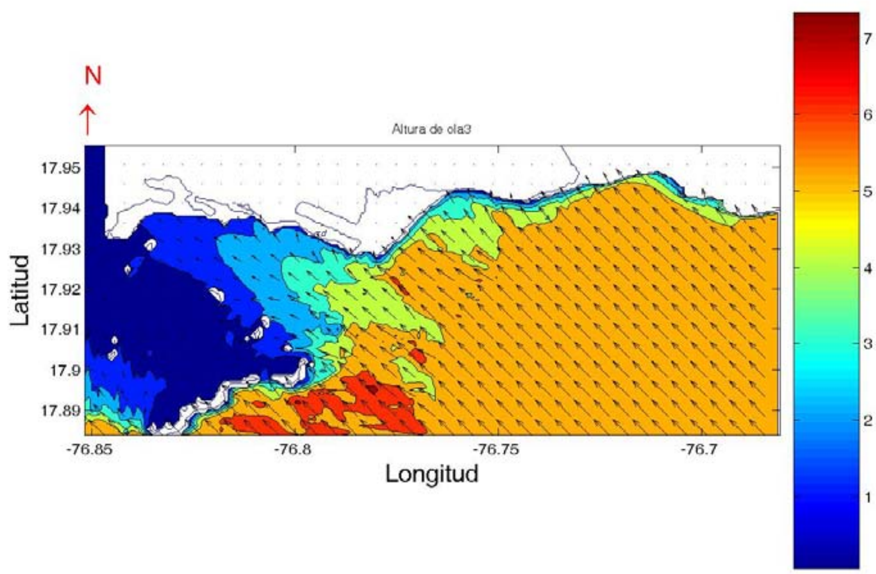


Figure 5. Wave height distribution for the shallow water in front of Palisadoes Peninsula, (6-meter wave in shallow–deep water boundery).

But for a category 5 hurricane (12-meter waves in the boundary), waves in the eastern area of Palisadoes reach 3 meters, and in Caribbean Terrace they reach 5 meters near shore (Figure 6), increasing the destructive potential of the sea.

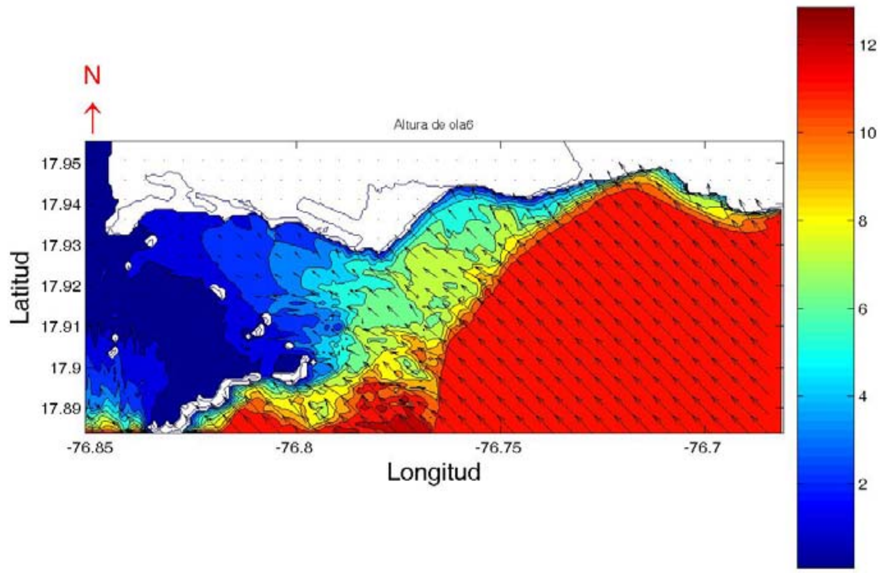


Figure 6. Wave height distribution for the shallow water in front of Palisadoes Peninsula, (12 meter waves in the boundary).

From the analysis it is evident that, for most of the sector, storm surge is the main component in flooding and destruction.

These calculations show that waves attenuate in shallow waters south of the peninsula, and they are less significant than in deep water; but they can complicate the situation, because battering waves superimposed on surges produce strong impacts on targets. In the case of Caribbean Terrace, waves become more important and combined with storm surge they are very dangerous, as it occurred in Hurricane Ivan in 2004.

The analysis shows that waves coming from the South and Southeast are the most dangerous for Caribbean Terrace and the eastern sector of the peninsula.

Therefore, it may be concluded that storm surges and wind waves may cause severe damage to lives and properties in the coastal study area. In the case of storm surges, experience shows that from the statistical point of view it is advisable to use estimates of at least 95 % reliability; consequently, the protection structure for the selected sector must be not less than 5 meters high, for a 100-year return period.

IV. 4 Sediment Transport Modelling

It is known that sediment transport occurs in a given fashion that results from the interaction of hydrodynamic processes with coastal zone configuration, bathymetry and sediment characteristics. Accordingly, the interpretation of sediment transport patterns contributes to a better understanding of coastal accumulation and erosion processes.

With the intension of verifying the interpretation of accumulation and erosion processes carried out on the basis of morphodynamic variations and hydrodynamic characterisation of Palisadoes in epigraphs above, it is decided to apply mathematical modelling to sediment transport.

Numeric simulations were carried out for wave transformations in its propagation from indefinite depths to the coast. Starting from those results, the field of currents induced by wave breaking was modelled, and with those results, both the wave field and the breaking current field, sediment transport was simulated.

For that purpose it was used the Coastal Modelling System (CMS, 2005), graphic interface developed by the University of Cantabria, Spain. This interface integrates a series of numeric models, among which stand out:

- Oluca: wave propagation model, based on the “mild slope equation” or Berkhoff’s equation (1972).

- Copla: beach current model, numeric model that solves flow equations within the breaker area. It takes as input data those resulting as wave field output data, calculated using Oluca model.

- Eros: bi-dimensional and horizontal model for beach morphologic evolution that solves the equations for sediment flow within the breaker area, as well as the changes in bathymetry associated to spatial variations of sediment transport. It takes as input data those resulting as output data from Oluca and Copla models. This model allows to know, in a rapid fashion, the initial erosion-sedimentation trend of a beach subject to given hydrodynamic conditions.

Under habitual wave conditions, that is to say the annual mean conditions, the beach profile is maintained in “equilibrium”, until a change in hydrodynamic conditions causes the alteration of that equilibrium, with which large sediment volumes move cross-shore and alongshore.

To simulate wave transformations, breaking currents and sediment transport, the propagation was calculated for extreme wave (H=6m, T=10s), corresponding to the characteristics of a hurricane of similar category to that of Ivan, in the South and South-East directions. In the case of the Southeast direction, it was also included the modelling of sediment transport for habitual wave corresponding to the SSMO data used by Hendry, (1979); that is to say (H=1m, T=6s) that annual mean values may be considered.

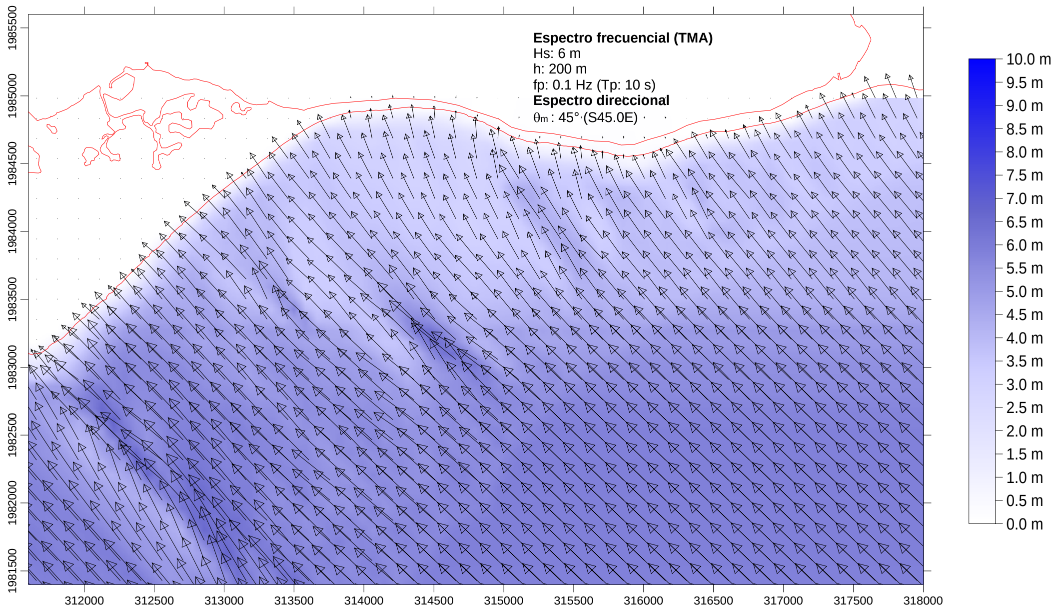


Figure 7. Significant wave height + magnitude vectors. Southeast direction.

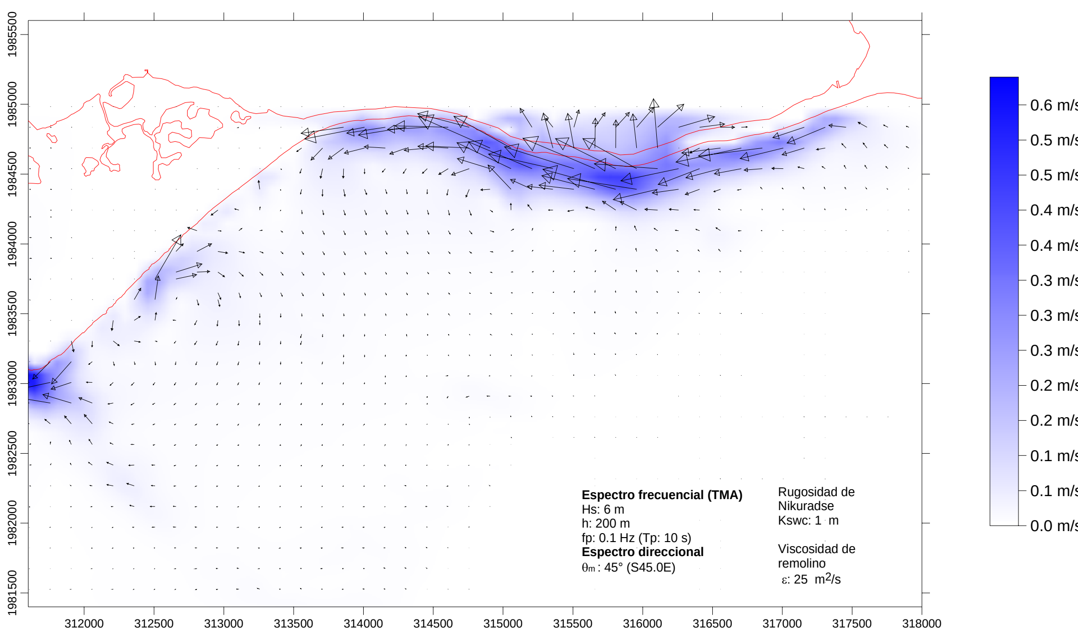


Figure 8 . Current vectors. Southeast direction.

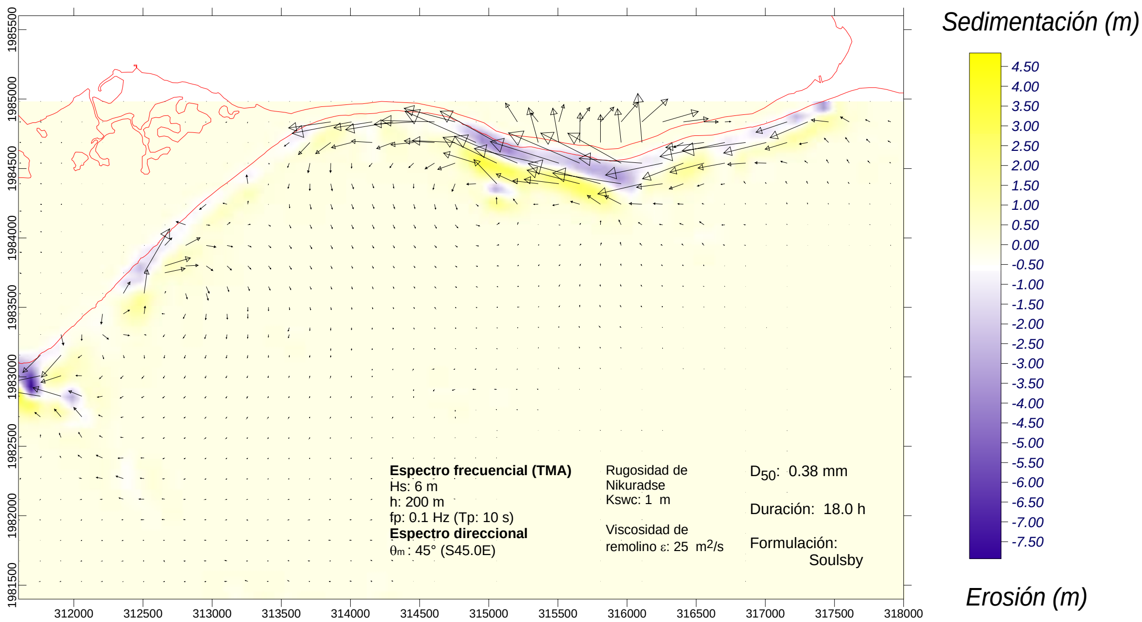


Figure 9 . Current vectors. Sedimentation-erosion trend. Southeast direction.

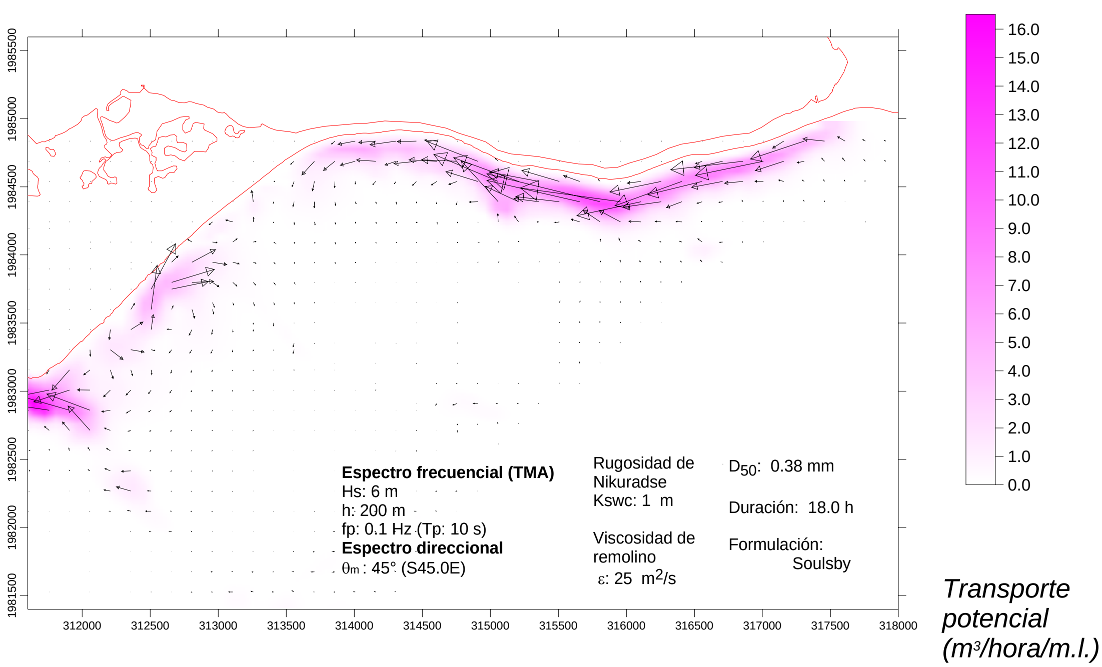


Figure 10 . Graphic of combined transport and magnitude vectors. Southeast direction.

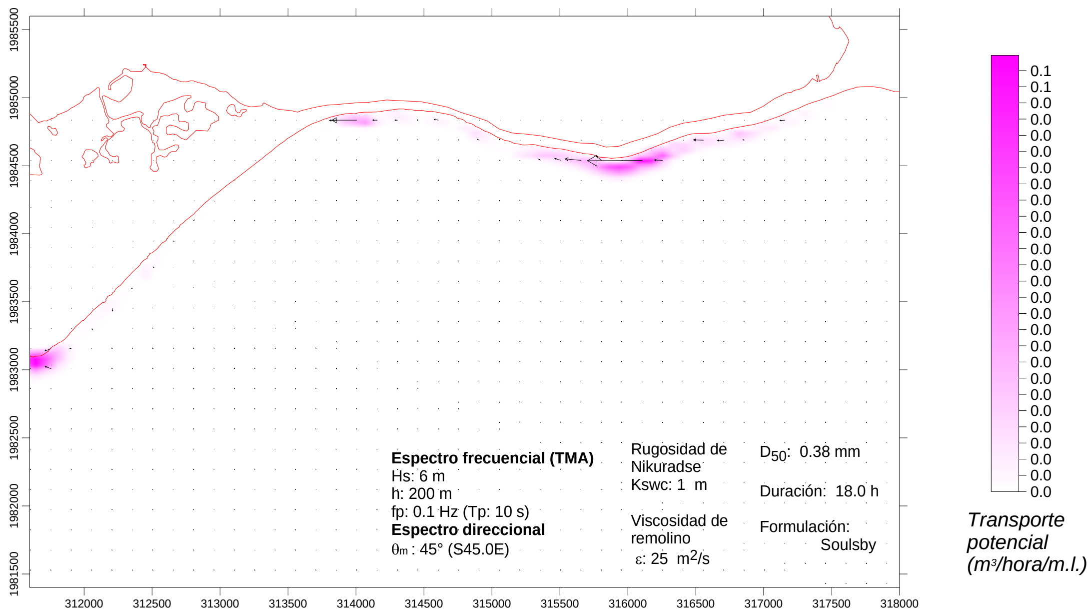


Figure 11. Graphic of combined transport and magnitude vectors. Southeast direction. Hs = 1m, T= 6 sec.

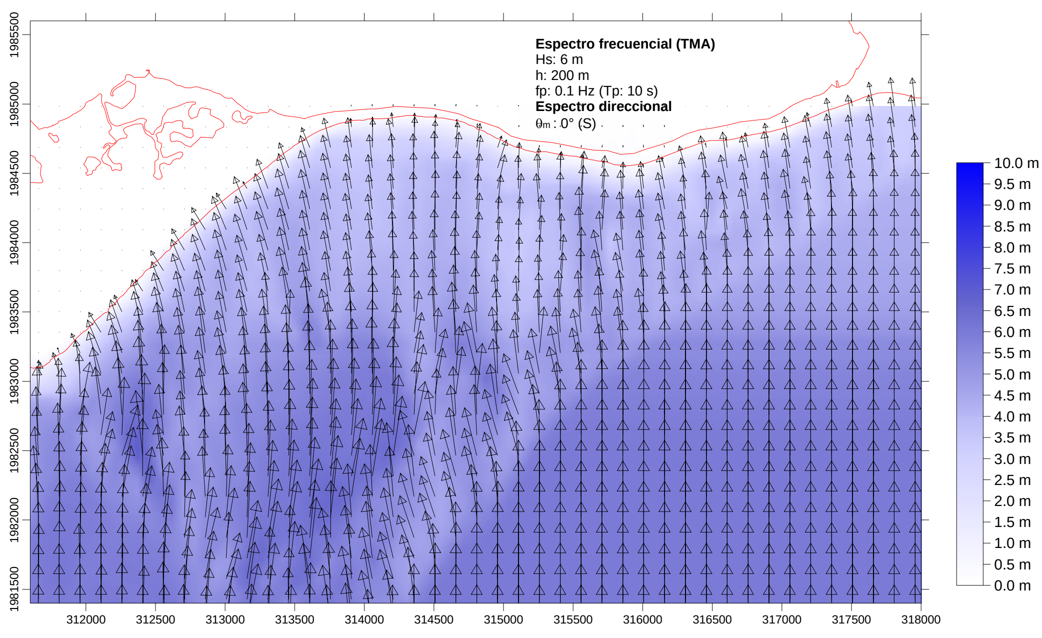


Figure 12. Significant wave height + magnitude vector. South direction.

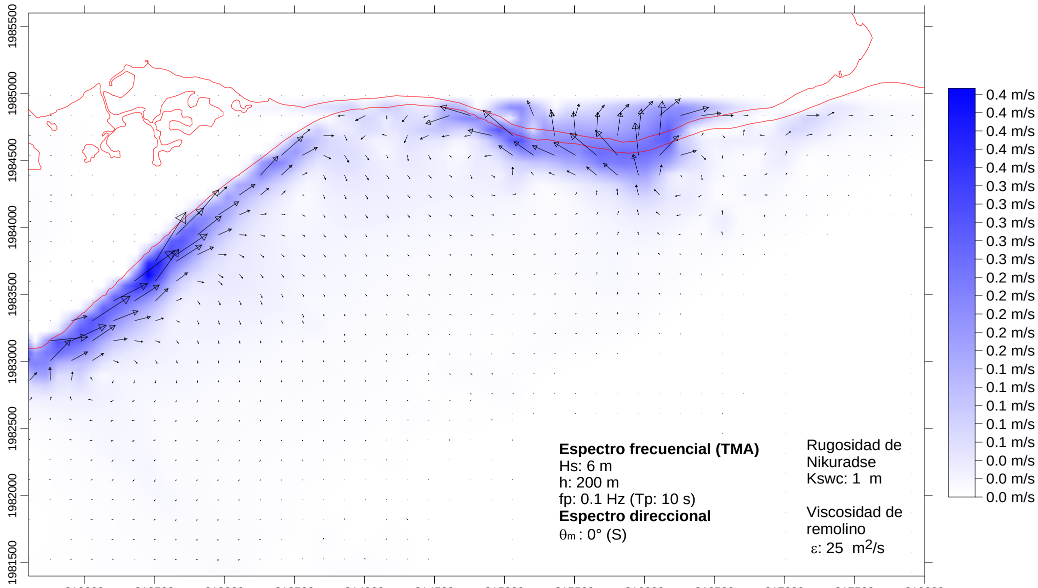


Figure 13. Current vectors. South direction.

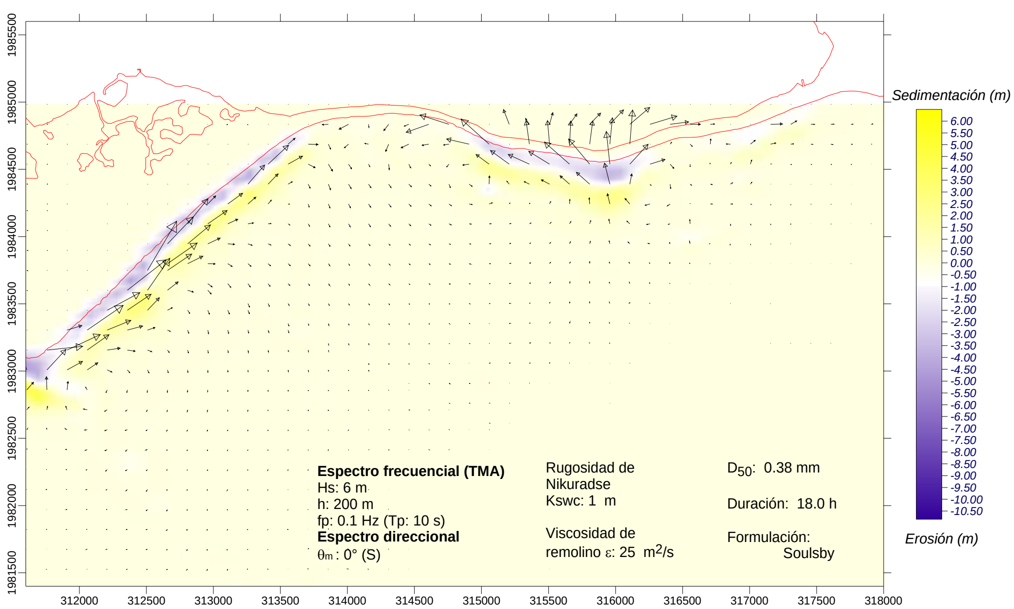


Figure 14. Graphic of current vectors. Sedimentation-erosion trend. South direction.

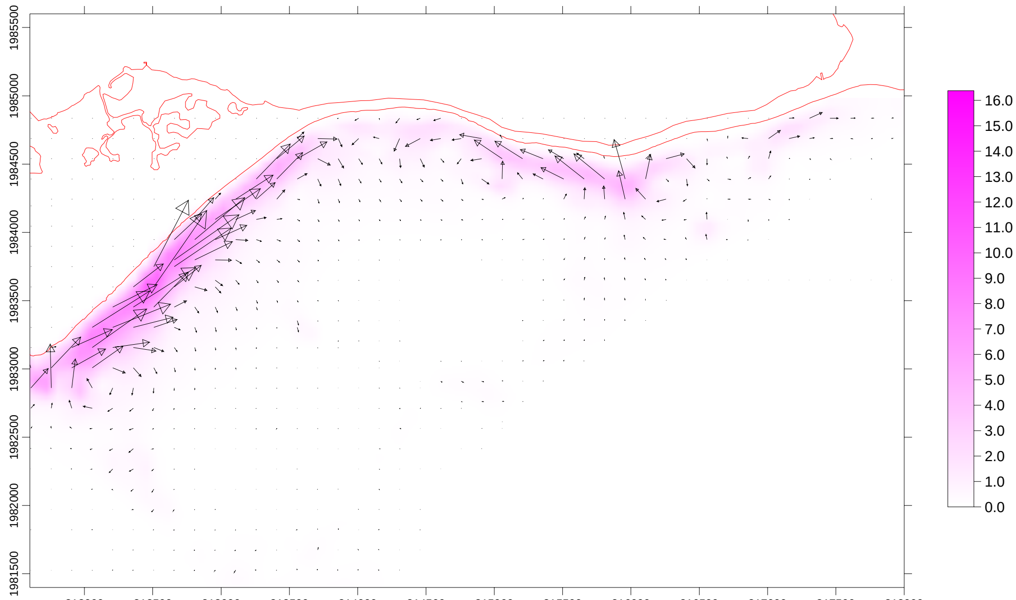


Figure 15. Graphic of combined transport and magnitude vectors. South direction.

The modelling sequence for Southeast direction in hurricane wave conditions, shown in Figures 7 to 10, allows drawing attention to the maximum energy concentration in the central sector of eastern Palisadoes. In the model for currents, (Figure 8), as well as in the sedimentation-accumulation model, (Figure 9), intensity vectors are increased in that area, showing a clear trend to the overtopping of material toward the inner part of the Harbour.

In the case of modelling in South direction conditions, (Figure 12), it is observed the increase in energy concentration in the sector due East of Plumb Point, and the increase in potential transport vectors, (Figure 14), from that area eastward, to create a convergence zone in the Palisadoes most critical area. It is very probable that such convergence constitutes an indicator of the sand transport process that occurs offshore during storms, which is not represented in the model. The generation of this type of transport has caused the formation of the large sand deposit found in the submarine slope during the field trip in December, which was formed due to the existence of a basin that acts as a sediment trap.

In the case of the sediment transport model applied to habitual conditions of Hs= 1 m, and T= 6 sec, in Southeast direction, (Figure 11), it may be observed that the potential transport magnitude is significantly reduced in the eastern end of Palisadoes adjacent to Caribbean Terrace, and it is only increased a little in the central part, which is in correspondence with the current records obtained during the field works.

The results reached through this project constitute a contribution to the understanding of coastal processes in the Palisadoes, and they essentially corroborate the schemes developed by previous works. It should be pointed out that the project has generated a volume of information that deserves to be processed with greater rigour in the framework of future research works, and especially for the purpose of maintaining a monitoring system on the evolution of the tombolo.

IV. 5. Assessment of the Erosive Processes

According to the results analyzed in epigraphs above, it is possible to synthesize the following basic ideas on the erosive process that Palisadoes is undergoing:

First of all, it should be highlighted that the erosive process in Palisadoes most critical sector is mainly characterized by the transfer of sand from the dune toward the inner part of Kingston Harbour, due to hurricane-caused surge and wave. This process became evident with the occurrence of Hurricane Ivan in 2004. (Picture 9).

Picture 9. Transfer of sand from the dune toward the inner part of Kingston Harbour produced by Hurricane Ivan in 2004.

It is very probable that the present evolution observed in Palisadoes is, to a certain extent, a demonstration of the coastal zone response to sea level rise caused by Climate Change; although other factors, like the increase in hurricane occurrence in recent years and the possible deficits in natural sand inputs to the coastal system, may also constitute causes of the process.

The suspicion that there are deficits in present sand inputs is justified when taking into account the mining activity developed in the basins of the rivers that supply sediment to Palisadoes. Hendry, (1979), reports mining in Hope River basin of the order of 900 000 cubic yards per year, 30 000 in Chalky River, and 200 000 in Yallahs River.

It is reasonable to think that in a system where all factors function negatively, the system's defence mechanism is to self-regulate the sediment balance by means of the erosion of cumulative forms, that is to say the dunes and beaches.

The interpretation of Palisadoes erosion process has been fundamental to be able to evaluate engineering alternatives for its protection, understanding that the physical destruction of the tombolo constitutes the most severe environmental impact that Palisadoes may undergo.

V. STRATEGY FOR THE PROTECTION OF THE PALISADOES

Keeping in mind the intensity of the erosive process that the Palisadoes tombolo is undergoing, and in particular the high vulnerability of the road after the impacts of Hurricane Ivan, it is evident that Palisadoes requires the application of management and protection measures that respond not only to a strategic vision for its development, but also to the urgent need of avoiding the formation of breaches and the breakage of the road.

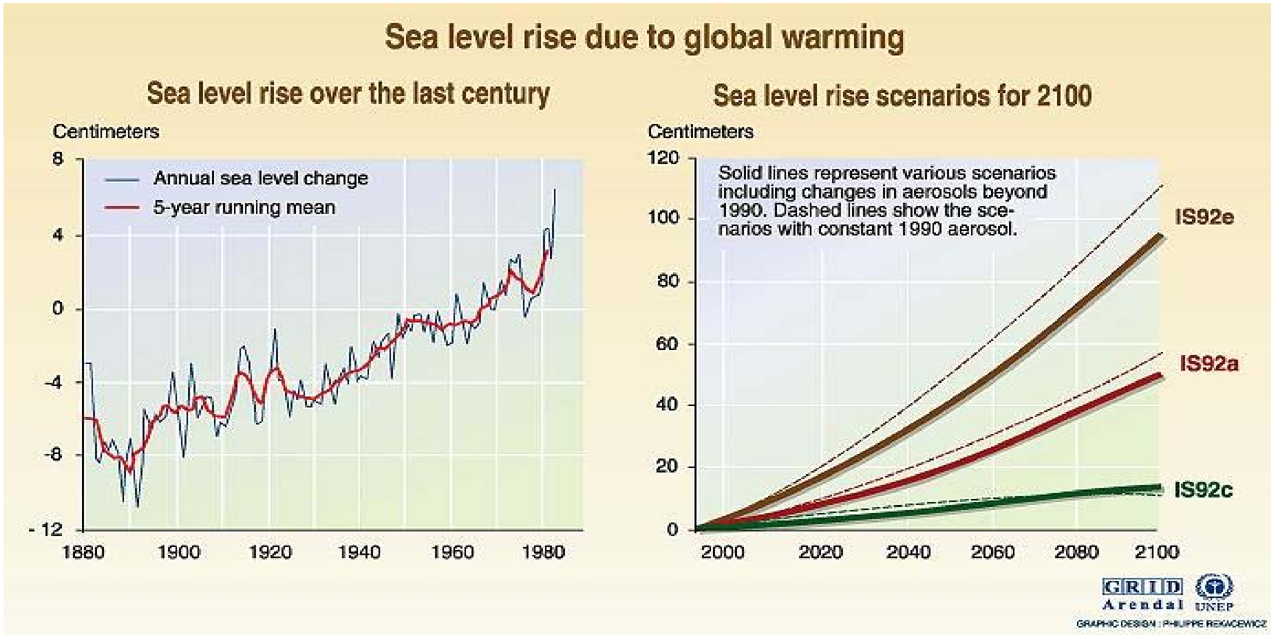
The evaluation of long term measures is inserted in an Integrated Coastal Management Program that focuses on engineering as well as on environmental and socioeconomic aspects of Palisadoes, described in the Terms of Reference, (Lyn and Thompson, 2005).

In an integral analysis of Palisadoes development, the tombolo's vulnerability to the occurrence of earthquakes is an element of fundamental importance. Although the knowledge of the area's seismic activity requires of more thorough investigations, it is unquestionable that the existing information justifies including this element in all the risk analyses of the existing infrastructure and of future investments, even in the case of works for coastal defence against hurricanes.

Another element of vital importance in the conception of a long term program for Palisadoes development is the continuous sea level rise that occurs as a consequence of Climate Change.

According to the Intergovernmental Panel for Climate Change (2006), global warming measurements hint at the occurrence of the worst scenarios modelled to forecast these changes. As it can be appreciated in the figure 16, in the most critical scenario the sea level will rise up 1 m in next 100 years, enough to affect extensive coastal territories.

From the point of view of planning for territories threatened by the sea level rise, the adaptation strategy constitutes one of the options recommended by the Intergovernmental Panel for Climate Change (2006) and it consists of the gradual and orderly abandonment of socioeconomic activities in the threatened areas.



Source: Climate change 1995, The science of climate change, contribution of working group 1 to the second assessment report of the intergovernmental panel on climate change, UNEP and WMO, Cambridge university press, 1996; Sea level rise over the last century, adapted from Gornitz and Lebedeff, 1987.

Figure 16. Different future scenarios estimated in the early 1990's predict a rise in up to one meter by the end of the XXI century.

The analysis for the application of the long term adaptation strategy in the case of Palisadoes would mean to consider the relocation of vital economic objectives such as the airport.

According to the elements considered, it is reasonable to reserve Palisadoes's areas in development for the population's recreational and leisure time activities, minimising new investments vulnerable to earthquakes and hurricanes.

This idea is strengthened by the fact that Parliament declared the entire Palisadoes and Port Royal Cays to be a Protected Area since 1998, under The Natural Resources Conservation Authority Act, leading to the application of more rigorous management measures.

V. 1 Construction of a new road.

The definition of long term engineering solutions should be conciliated with the planning measures that will be included within an Integrated Coastal Management Program and with Palisadoes condition as Protected Area.

However, it is evident that in a short and medium term the Management Program for Palisadoes will continue considering the protection of the only access road to Port Royal and the Norman Manley Airport as a vital and prioritised action.

Within this concept of priority and taking into account the continuous sea level rise predicted for next decades, it is reasonable to think of the construction of a new road on the North side of the existing one, increasing its level in about 2.0 m and incorporating a drainage system that allows water pass toward the inner part of the Harbour at times of severe sea penetrations.

With the new road Palisadoes would have a first defence level constituted by the beach and dune and a second level at the height of the current road, thus guaranteeing the functioning of the new access road to Port Royal and the airport even under the effect of a significant increase in sea level.

V. 2 Urgent Measures

The urgent solutions that are proposed have been conceived in such a way that they ensure an effective protection of 5 km of coast before the occurrence of an extreme erosive event of the category of Hurricane Ivan; while for their typology, location and materials used, they do not compromise future evaluations of the use and protection of Palisadoes.

As it was explained in the chapter IV, Palisadoes current vulnerability has been caused by the intense erosion process that its natural dune has been undergoing through several decades, as a consequence of the impact of hurricanes and particularly because of the pass of Hurricane Ivan in 2004.

According to the Classification Of Coastal Engineering Problems considered in the Shore Protection Manual from Army Corps USA, (1984), (fig.17), Palisadoes protection can be understood as a Shoreline Stabilization and Backshore Protection.

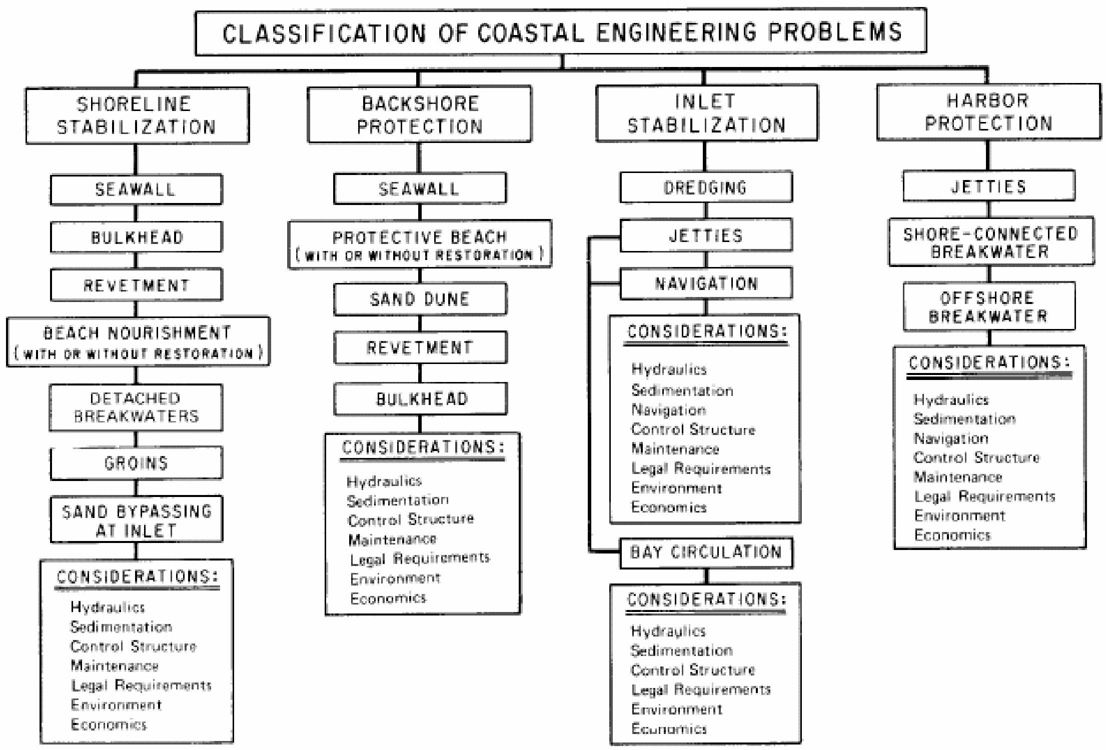


Figure **17. Classification of coastal engineering problems. (Shore Protection Manual. USA)**

Keeping in mind that in Palisadoes there are 5 km of coast characterised by the dune and beach formation that should be immediately protected, the most advisable option is dune reconstruction.

The possibility to have sand deposits very near Palisadoes critical sector reduces sand transportation costs by using a trailing suction hopper dredger, thus minimizing collateral damages to traffic and viability caused by the transportation of large sand volumes, and reducing the execution time of the work.

Taking into account Palisadoes current situation, the application of artificial sand nourishment has the following advantages:

- It is the only alternative that ensures the construction of an effective protection for 5 km of coast in a term not longer than 6 months.

- It is a solution totally compatible with the natural characteristics of Palisadoes.

- For its durability, it is a medium term solution alternative and the magnitude and frequency of its maintenance will be conditioned to the occurrence of extreme erosive events, whose return period varies from 3.9 years for a Tropical Storm up to 130 years for a hurricane of category 5.

- It is an alternative that does not compromise the application of other long term solutions.

As it is appreciated in pictures10 and 11, the work sector comprises a tract of 300 m where the proximity of the road to the coastline does not ensure that the mere dune reconstruction protects the road in case of the occurrence of a hurricane. For this sector it has also been conceived the construction of a quarrystone revetment.

Pictures 10 and 11. The more critical sector of Palisadoes.

Considering that it is an immediate action, it has been evaluated the option of building the revetment using boulder stones obtained from Yallahs quarry, (pictures 12 and 13), where there are stones with the required size and density at a distance of 23 km from the place.

Pictures 12 and 13. Availability of boulders in Yallahs quarry

Also as an immediate action, it has been considered convenient to incorporate to the project the filling of some breaches formed by Hurricane Ivan between the critical sector and Plumb Point, strengthening the dune's structure.

The evaluation of other engineering alternatives for the coastline stabilization and backshore protection of 5 km of Palisadoes, such as seawall, breakhead, revetment and groin, demonstrates that all of them present three fundamental inconveniences:

- They are not alternatives of immediate application because of the time required for the process of decision-making, projection and execution to protect 5 km of coast.
- They constitute hard solutions that, once executed, compromise significantly the long term decision-making.
- The collateral impacts on traffic and viability may be considerable.

V. 3 Short Term Measures

Once the dune reconstruction is executed, it will be necessary to reconstruct at least the groyne located in the most western position of the current field of groynes. This will contribute to coastline stabilization in the most critical sector.

Although the design and construction of new groynes in the most critical sector are being recommended as a measure to execute in a short term, the construction of the first groyne in the western end should be considered as a work to execute as soon as possible.

It can also be evaluated as a short term alternative the construction of 400 m of the new road in the most critical sector, which besides ensuring the long term protection of the access to Port Royal and the airport, may be considered as a pilot project to demonstrate the feasibility of this solution.

As part of the study carried out, it was included the coastal front of Caribbean Terrace, where Hurricane Ivan caused the almost total destruction of some 17 houses located on the first coast line. As it is appreciated in pictures 14 and 15, the ruins of the impacted facilities still remain there.

Pictures 14 and 15. Caribbean Terrace houses damaged by Hurricane Ivan in 2004.

The results of modelling the sea level rise due to storm surge and wave associated to tropical hurricanes (Chapter IV) demonstrate that due to its steep submarine slope the coastal sector of Caribbean Terrace is the most vulnerable in Palisadoes to the destructive effect of the wave.

Following the adaptation proposal of the Intergovernmental Panel for Climate Change, in this coastal sector it is most advisable to remove the remains of the destroyed facilities and to build in their place a seawall that protects the houses located on a second line.

The structure could be built with geotubes filled with sand and be covered by means of the construction of a properly forested artificial dune.

Another appropriate option is to build a seawall or revetment using concrete or stone structures in the same position, with the idea of taking advantage of this structure as a promenade, besides its usefulness as a coastal defence. Though this solution will probably be more expensive, it seems to be the most suitable for the residential vocation of Caribbean Terrace.

Regarding the need to conceive a protection measure for the coastal front corresponding to the end of the Norman Manley International Airport runway in Plumb Point, it should be pointed out that, due to the ground configuration and height, the risk of damages to the airport by surge and wave effect is reduced to a possible sea invasion caused by the occurrence of a category 5 hurricane. Therefore, in the conception of this project, priority was granted to a critical 5-km sector where a tropical storm of much lower category may cause the breakage of the tombolo, thus cutting off the access to the airport.

It is recommendable to prepare a risk study for the airport on the effect of extreme erosive events, with the information provided by this project as regards surge height in Plumb Point and the characteristics of the Palisadoes erosive process, before conceiving any coastal protection actions.

VI. DESIGN OF THE PROTECTIVE DUNE

VI. 1 Borrow area

a) Location

As borrow area it has been selected a marine sand deposit located very near the fill area, as can be observed in the maps of the location of the work area (Map, sheet 1) and of the barometric information (Map, sheet 2).

The area selected within the deposit extends in an elongated and narrow strip parallel to the coast, with a surface of 1.143 km^2. Following the projection of its central line, its length is 3 560 m and its width varies between 190 m and 430 m, allowing the execution of long dredging lines that guarantee a high efficiency in the work. Table 9 shows the coordinates that limit the extraction polygon.

Table. 9. Coordinates of the vertexes of the selected borrow area.

Limits of the borrow area (Datum WGS 84)				
Vertex	Easting (UTM)	Northing (UTM)	Latitude (N)	Longitude (W)
1	312256.09	1982838.59	17° 55' 31.84"	76° 46' 20.98"
2	312671.61	1982648.88	17° 55' 25.80"	76° 46' 06.80"
3	313902.85	1984034.37	17° 56' 11.24"	76° 45' 25.41"
4	314468.15	1984063.08	17° 56' 12.35"	76° 45' 06.21"
5	314904.97	1983925.01	17° 56' 08.00"	76° 44' 51.32"
6	315381.48	1983855.80	17° 56' 05.89"	76° 44' 35.11"
7	315371.84	1984040.68	17° 56' 11.90"	76° 44' 35.50"
8	314975.85	1984140.91	17° 56' 15.04"	76° 44' 48.99"
9	314292.73	1984468.76	17° 56' 25.49"	76° 45' 12.30"
10	313615.50	1984163.43	17° 56' 15.35"	76° 45' 35.22"

b) Depth and relief

As it may be corroborated in the map corresponding to bathymetric information, (Map sheet 2), the minimum depth of the borrow area is 11.8 m, with a maximum of 24 m and a mean of 16.8 m, resulting in a regular surface without irregularities in the relief or obstacles that affect the dredging, except for the presence of a submarine telephone cable.

In the bathymetric map of Kingston Harbour scale 1:20 000 of 1999, reference is made to numerous cables that are in disuse within the work area, and it may be observed that one of those cables crosses the sand borrow area; although it has not been possible to verify to date their permanence in the area and whether they are in operation. This is an issue that should be clarified before the execution of the project.

c) Sand volume

The bathymetric survey carried out with the Acoustic System DT-5000 allowed corroborating the existence of a sand deposit of over 1 m in thickness and appropriate relief characteristics to be selected as borrow area, (Annex 1).

The direct measurement of thickness by means of the use of a manual driller with a section of 1.65 m in 36 stations, and with a double section of 3.3 m in 21 stations, (Table 1, Annexe 2), shows that in 60.34 % of the drills the thickness measured was higher than 1.65 m, and higher than 3.3 m in 36.2 %. Only in two stations the measurements were different from those results, with 0.67 m in a vertex of the area and y 1.5 m in another station.

Taking into account that the distribution of the stations is practically random and assuming that the measurements were only of the exact length of the driller sections used, it may be ensured a conservative volume of 2 537460 m^3.

It should be explained that the objective of the sand deposit assessment aimed at finding the volume required for Palisadoes dune reconstruction project and not at a full quantification of the sand reserve. The search was restricted to a depth of up to 24 m and thickness values were always higher than 1.65 m and 3.3 m. Therefore, it may be expected the existence of a significantly bigger sand volume than calculated.

d) Sand composition

The results of the grain size analysis of all the samples obtained in the project, carried out by the Geology and Geography Unit of the UWI, appear in Annex 1.

For the specific case of the stations corresponding to the borrow area, it was prepared the Table 1, Annexe 2, that synthesises the characteristics of each station and includes the mean diameter of the particle in millimetres. The grain size spatial distribution in the borrow area is represented in Sheet 3.

In Table 1, Annexe 2, it may be confirmed that the mean diameter of the samples taken in the borrow area varies from a minimum value of 0.11 mm, corresponding to very fine sand, to a maximum of 0.89 mm, corresponding to coarse sand. Hence it is obtained a typical average sample of 0.32 mm that classifies as mean sand, according to Wentworth's classification, Shore Protection Manual, (1984). As it may be verified in Table 2, Annex 2, the Standard deviation ($\sigma\phi$) of most samples was between 0.5 and 1.0, with little difference between the samples corresponding to the borrow area and those from the dune.

As explained in chapter 4, both the macroscopic description of the sand composition and the analysis of thin sections of 15 samples from the borrow area, (Table 2, Annexe 2), demonstrate the predominance of material of terrigenous, non-carbonated origin, in correspondence with the characteristics of sediment formations in the region.

e) Suitability of the sand to use

The assessment of the suitability of the borrow area sand for the reconstruction of Palisadoes dune depends on its degree of similarity with respect to the grain size and composition of the native sand.

The macroscopic description of the sand of the dune along the Palisadoes demonstrates the homogeneity of the material in its whole extension, with the predominance of well-classified fine and mean sand of terrigenous origin. Table 10 shows the mean diameter (Md) of 3 samples taken from the dune, distributed in the fill sector.

Table 10. Sand samples from the dune in the fill sector.

Coordinates		Station	Samples	Md (mm)	Description 16
X (UTM WGS 84)	Y (UTM WGS 84)				
312543.78	1983974.39	L-2	L-2	0.28	Picture 17 Dune breach. Western limit. Critical Sector
312894.9	1984265.39	L-4	L-4	0.47	Picture Dune breach. Western limit. Critical sector
313771.18	1984885.65	L-5	L-5	0.38	Picture 18 Dune remains. Critical sector



Photos. 16, 17 and 18. Sand sampling in the dune.

In table 11 it has been included the average value of the samples corresponding to the dune (0.38mm), and the average grain size value of the samples from the borrow area (0.32mm), confirming the similarity of these values.

Table 11. Comparison of the grain size of the representative sand samples from the dune and from the borrow area.

Coordinates		Station	Samples	M (mm)	Description
X (UTM WGS 84)	Y (UTM WGS 84)				
312543.78	1983974.39	L-2	L-2	0.28	Photo 12 Dune breach. Western limit. Critical Sector
312894.9	1984265.39	L-4	L-4	0.47	Photo 13 Dune breach. Western limit. Critical sector
313771.18	1984885.65	L-5	L-5	0.38	Photo 14 Dune remains. Critical sector
Average Md value				0.38	Dune
Average Md value				0.32	Borrow area

As regards the percents of the main carbonated components by weight, Table 12 allows to prove that the samples corresponding to the dune have lower percents than those taken in the borrow area.

Table 12. Percents of the main components by weight. (UWI). (The sample identified as M5 corresponds to the borrow area, and the L5 one, to the fill sector).

Samples	%. Carbonate	% Quartz	Samples	% Carbonate	% (Quartz)	Samples	% (Carbonate)	% (Quartz)
M5	55.6	‘	M37	11.7	‘	M59	14.1	‘
M18	24.5	50.41	M41	12.2	62.50	M60	14.2	68.16
M19	25.0	68.14	M46	11.5	87.06	M65	8.79	‘
M35	12.9	‘	M51	39.0	‘	M69	7.96	‘
M36	10.8	86.92	M55	35.0	‘	M71	11.9	‘
L2	5.1	‘	L4	7.98	crystalline 11.41 opaque 30.42 rock frag. 14.45 amphibole 5.70 crystalline 11.41 feldspar 3.80 quartz 26.24	L5	3.21	69.0

As it may be observed in the description of the stations from the borrow area (Table 1, Anexe 2), and in the distribution of the carbonate percents in map, (Sheet 3), sample M5, with the highest carbonate percent (55.6%), corresponds to station 5 located in the southeastern vertex of the borrow area; and the M-55, with one of the higher percents, (35%), is on the southern limit line of the area. Sample M-51, with a 39% of carbonate, corresponds to a station located very near the eastern limit of the borrow area. As it is observed in the results, the highest carbonate concentration is located towards the southeastern end of the borrow area, and especially on its southern limit. Taking into account that the dredging lines never reach the surroundings of the borrow area limits, it may be stated that those stations will not be included in the dredging operation.

However, the visual description of the sand, as well as the results presented in Table 12, indicate that the highest percent of the material's weight corresponds to terrigenous sediments mainly integrated by quartz. It should be noted that in sample L-4 significant percents of other minerals were identified, which is probably due to the fact that the sand supply in this tract comes from the destruction of cobbles and pebbles that were used as filling material in the groynes and that are currently spread all over the area and fragmented by the wave.

According to both the grain size distribution and the sediment composition percents, dredging lines will be established in such a way that it is ensured the dredging of material with similar characteristics in all the trips of the dredger.

f) Currents

With the objective of evaluating the possible impact of current intensity on the borrow area, continuous records of current speed and direction were registered at a station located 16 m deep and separated 3 m from the bottom at a point in the central part of the basin, with the coordinates that appear in Table 13.

Table 13. Coordinates of the current meter station in the borrow area.

Current meter station. Borrow Area (E-3)	Coordinates				Depth (m)	Separation from bottom
	Flat (UTM WGS84)		Geographical			
	X	Y	Latitude	Longitude		
	314287.79	1984259.47	17^0 56' 18.68''	76^0 45' 12.40''	16	3 m

The results shown in the wind rose in fig. 18 allow affirming that the current is oriented in a direction between WNW and SSE, with clear predominance of West direction, thus confirming that the tide regime does not influence the behaviour of currents in the borrow area.

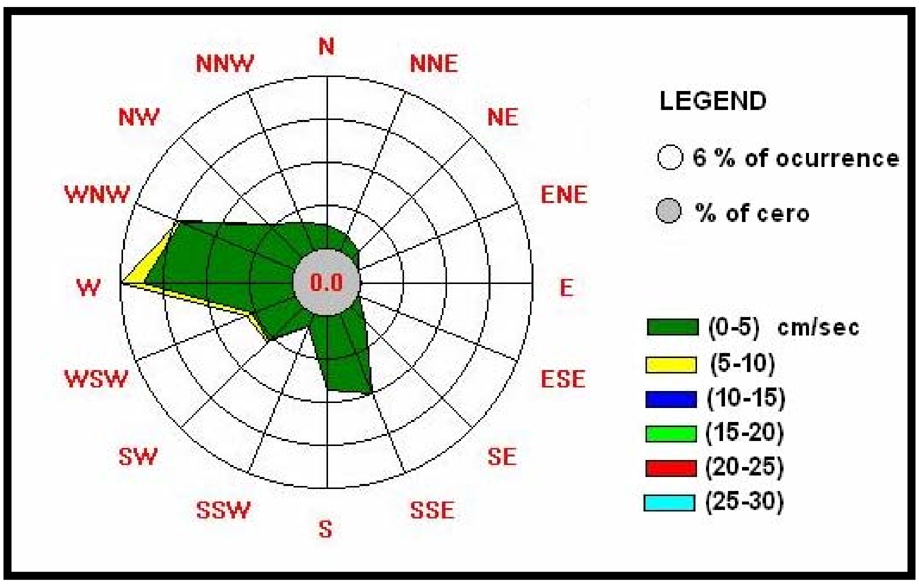


Figure. 18. Currents rose of station 3 located in the borrow area.

The maximum speeds registered in West direction were in the range of 5-10 cm/sec and did not surpass 10 % of the records, while the remaining 90 % was in the range of 0-5 cm/sec, evidencing that with those low speeds the current in the borrow area does not constitute a hindrance for the dredging activity.

It must be highlighted that during the sampling period the study area was subject to an intense sea breeze that caused waves up to 1 m high in directions between East-northeast and East-surest, in correspondence with the habitual regimen described for December, (Information from the Met service, Annex 4).

g) Accessibility

As it may be observed in map, (sheet 2), corresponding to the bathymetric information of the study area, the depths in the surroundings of the borrow area guarantee the access to it from any direction, without any risks for sailing.

From positions with minimum depth of 11.8 m on the North edge of the borrow area to 6 m deep in shoreward direction, the minimum distance is 250 m, which represents the safety margin for dredges with draught over 5 m.

VI.2 Fill area

a) Definition of fill sectors

The sand fill area extends from a point located near Gypsa company's facilities to the East, to a point East of Plumb Point, along 6.6 km (sheet 4 and 5), and it has been divided in four (4) sectors whose geographic limits are shown in Table 14.

The area selected to apply dune reconstruction includes the sector defined as critical sector in the Project's Terms of Reference, to which a 2 400-m sector has been added with the purpose of strengthening the natural dune in the surroundings of Norman Manley International Airport.

Table 14. Geographic limits of the sand fill area.

Sectors	**Beginning** (UTM WGS84)		**Ending** (UTM WGS84)	
	X	**Y**	**X**	**Y**
1	317820.55 17° 56’ 47.33”	1985107.33 76° 43’ 12.63”	315226.99 17° 56’ 31.76”	1984652.78 76° 44’ 40.62”
2	315226.99 17° 56’ 31.76”	1984652.78 76° 44’ 40.62”	314554.12 17° 56’ 39.65”	1984901.61 76° 45’ 03.56”
3	314554.12 17° 56’ 39.65”	1984901.61 76° 45’ 03.56”	313779.79 17° 56’ 37.63”	1984846.82 76° 45’ 29.85”
4	313779.79 17° 56’ 37.63”	1984846.82 76° 45’ 29.85”	311948.18 17° 55’ 47.62”	1983326.67 76° 46’ 31.60”

b) Calculation of fill volume per sector

The calculation of the fill volume for an artificial beach nourishment project is usually done following an approximation procedure that combines empiric criteria with mathematical models and economic or social interests.

In this project, the application of artificial sand nourishment aims at the reconstruction of the natural dune along 6 600 m of Palisadoes coastal front, with the objective of protecting the road and maintaining the physical stability of the peninsula.

In the case of beach recovery projects, mathematical models have been developed directed to establish an equilibrium profile in which the beach preserves a dynamically stable morphology in function of bottom slope, sediment composition and wave parameters.

These models are particularly useful to calculate the sand volume required to achieve the desired beach dimensions and evaluate the suitability of the sand to introduce artificially, which facilitates decision-making as regards the fill volume of the project.

However, in the particular case of dune reconstruction, design criteria are still empiric, mainly based on measurements or estimations of the sand volume lost in a given time period, or due to the occurrence of an extreme erosive event like a hurricane.

When referring to protective dunes, as in the case of the Palisadoes, the design criteria also includes information obtained through the mathematical modeling of sea level surge height for the occurrence of a hurricane category 4, as explained in chapter 4. With this information it is achieved that the dune minimises the overtopping of water, and that filling material for the road is not eroded by the wave.

As a typical dune restoration work it may be mentioned the project executed in Panhandle, Florida, as part of the Beach and Dune Recovery Strategic Management Plan (Bureau of Beaches and Coastal Systems, 1996).

In this project, the calculation of the sand volume required for dune restoration was done taking into account the differences found between the profiles before and after the hurricane. For most sectors, it was designed a typical dune 8-foot high over the berm and 40 feet wide in its base, so that the recovery of at least half of the original dune is guaranteed.

In the case of Palisadoes, the lack of profiles before and after Ivan does not allow to make a quantitative evaluation of the sand eroded and the calculation of the sand volume required for the reconstruction of the dune and its design. It has been done taking as reference the morphological characteristics of the dunes that were not destructed or overtopped by Ivan.

The profiles used for this analysis correspond to sections 1, 2 and 3 carried out by the Survey Department, (Annex 3), whose geographic location is shown in Map, (Sheet 1).

Taking into account the morphological characteristics of those profiles and the surge 5 m height calculated in chapter IV, the sections of sand fill profiles were designed with maximum height between 7 and 8 m as regards mean sea level, and a 50-m width in sectors 1 and 2, (Map, sheet 4 and 5).

The application of this evaluation to the whole study area led to the definition of 4 fill sectors with typical design profiles for each sector, based on which it was calculated the sand fill volume shown in table 15.

Table. 15. Distribution of the sand fill volume per sector.

Sector	Length	Total Volume	Density (Average)
1	2 700 m	540 000 m^3	200 m^3/m
2	720 m	216 000 m^3	300 m^3/m
3	780 m	140 400 m^3	180 m^3/m
4	2 400 m	208 000 m^3	87 m^3/m
Total	6 600	1 104 400	

Only in sector 3, corresponding to the most critical tract in the Palisadoes, the construction of the new dune will cause a seaward extension of the present coastline in about 30 m, which is necessary considering the road's proximity to the coast, (Map, Sheet 4). The dune created with this design will be in correspondence with those reconstructed in the neighbouring sectors, and will guarantee that the foredune natural remodelling process is in accordance with the regular wave regime.

During the foredune natural profiling, a sand volume will be dragged westward by the coastal transport, as explained in chapter IV. This will be minimised through the construction of the groyne proposed in chapter V.

On the other hand, it should be mentioned that sector 4 corresponds an area located East of Plumb Point that was incorporated to the project with the purpose of ensuring the fill of some breaches caused by Hurricane Ivan, through which the water could overtop and affected some areas of the airport by flooding.

VII. DESIGN OF THE REVETMENT TO PROTECT THE MOST CRITICAL SECTOR

As explained in chapter V referring to the strategy for Palisadoes protection, the construction of a revetment in the most critical sector is conceived as an urgent measure, and it is proposed taking into account the high vulnerability of that site to storm wave attack at present, due to the destruction of the groynes and the almost disappearance of the sand. Pictures 19 and 20 show that the road is less than 25 m away from the coastline, and seawater reaches the road with the occurrence of only the strong sea breeze at noon.

Pictures 19 and 20. Most vulnerable sector of the road that provides access to Port Royal and the Norman Manley International Airport.

It is evident that this sector has been the most vulnerable in the peninsula since the 1950's when, after the pass of Hurricane Charles in 1951, it was decided to protect 850 m of coast by means of a groyne field, integrated by 9 structures built with crates filled with cobbles and pebbles, which were closed and adjusted on the upper side using concrete pieces.

Chapter IV mentions that the littoral transport in the last years has not guaranteed the arrival at this sector of the volume of material required for the stabilization of the coast, and the groynes have lost their effectiveness, besides having been partially destroyed by the strong wave and particularly by Hurricane Ivan in 2004.

Due to the importance of maintaining this road in operation, and taking into account that the works to rebuild the natural dune may take several months, it has been considered convenient to recommend the construction of a revetment.

A revetment is a type of structure conceived precisely to protect road slopes and seawalls, at a height and separation from sea level that keep them partially away from the stronger wave attack; although they are designed strong enough to face the sea level rise caused by extreme erosive storms.

At first, it was conceived to build a structure using geotubes, like those shown in Pictures 21 and 22. But, taking into account the low availability of filling material and its unsuitable quality, as well as the depth of over 1 m at the site where the structure should be located, it was decided to design the revetment using quarrystone.

Pictures 21 and 22. Example of geotube structures to protect the coast.

VII.1 PARAMETERS TO DESIGN THE QUARRYSTONE REVETMENT

The basic information used for the design was the following:

- The spring tide (St), according to observations carried out between 1965 and 1968 in Port Royal, is 0.40 m (Keith Millar's information, provided to the Project by Chris Burgss).

- The storm surge (Ss) for the different categories of tropical storms, according to the MONSAC model (Table 3, Epigraph 5, Chapter IV).

- The toe of the structure will be located on the mean sea level (MSL).

- The total depth of the design at the toe of the structure is Ds = St + Ss

- The characteristics of the wave in indefinite depths are Ho = 6m and T = 10s, corresponding to the wave generated by a hurricane.

- The revetment will be built using boulders from Yallahs River quarry.

For the particular case of this type of revetments, the design wave to calculate the structure's stability will be the maximum wave that breaks directly on the structure (Hb), as shown in Figure 1.

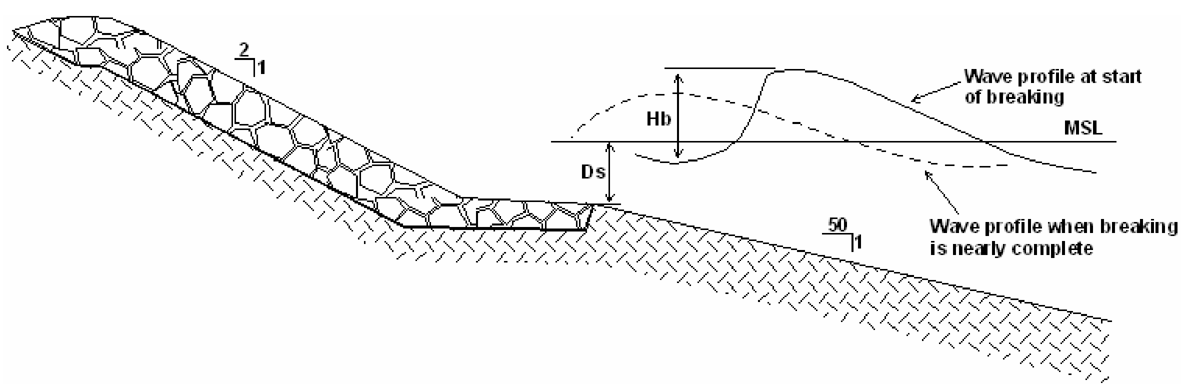


Figure 19. Definition of breaker geometry.

The calculation of the maximum breaking wave at the toe of the structure was carried out using the breaking criteria by Larson and Kraus (1994).

$$H_b = 0.095 \cdot e^{4m} \cdot L_b \cdot \tanh\left(\frac{2\pi d_b}{L_b}\right) \qquad L_b = \frac{gT^2}{2\pi} \cdot \tanh\left(\frac{2\pi d_b}{L_b}\right)$$

where:

H_b = height of the breaking wave.

L_b = length of the breaking wave.

d_b = breaking depth.

m = mean slope in the breaker area (m = 0.02, slope 1:50, according to bathymetric map 1:10 000, 1999).

Substituting in the expression above, it is obtained:

H_b = 1.70 m

Once determined the height of the design wave, it is possible to determine the stable armour stone weight (W), which was calculated using Hudson's formula (Shore Protection Manual, (1984)):

$$W = \frac{W_r H^3}{K_D (S_r - 1)^3 \cot \alpha}$$

where:

W = stable armour stone weight (Kg.)

W_r = unit weight of armour unit (2660 Kg/m^3, corresponding to granite igneous rock, that with the lowest density).

H = design wave at revetment (1.70 m)

K_D = 2 (stability coefficient, for breaking-wave condition and 2 random layers of rounded quarrystone)

$S_r = W_r/W_w$ = 2.82 (specific gravity of armour unit)

$\cot\alpha$ = 2 (slope 1:2) (α, angle of revetment slope)

By doing the corresponding substitutions, it is possible to determine the weight of the armour units:

W = 800 Kg.

According to the Shore Protection Manual, (1984), the weight range of the armour units for the outer layer of the structure may vary from 0.75W to 1.25W (600 Kg. to 1000 Kg.), with 50 % of individual rocks weighing over 800 Kg.

The size of the boulders may be defined in terms of the side of the equivalent cube, Dn, or of the diameter of the equivalent sphere, De, through the following ratios (Document of Reference, (2004)):

$$Dn = \left(\frac{W}{W_r}\right)^{1/3} \qquad De = 1.24\left(\frac{W}{W_r}\right)^{1/3} \qquad Dn = 0.806De$$

Since the boulders available in Yallahs River quarry have certain degree of roundness, the size of the boulders will be defined through the diameter of the equivalent sphere, De. Doing the corresponding substitutions it is obtained:

De = 0.80 m

Another important parameter within the revetment design is the crest height, to prevent the overtopping of the structure by the wave and the turning over of armour units on the crown/top. For that purpose, it is necessary to determine the wave runup (Figure 20).

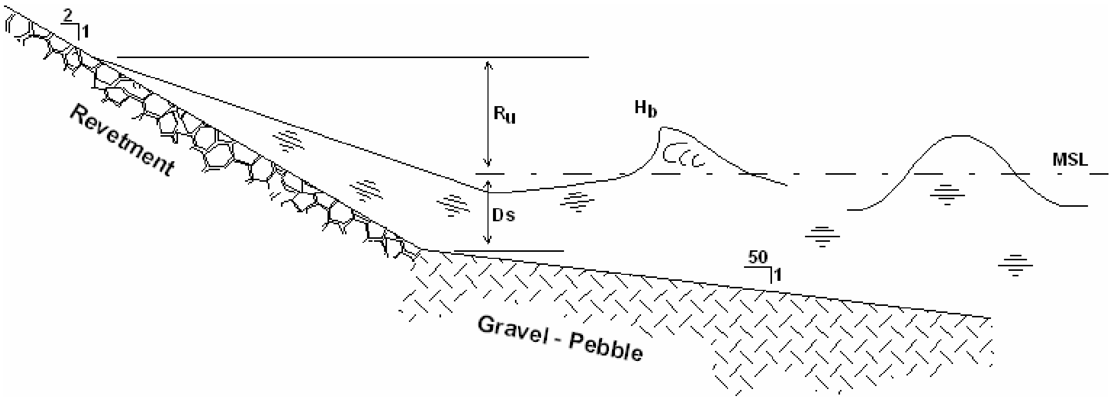


Figure 20. Definition of wave runup.

To calculate the wave runup it was applied the formulation of Ahrens and McCartney (1975):

$$R_u = H_i \cdot \frac{a \cdot I_r}{1+(b \cdot I_r)} \qquad I_r = \frac{\tan\alpha}{\sqrt{\frac{H_i}{L_o}}}$$

where:

R_u = runup.

I_r = Iribarren number.

H_i = height of the wave falling at the toe of the structure.

Lo = deepwater wavelength

α = angle of revetment slope

a, b = empirical coefficients associated to corresponding types of armour unit.

a = 0.692

b = 0.504

Applying the above expressions it is obtained:

R_u = 1.65 m

Finally, the revetment crest height (E) is the result of the addition of the total design depth at the toe of the structure and the wave runup; that is to say:

$E = Ds + R_u = 4.2$ m

Starting from the procedure followed so far, the following table presents a summary of the calculation of the structure for scenarios of hurricanes C3, C4 and C5:

Table 16. Structure parameters by hurricane category.

Hurricane	Hb (m)	Ru (m)	W (Kg)	Ds (m)	E (m)
C3	1.70	1.65	800	0.80	4.20
C4	2.30	2.13	2070	1.10	5.70
C5	3.00	2.66	4430	1.50	7.30

Map sheet 6 presents a ground plan view and the typical sections of the proposed structure for a hurricane C3 including the designed parameters.

VIII. EXECUTION OF THE WORKS

To ensure a high productivity in the transportation of 1 104 400 m^3 of sand from the borrow area to the Palisadoes coastal front it is convenient to use a trailing suction hopper dredger.

The carrying capacity of this type of dredger may vary significantly, from several hundreds to several thousands cubic meters, and the decision almost always depends on equipment mobilization and demobilization costs.

The execution of this project has been conceived for a medium size dredger, with hopper capacity between 2 000 m^3 and 3 000 m^3, and draught between 5 m and 6 m, regularly available in the dredger market (Picture 23).

Picture 23. Quality Star trailing suction hopper dredger, belonging to ASTIMAR S. A. Company, coupled by its prow to a floating pipeline to start the sand discharge. Hopper capacity 2 400 m^3.

Taking into consideration the maximum transportation distance of 3 km, an average load of 2 000 m^3 per trip, and a continuous 24-hours-a-day working regime, (usual conditions in this type of project), it may be planned to carry out 5 complete load-and-unload cycles a day, for a productivity of 10 000 m^3 per day and an estimate of 110.4 days. Bearing in mind the need to refuel the dredger every 15 days, and the days required to change the position of the pipeline, it may be estimated an execution time of 125 days.

Work execution will be carried out following the scheme shown in Map (Sheet 7). According to that scheme, it will be necessary to place the dredger at 8 discharge points at the locations shown in the table 17.

Table17. Locations to couple the dredger with the pipeline (See Map Sheet 7).

No.	Dredger Position (WGS 84)			
	Easting (UTM)	Northing (UTM)	Latitude (N)	Longitude (W)
1	317403.19	1984747.65	17° 56’ 35.51”	76° 43’ 26.70”
2	316447.11	1984451.40	17° 56’ 25.59”	76° 43’ 59.09”
3	315318.11	1984384.87	17° 56’ 23.08”	76° 44’ 37.44”
4	314507.39	1984544.30	17° 56’ 28.02”	76° 45’ 05.03”
5	313872.09	1984595.76	17° 56’ 29.49”	76° 45’ 26.64”
6	313280.64	1984226.71	17° 56’ 17.31”	76° 45’ 46.61”
7	312715.52	1983643.00	17° 55’ 58.15”	76° 46’ 05.63”
8	312135.35	1983095.70	17° 55’ 40.17”	76° 46’ 25.16”

As observed in the scheme in Map Sheet 7, it will be required a 200-m long pipeline in the water and a 500-m long pipeline for longshore sand distribution, for a maximum pipeline length of 700 m.

Sand fill is conceived to start by sector 1, that is to say, from East to West in the coastal drift direction. The cross-shore pipeline will be connected to the long-shore pipeline to distribute sand from the discharge point, first eastward and then westward. Once the fill volume has been distributed in both directions, the cross-shore pipeline is moved to the next discharge point.

Fill density control during the progress of fill discharges is ensured by means of the number of tube tracts that are placed in between dredger trips, so that the discharged volume is in correspondence with pipeline length, according to the density corresponding to each sector.

Dune and beach profile conformation will be controlled through the on-site supervision while sand is being discharged, and by means of topographic levelling as the operation advances along 100-m tracts. Fill material will be immediately spread, using a bulldozer, to achieve the design profile (Pictures 25 and 26).

Pictures 25 and 26. Spreading of fill material for the conformation of the dune and beach profile.

Taking into account that it is a dune reconstruction project, it will be necessary to move a significant sand volume. At least 2 bulldozers will be required to work on a full-time basis in this task, apart from the equipment needed by the dredger to back up its operation while placing and moving the pipeline.

On the other hand, to select the execution period for the works it is necessary to take into consideration weather conditions in the region. The analysis of the area's hydrodynamic characteristics, presented in chapter IV, shows that year-round sea breeze occurrence will be a difficulty to execute the project. According to that information, the optimum months are November, December, January and February.

Conditions like 1-m wave height and 6-sec periods (predictable for normal summer conditions) are admissible to execute these works, but manoeuvres to change cross-shore pipeline position will become more difficult.

Project execution in summer also comprises the risk of tropical storms, which may occur mainly from June to October.

In the case of revetment construction, work execution involves two main requisites:

1. Appropriate ground preparation, through the conformation of the surface required to place the boulders that integrate the revetment, as shown in the design profile in Map (Sheet 6). To achieve the required surface, existing material should be removed using a bulldozer and deposited seaward.

2. Cobbles should be placed according to the scheme in Map Sheet 6, so that there is a base integrated by bigger stones at the toe of the structure and the revetment superficial covering is also shaped by the bigger boulders.

Bearing in mind the design parameters established in chapter VII, material density is 36 m^3/m using boulders of 0.80-m size and 800-kg weight (See Map Sheet 6).

With a length 310 m, the structure reaches a volume of 11 160 m^3, representing a total of 17 170 tn of quarrystone.

Quarrystone will be obtained from Yahllas quarry, located around 23 km away from the structure construction site. Estimating a 3-hour period for a complete loading-transportation-unloading cycle, a truck can only make two trips to the site per day.

With a team that includes 25 trucks, each carrying 8 tn per trip, it will be possible to transport 400 tn/day, representing a total of 43 working days. Assuming that work frequency is 6 working days and 1 resting day, 49 days will be required to build the revetment.

All ground preparation work will be executed by two bulldozers.

Table 18 shows the proposed work schedule according to the time periods that have been estimated separately for each work, considering possible to start building the revetment in March and reconstructing the dune in May.

If the number of trucks for material transportation is increased and a dredger with higher capacity is used, the execution time may be significantly reduced. But, with the present calculation criteria the revetment will be built by the end of April, and the dune will be reconstructed by the end of September.

As regards the dune, it should be emphasized that the direct exposure of a large sand volume to wind effect will produce aeolian transport, which is undesirable due to both the sand loss it represents and possible accumulations on the road.

To minimize this effect, it is recommendable to implement a dune stabilization project that will imply its reforestation and the application of some sand retention measures as their need becomes evident.

Table 18. Schedule for the execution of proposed actions for Palisadoes Protection and Rehabilitation.

WORK OBJECT	E	F	M	2007			J	A	S	O	N
				A	M	J					
REVETMENT CONSTRUCTION			--	-							
DUNE RECONSTRUCTION					-	--	--	--	--		

a) Quality plan for the execution

The objective of the quality plan for the execution is to prevent the occurrence of incidents that may result in loss of time, funds and/or work quality. It becomes a tool to control the project progress for both the contractor and the client.

Although some details in the Plan will only be precise after knowing the characteristics of the dredger that will execute the work, there is a scheme that facilitates the understanding of the work execution process and control aspects that are indispensable for this type of project.

Table 19. Scheme of the Quality Plan for Project Execution

		Invariable design elements	**Environmental restrictions**	**Causes of failures and risks**	**Safety measures**	**Control measures**
Borrow site	**Dredger**	Trailing suction hopper dredger. Capacity: > 2000 m^3 Dredge depth: >20 m	Pollution by hydrocarbons. Pollution by liquid and solid wastes. Other defined by environmental authorities	Links Fire Strike Engine etc. Storm conditions	Dredger Safety Plan	Checking Dredger Safety Plan
	Borrow area	Area boundaries. Extraction, Volume, Sand composition	Defined by environmental authorities	Fines, Stratification, Layout	Verification of: Position, Volume, Sand composition.	Report per each dredger trip
Transportation	**Dredger**	Vol/trip: > 2000 m^3 Length of floating pipeline: > 200 m	Defined by environmental authorities	Hopper fails. Submerged pipeline (leakage, plugged, etc). Floating pipeline (sinks, plugged, collision, etc).	Maintenance Plan and means for dredger repairs	Checking Dredger Maintenance and Repair Plan
Fill side	**Dredger**	Length of longshore pipeline: > 500 m	Defined by environmental authorities	Leakage, Landslide, Etc. Storm conditions	Verification of: Position, Volume, Sand Composition, Dredger Safety Plan	Checking Dredger Maintenance and Repair Plan, and Dredger Safety Plan
	Fill Area	2 bulldozers, Limits of fill sectors, Design profile, Fill volume per sector	Defined by environmental authorities	Engine Links Storm conditions	Maintenance Plan and means to repair bulldozers and front end loader. Dredger Safety Plan	Checking Dredger Maintenance and Repair Plan, and Dredger Safety Plan
Who			Environmental authorities	Contractor	Technical group supervising the project.	Representative of investment
Where				In the dredger and on land	In the dredger and on land	In the dredger and on land
When			Always	During execution	During execution	During execution

The way in which Quality Plan actions will be executed is defined in the project's execution process.

Table 20. Project Execution Process

ACTIVITY	Safety Measures	Who	How	Control Measures	Who	How
Dredging in the borrow area	Verification of: Position, Volume, Sand composition	2 specialists of the technical group	Verification of position using GPS. Measurement of sand volume in the dredger's hopper	Reception and checking of technical group's daily report	Client's representative	Daily reception of radio report and weekly reception of written report
Sand discharge	Verification of: Position, Volume, Sand composition	Specialists of the technical group	Verification of position using GPS	Reception and checking of technical group's daily report		Daily reception of technical group's written report
Dune conformation	Verification of design profile		Topographic levelling, Photographing.			

IX. PROPOSED MONITORING PROGRAM

The objective of the Monitoring Project is to carry out field measurements and studies that guarantee maintaining an updated assessment on the magnitude, extension and trend of Palisadoes tombolo development processes. The proposed tasks constitute an extension in time of those developed in the framework of the present project, so as to take advantage of the established reference baseline.

Based on the results of this monitoring project, significant information to evaluate dune reconstruction effectiveness will be obtained, and it will provide elements that allow the introduction of corrective measures or making new decisions.

Tasks of the Monitoring Project

Task 1. Topography survey.

Objective:
Evaluate space-time coastline and dune morphology variations.
Description:
Maintain a detailed control of morphologic variations of the beach and dune profile along the southern coast of Palisadoes tombolo, by repeating every three months the topographic levelings at the points established and georeferenced by the Survey Department. It will be required to extend the monitoring network West of Plumb Point to Port Royal, with at least one profile every 500 m.
Output:
Quantification of variations in dune sand volumes.
Establish practical recommendations for dune and beach maintenance and recovery works.

Task 2. Sedimentary Survey

Objective:
Evaluate space-time variations in beach and dune sediment composition.

Description:

Maintain a detailed control of space-time variations in grain size and mineral composition of beach and dune sediments along Palisadoes, by taking sand samples every three months at 5 points along the cross-section in 10 points distributed from Caribbean Terrace to Port Royal, coinciding with those profiles where morphologic variation control is carried out.

Output:

Assessment of space-time variations in Palisadoes sediment composition.

Establish practical recommendations for dune and beach maintenance and recovery works.

Task 3. Meteorological Survey

Objective:

Evaluate space-time variations of wind and atmospheric pressure characteristics for a better understanding and interpretation of Palisadoes hydrodynamic and morphodynamic factors.

Description:

Maintain a detailed control of hourly variations in wind direction and speed, by means of recording equipment at Norman Manley International Airport, as well as recording barometric pressure.

Output:

Obtain hourly records of wind speed and direction, as well as barometric pressure, which are useful to apply mathematical modeling in the interpretation of Palisadoes hydrodynamic and morphodynamic processes.

Establish practical recommendations for dune and beach maintenance and recovery works.

Task 4. Ecology Survey

Objective:

Evaluate the conservation state of marine ecosystems in Palisadoes, and particularly in the borrow area and adjacent areas.

Description:

Maintain a detailed control of space-time variations in marine ecosystems conservation state in the borrow area and in adjacent areas by means of sampling the density and diversity of fish and other marine organisms twice a year. The station network should be established by marine ecologists based on the information provided by the present project.

Output:

Establishment of an environmental baseline that guarantees an appropriate reference to assess the impact of tropical storms or man-made actions.

Establish practical recommendations for the adequate management of Palisadoes coastal and marine resources.

Task 5. Dune Vegetation Survey

Objective:

Evaluate vegetation recovery and stabilization rhythm in dune sectors reconstructed by artificial sand nourishment.

Description:

Maintain a detailed control of space-time variations in vegetation conservation state in the artificially reconstructed dune, by establishing a network of observation and photographing points. The station network should be established by marine ecologists based on the information provided by the present project.

Output:

Establish an observation and photographing system that ensures the assessment of dune reforestation process.

Establish practical recommendations to rectify or broaden the dune reforestation project that should be implemented after the artificial dune reconstruction.

In the framework of a project to monitor Palisadoes tombolo development, it is indispensable to establish a high-precision tide gauge, which should be incorporated to the Caribbean Program for the study of sea level rise as a response to Climate Change.

The information provided by this tide gauge will also be especially useful for regional seismic studies.

In this project, it has been identified the tasks that directly guarantee the information required to evaluate the effectiveness of the dune recovery project that will be executed, as well as to have appropriate information available in case maintenance measures are required.

In one way or another, these tasks are already part of research programs like those of NEPA, UWI, and Met Service, or are carried out by the Survey Department, as in the case of the topographic network established during this project.

It is recommendable that the proposed monitoring project is conceived as an extension of Palisadoes maintenance works, and as such, budgeted by NWA as its coordinating institution.

X. COSTS

Description	Unit	Quant	Rate	Amount	Accumulated Jamaican dollars
REVETMENT CONSTRUCTION **Haulage of boulders from Yallahs to the Palisadoes Rd.** **960 Front End Loader (To load Trucks in Yallahs)** **(50dys x 8hrs/dy)**	**Hrs**	**400**	**5000.00**	**2000000.00**	**2,000,000.00**
Tractor D9 (To stockpile boulders) **(50dys x 8hrs/dy)**	**Hrs**	**400**	**9000.00**	**3600000.00**	**5,600,000.00**
Trucking of boulders to Palisadoes Roadway. **(25 trucks carrying 8 tons payload per trip)** **(25trks x 2 trips/day x 50days x 8tons) x 23kms per trip**	**Ton/Km**	**460000**	**16.00**	**7,360,000.00**	**5,600,000.00**
Excavation of Revetment (4500m³) & placing of boulders **D9 Tractor To excavate Revetment** **(8hrs/dy x 6dys)**	**Hrs**	**48**	**9000.00**	**432,000.00**	**12,960,000.00**
D9 Tractor **To spread boulders in Revetment** **(51 dys x 8dys)**	**Hrs**	**408**	**9000.00**	**3,672,000.00**	**13,392,000.00**
Front End Loader **(51 dys x 8dys)**	**Hrs**	**408**	**2,500.00**	**1,020,000.00**	**17,064,000.00**
Labour **12 men x 51 days**	**Hrs**	**612**	**900.00**	**550,800.00**	**18,084,000.00**
Contingencies @ 20%				**2,642,220.00**	**18,634,800.00**
FILL DUNE **DREDGER MOBILISATION**				**US 350 000.00**	**US 350 000.00**
FILL DUNE OPERATION USING PIPELINE. (5.00 US x m^3)	**m^3**	**1 105 000**	**US $ 5.00**	**US $ 5 525 000** **Change rate: 66.00**	**US $ 5 875 000** **387,750,000.00 Jamaican dollars**
				TOTAL 409,027,020.00 Jamaican dollars	

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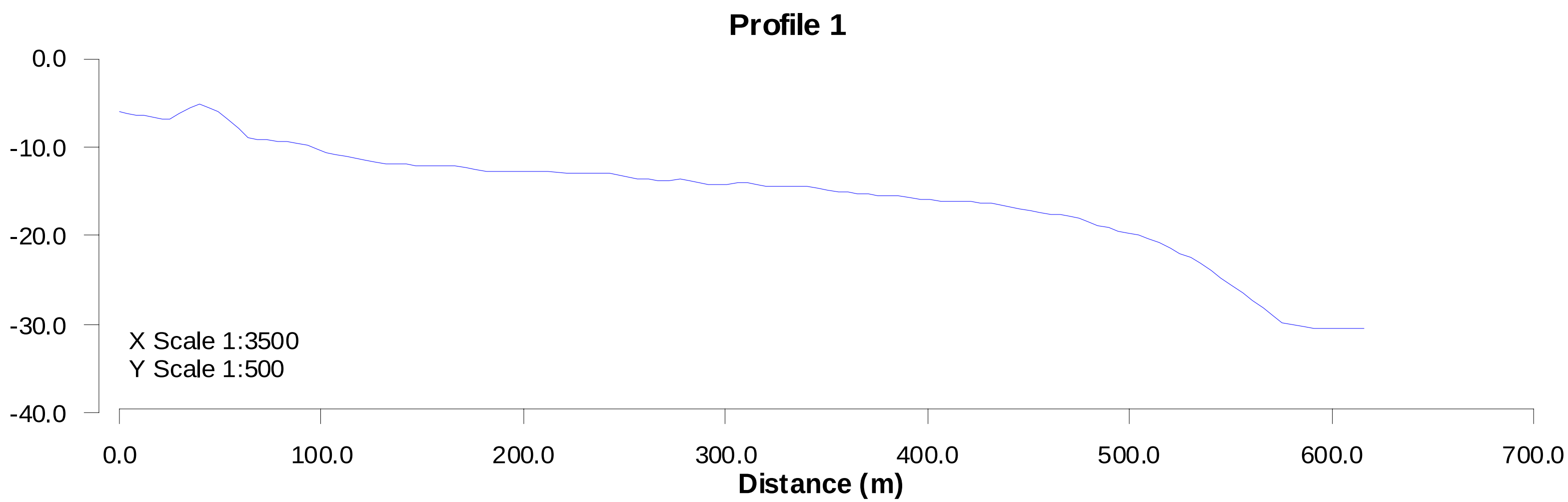
Annex 1

Profiles of the Bathymetric Survey
Field work. December 2006

The profiles are located in the Map Sheet 1.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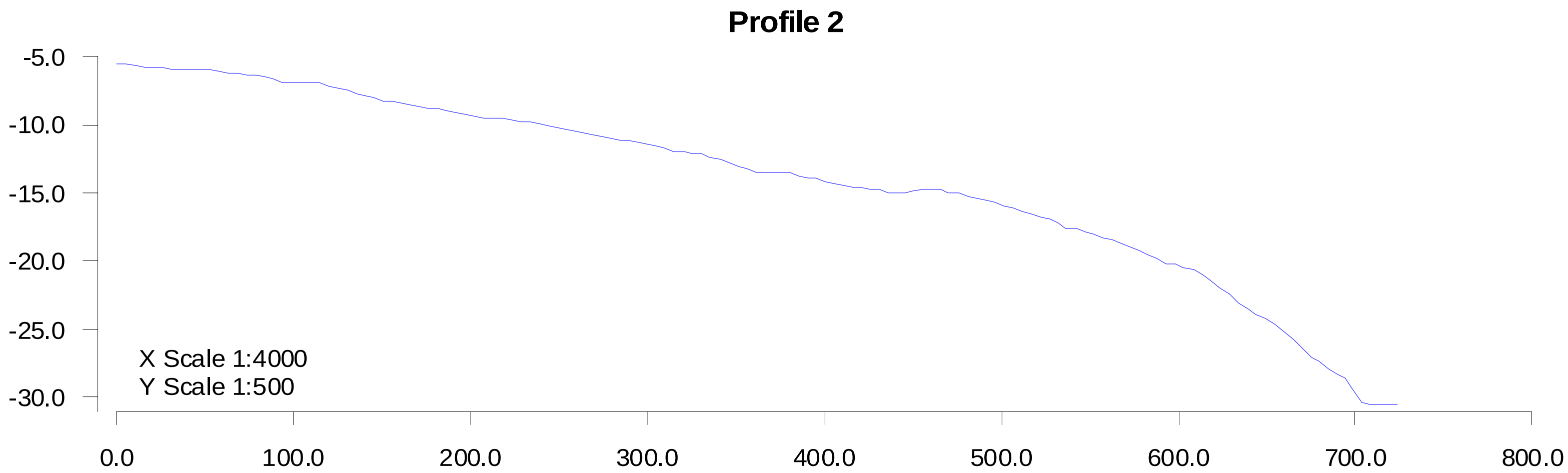
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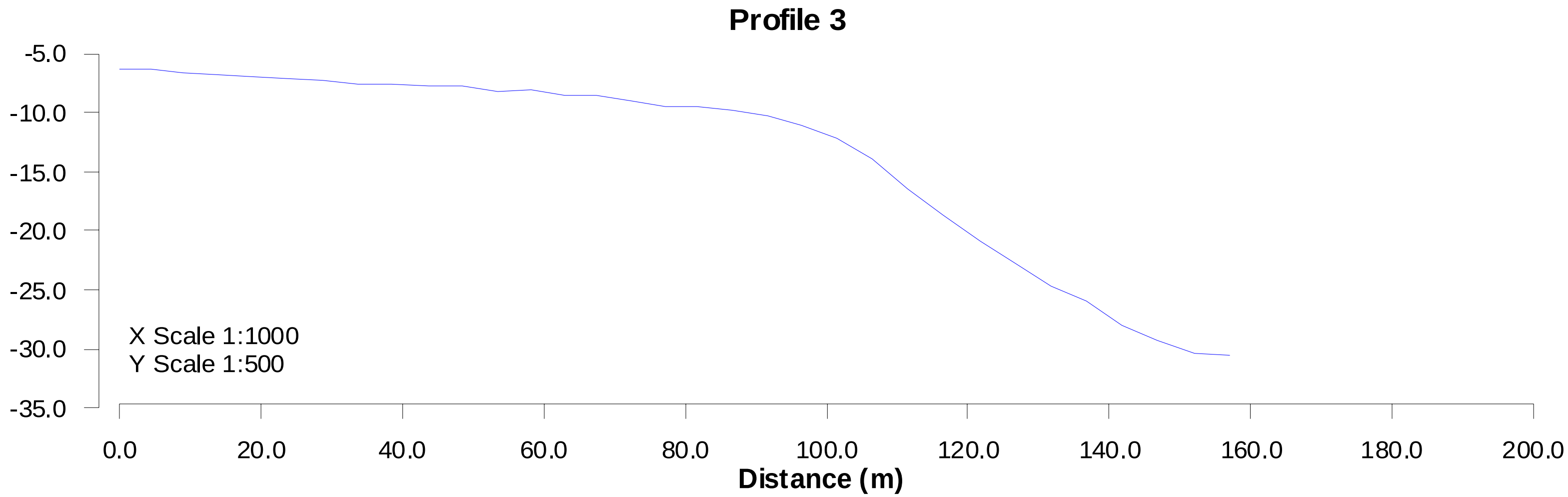
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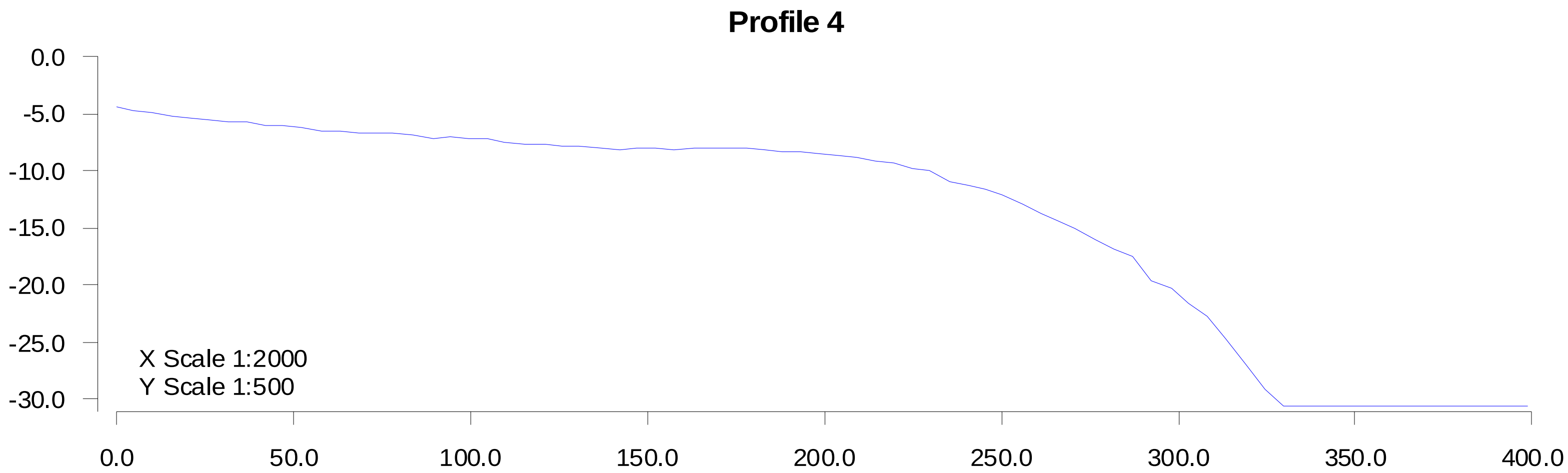
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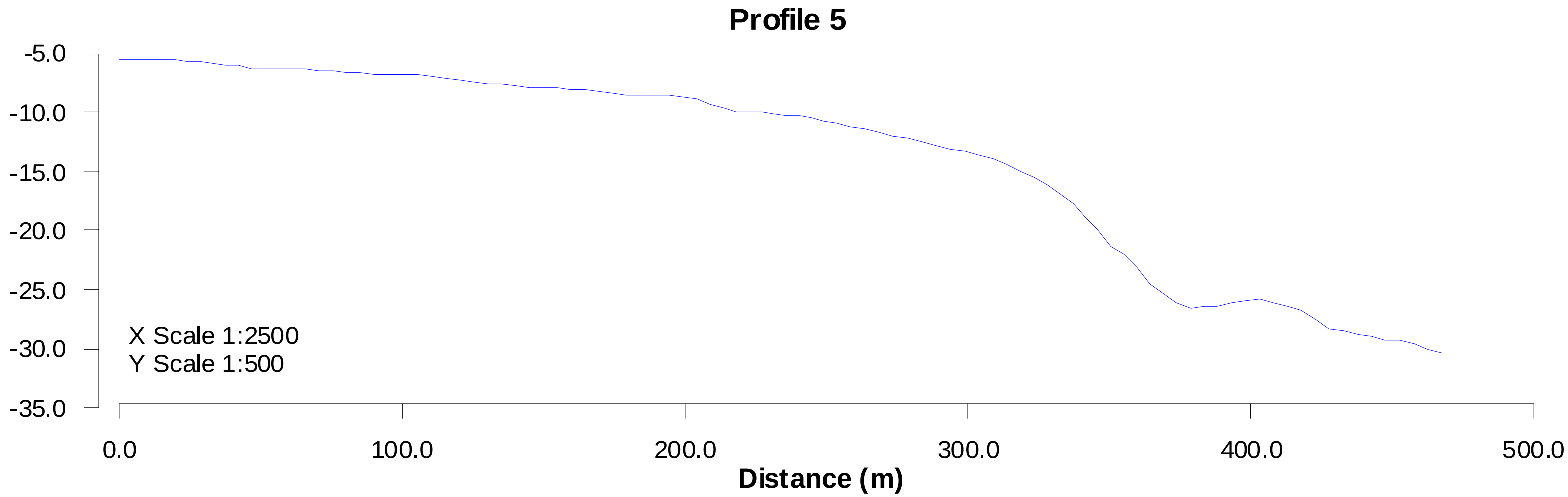
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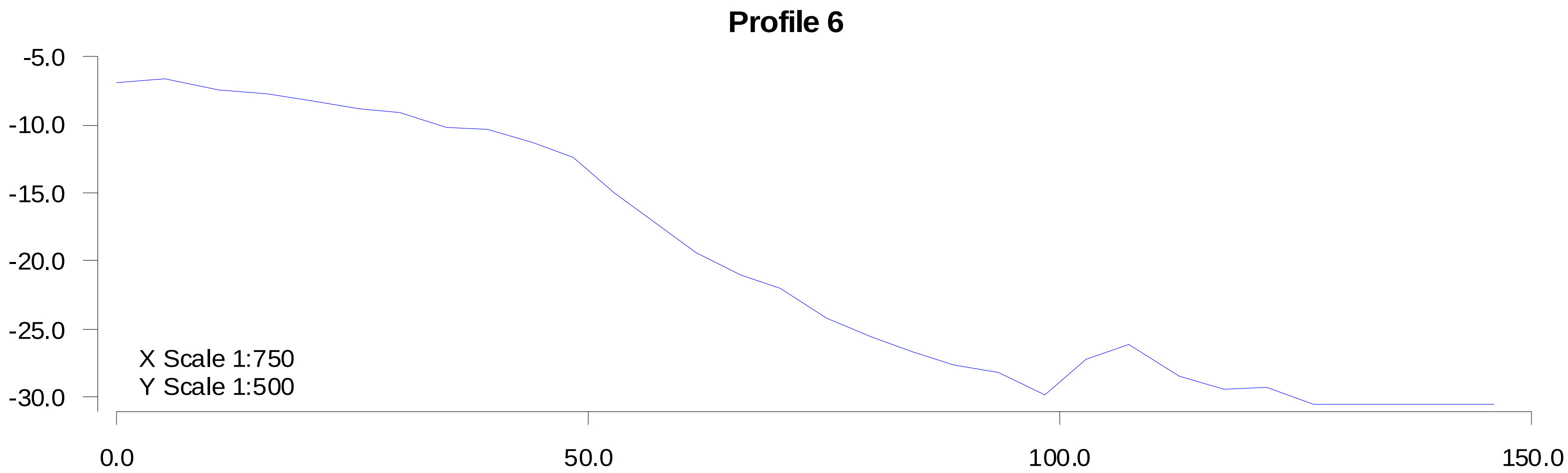
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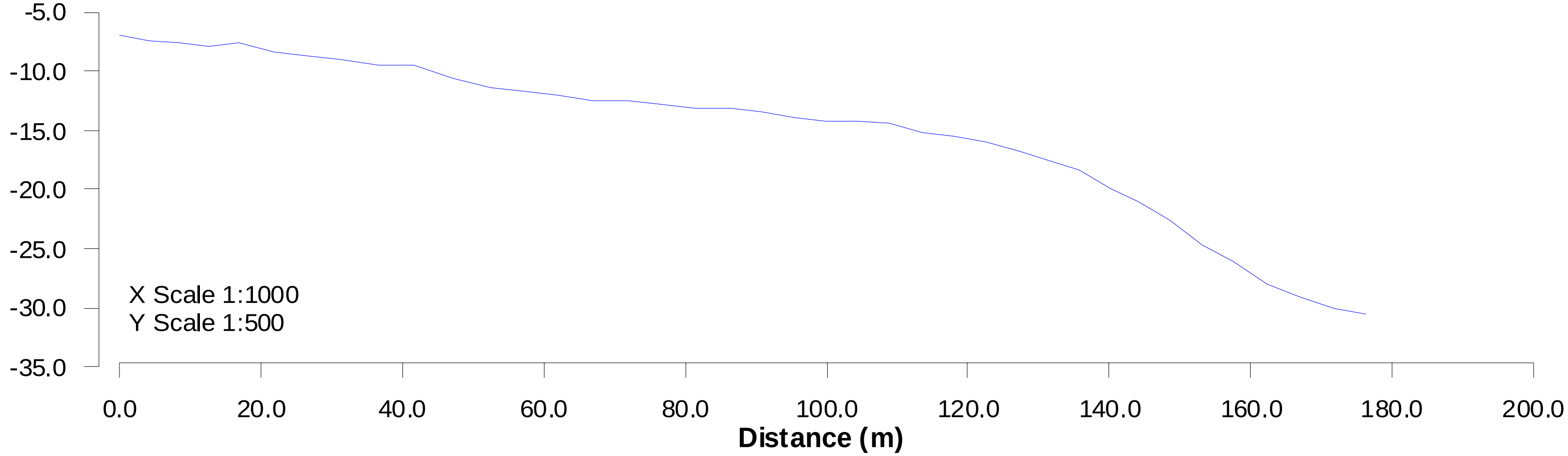

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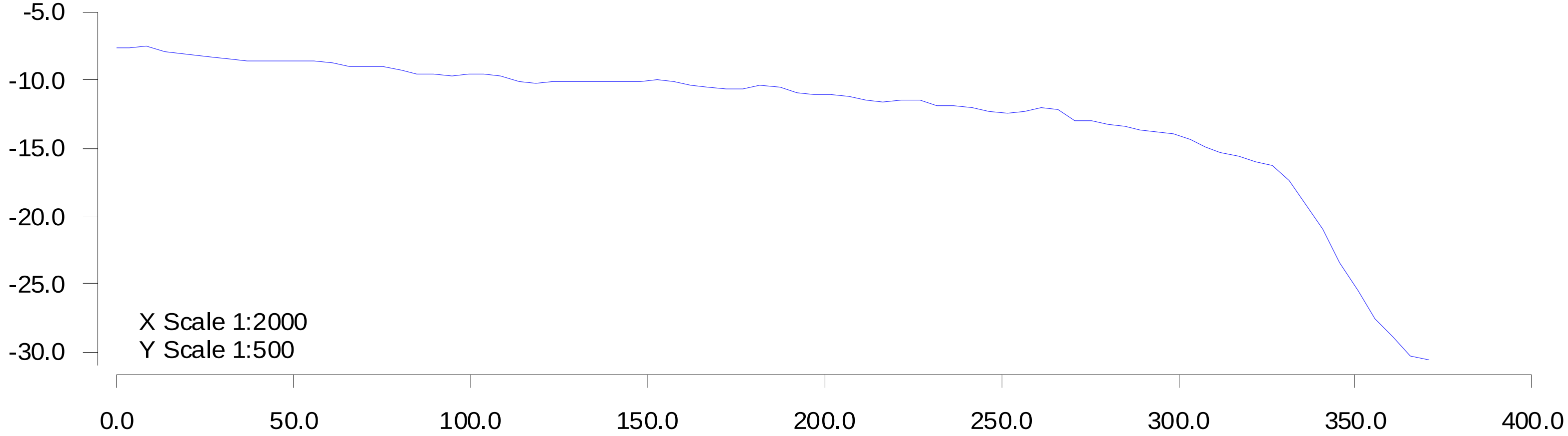

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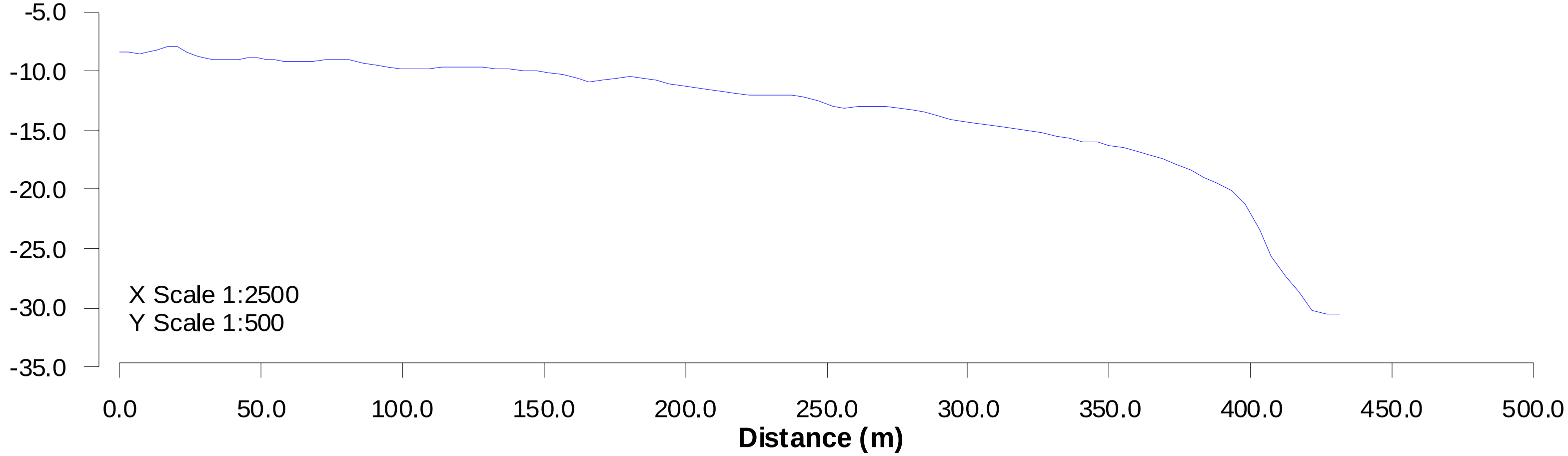

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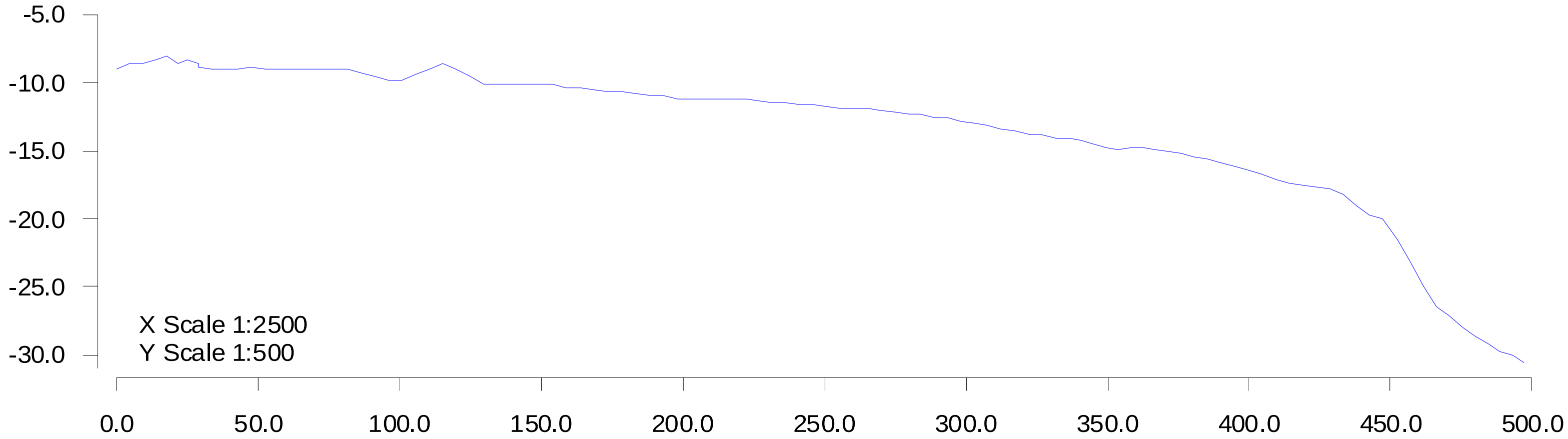

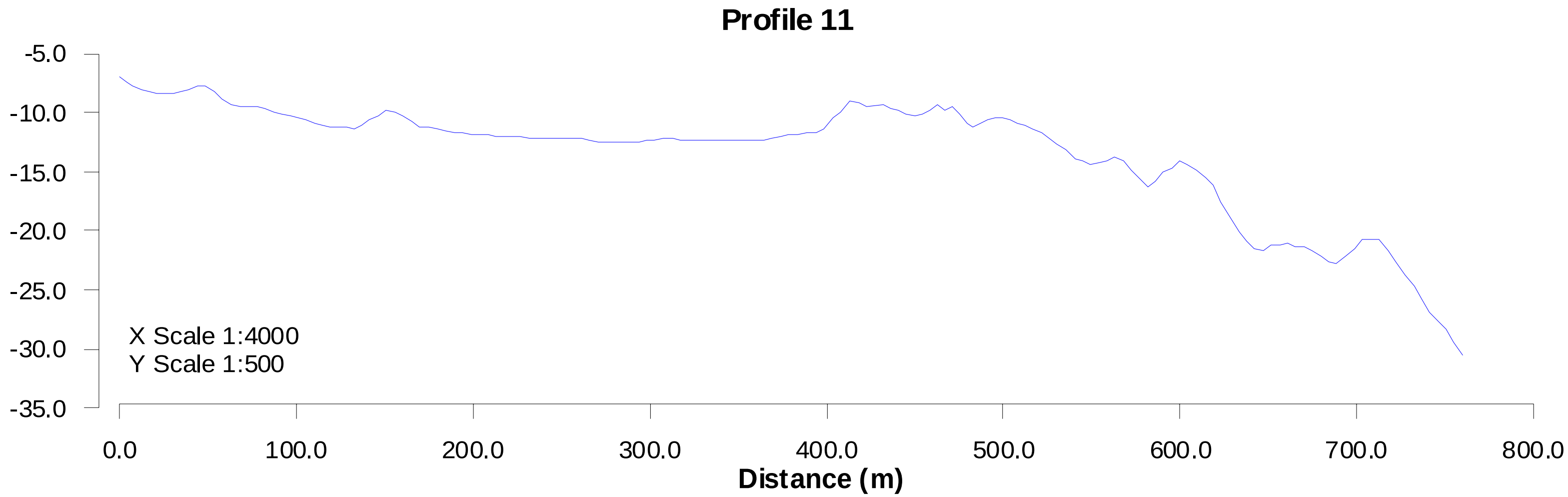
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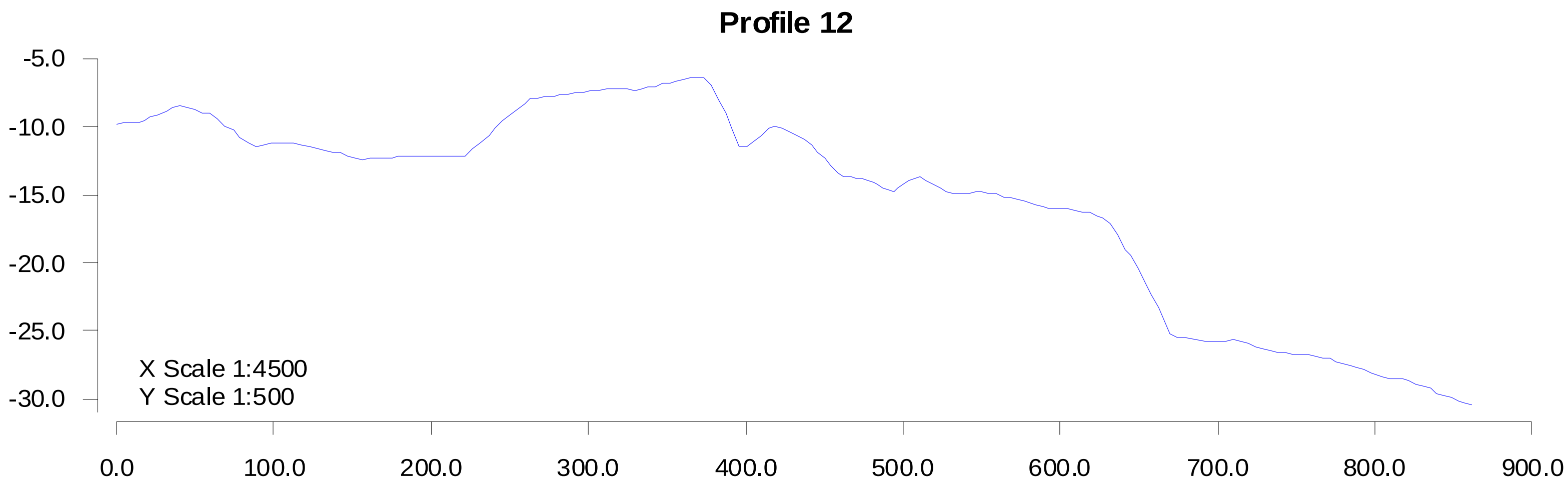
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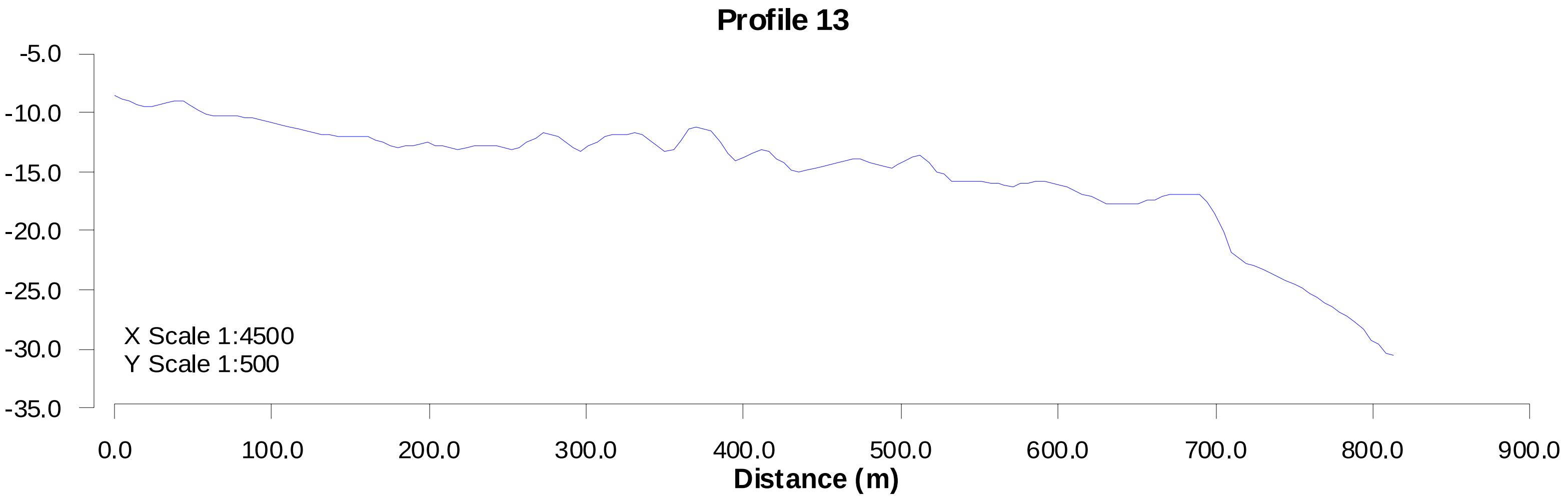

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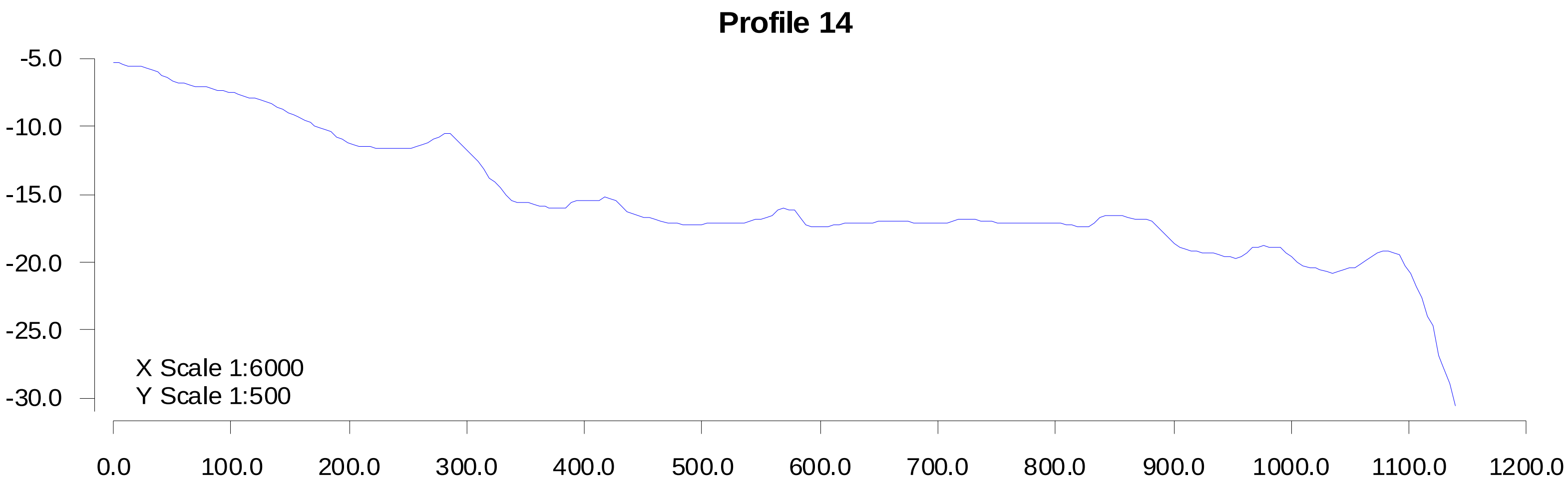

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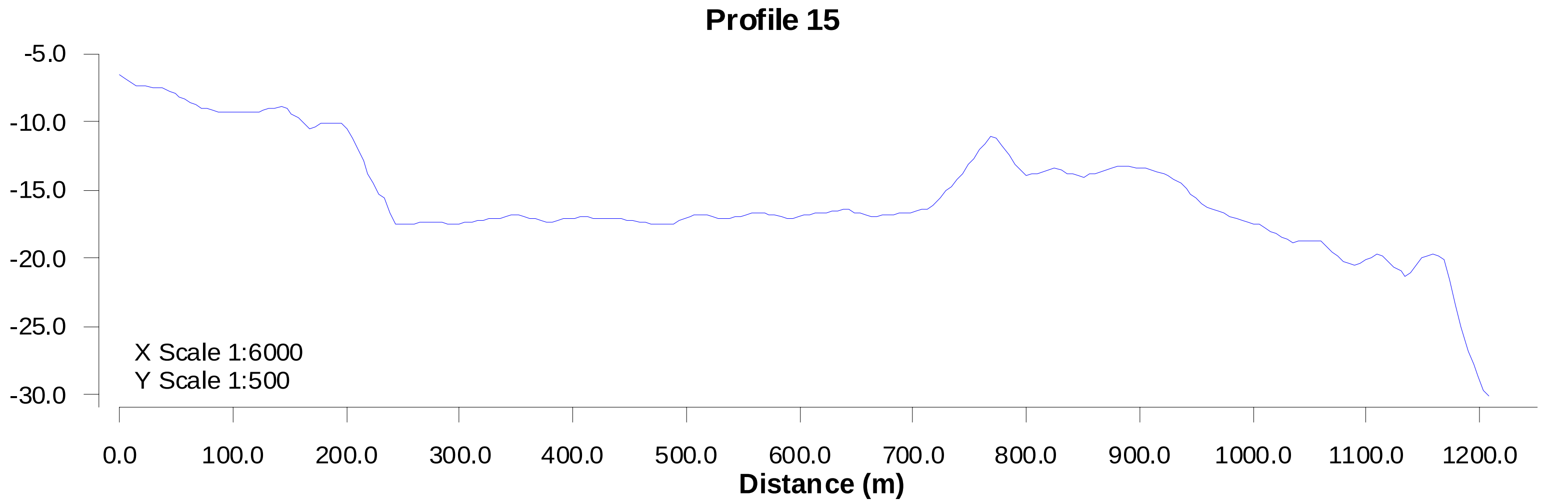
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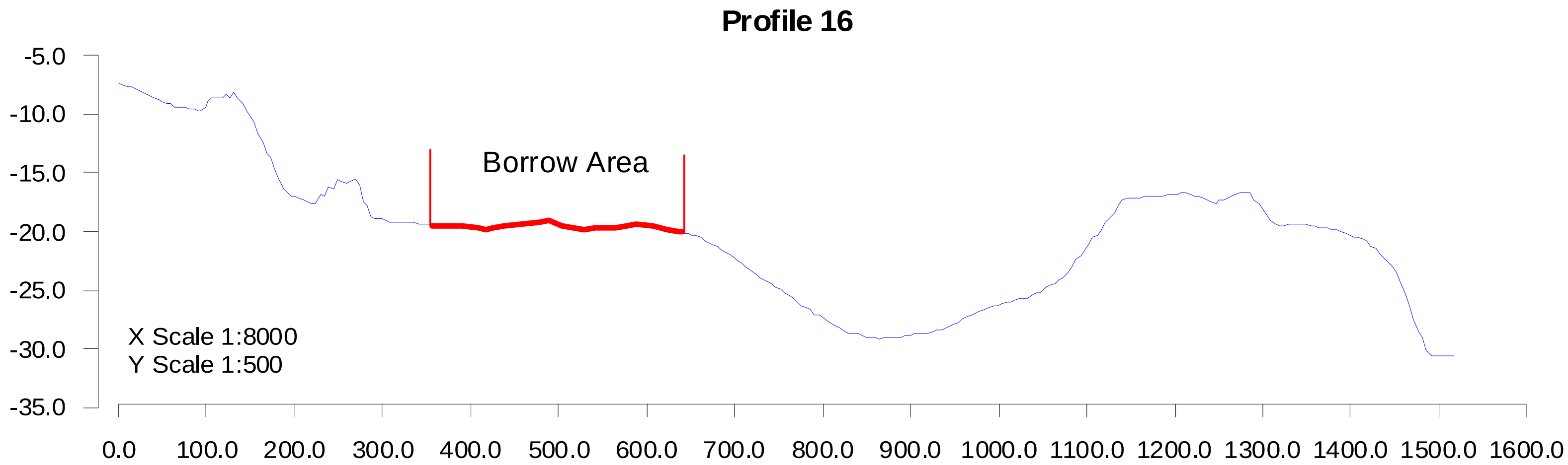
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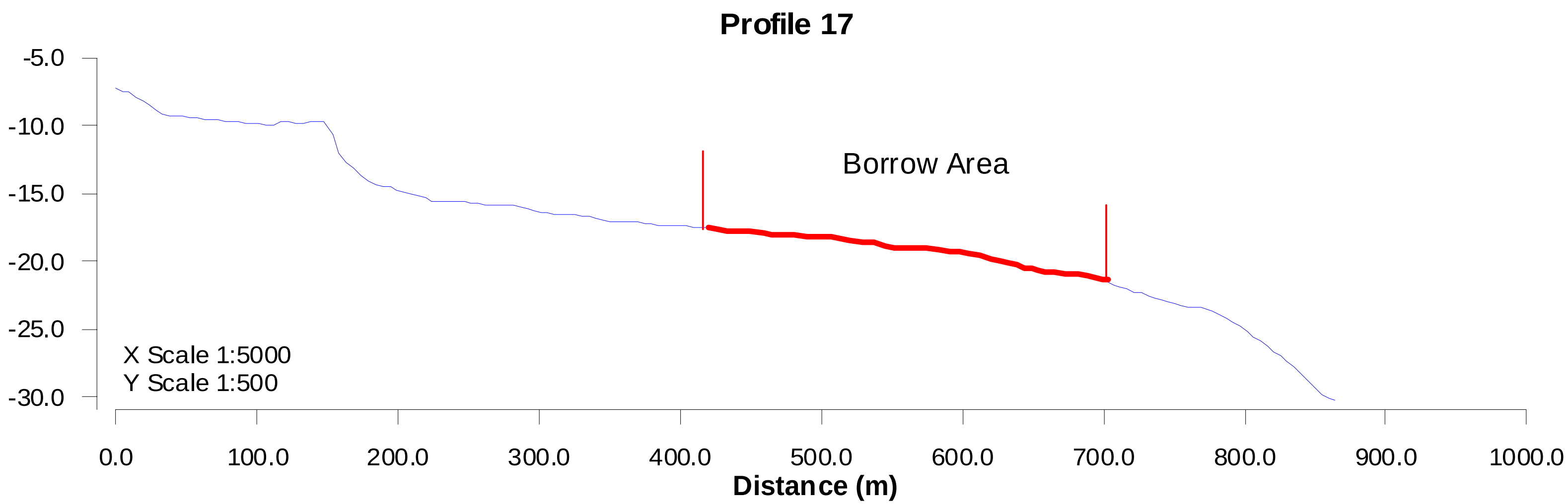
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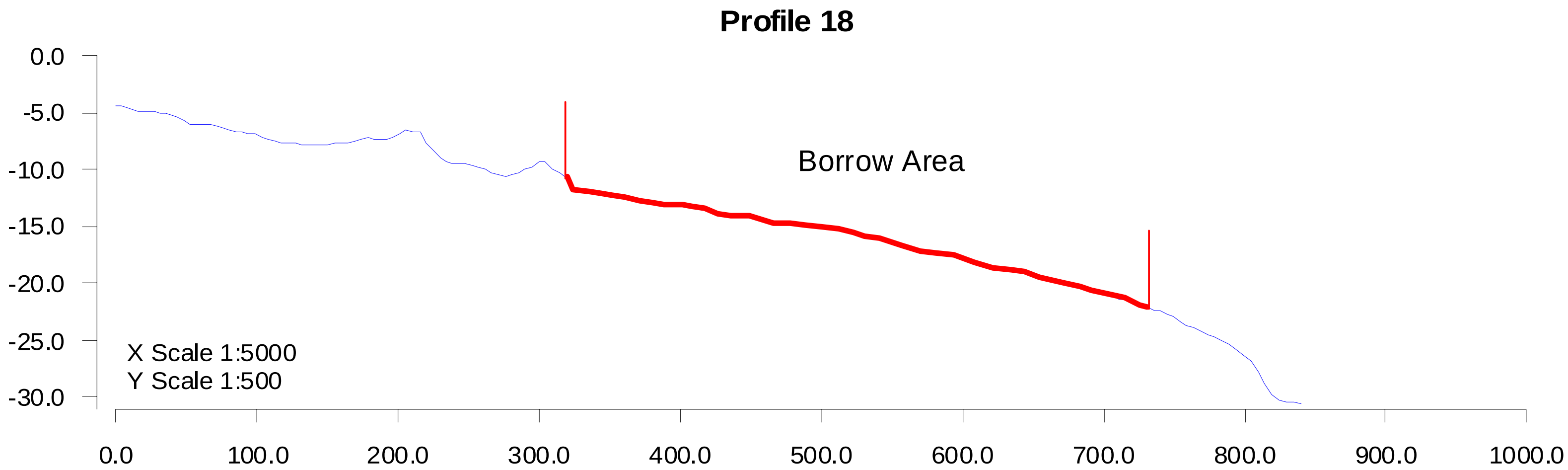
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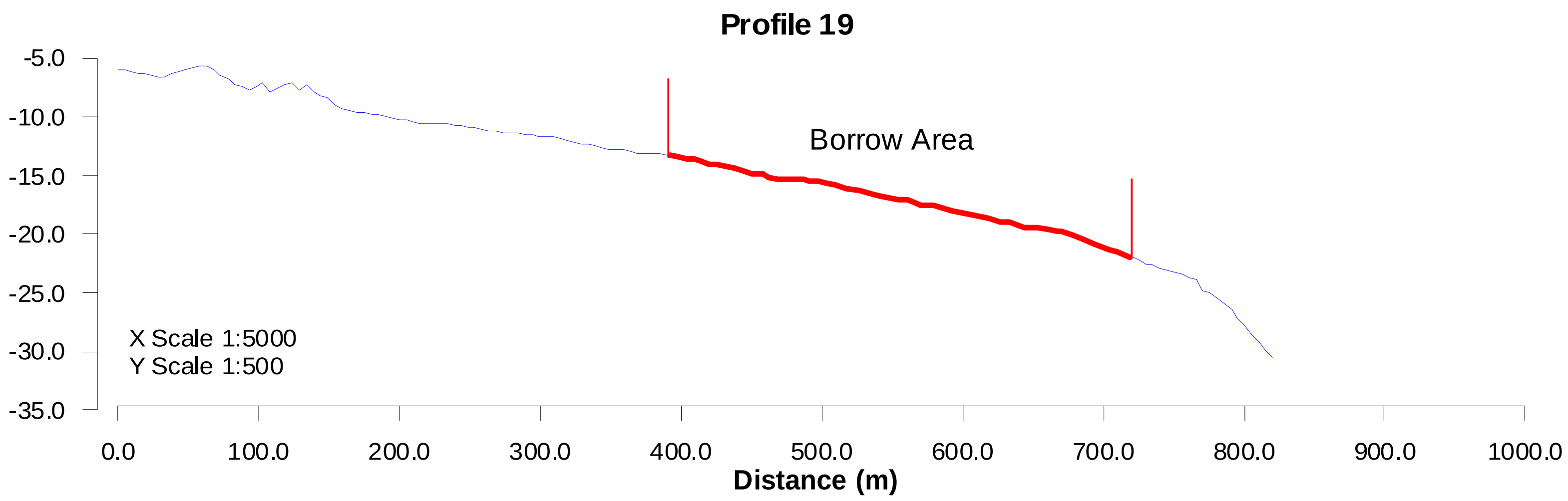
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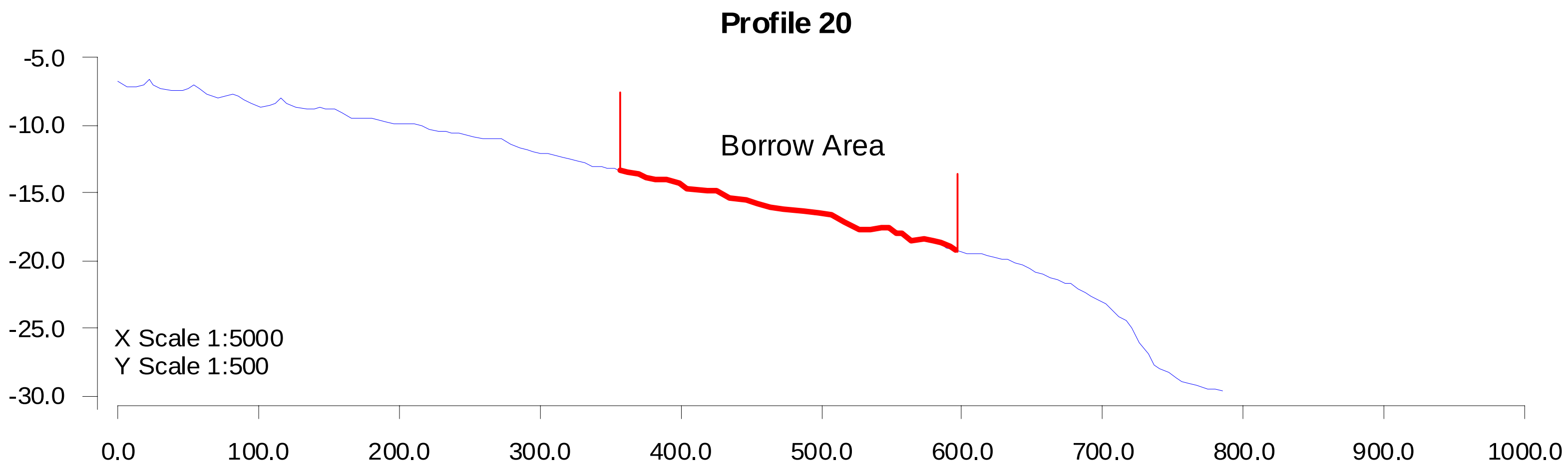
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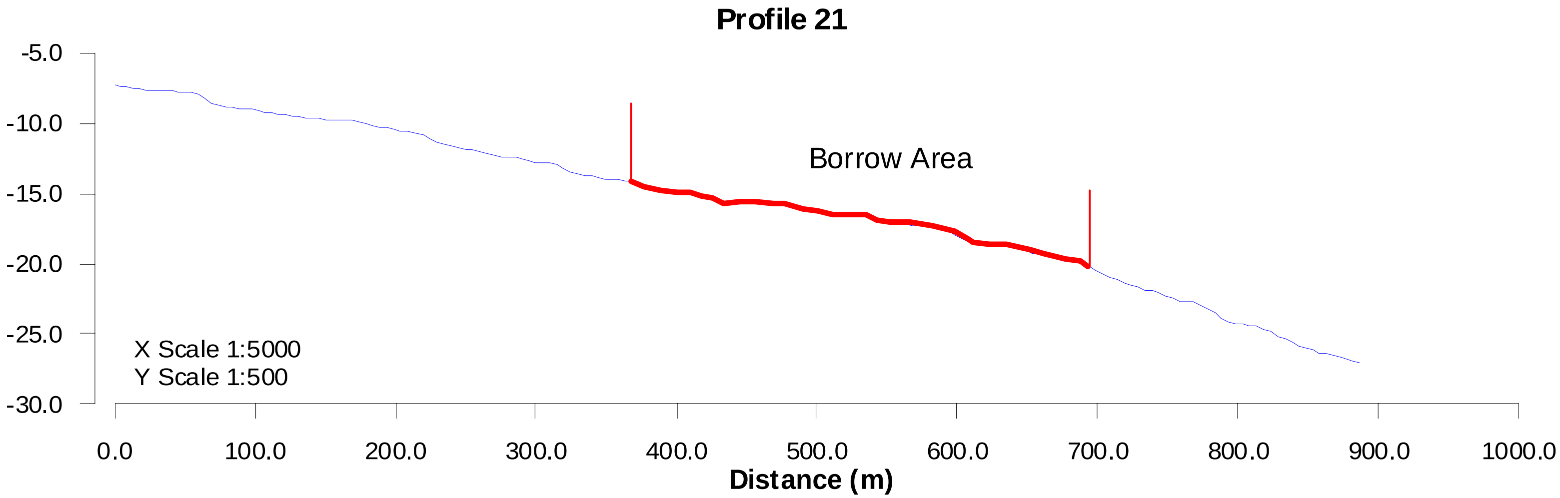
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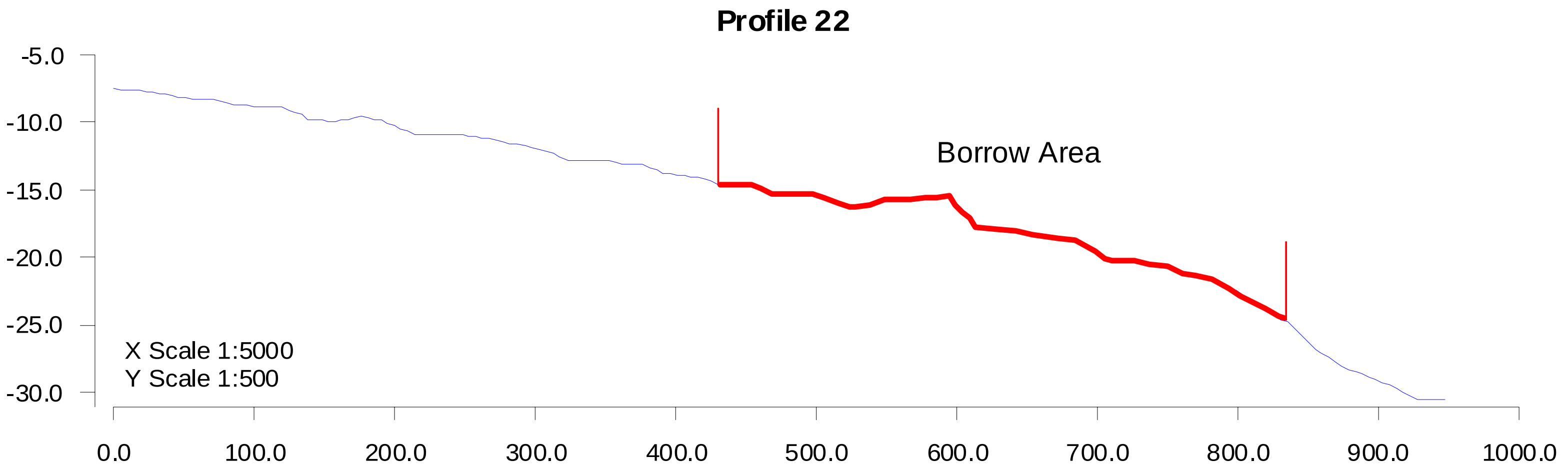
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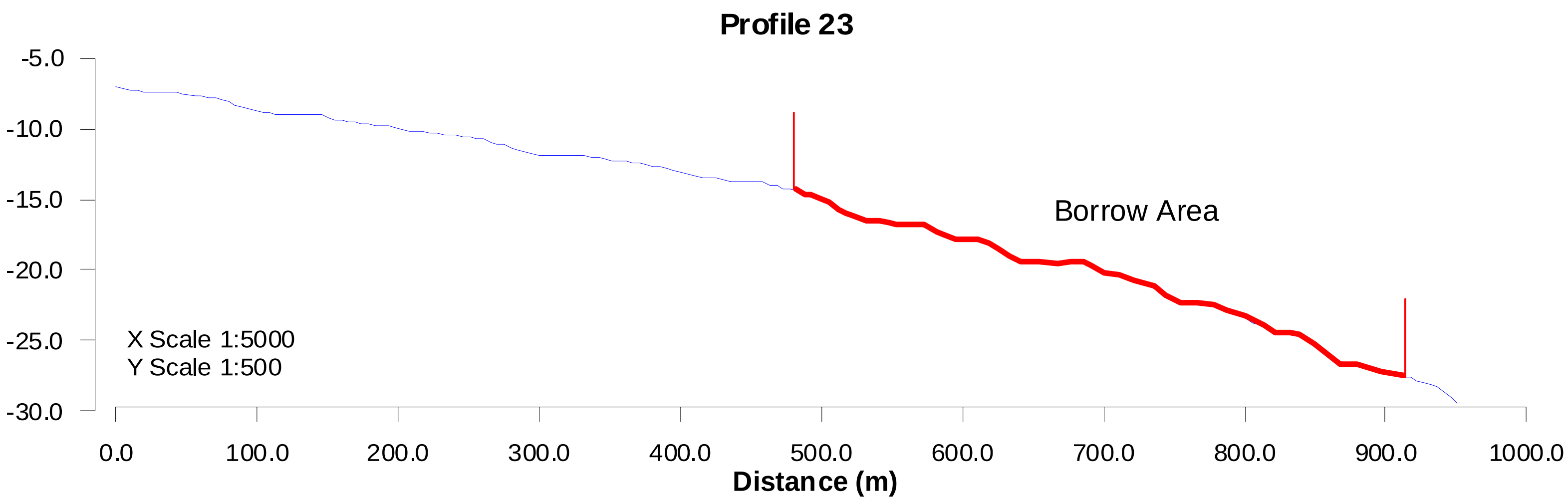
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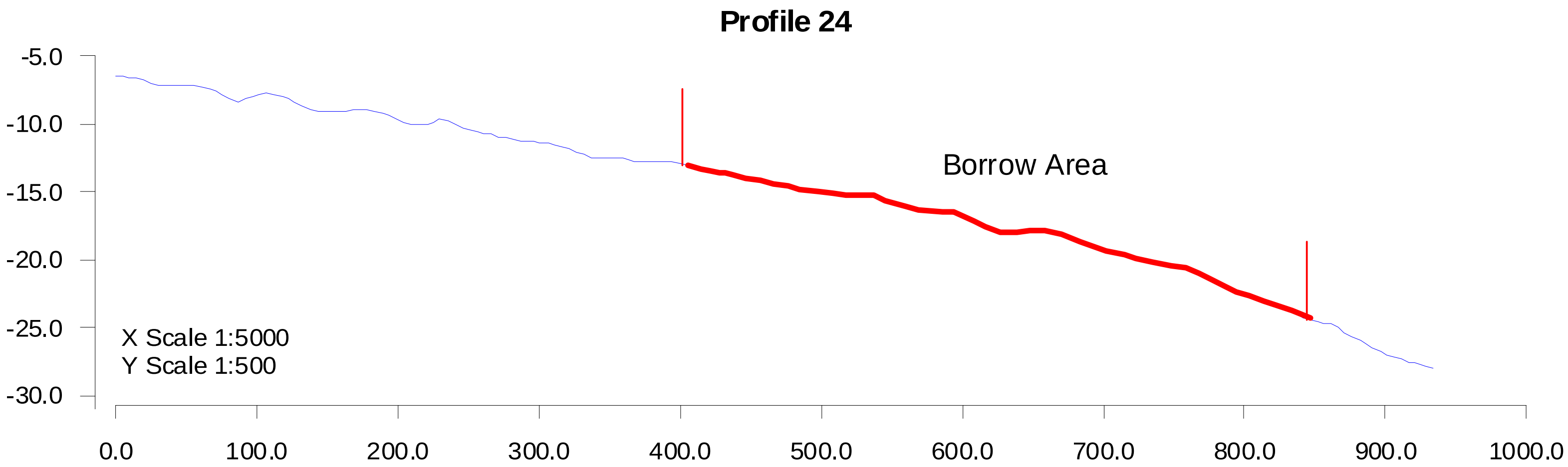
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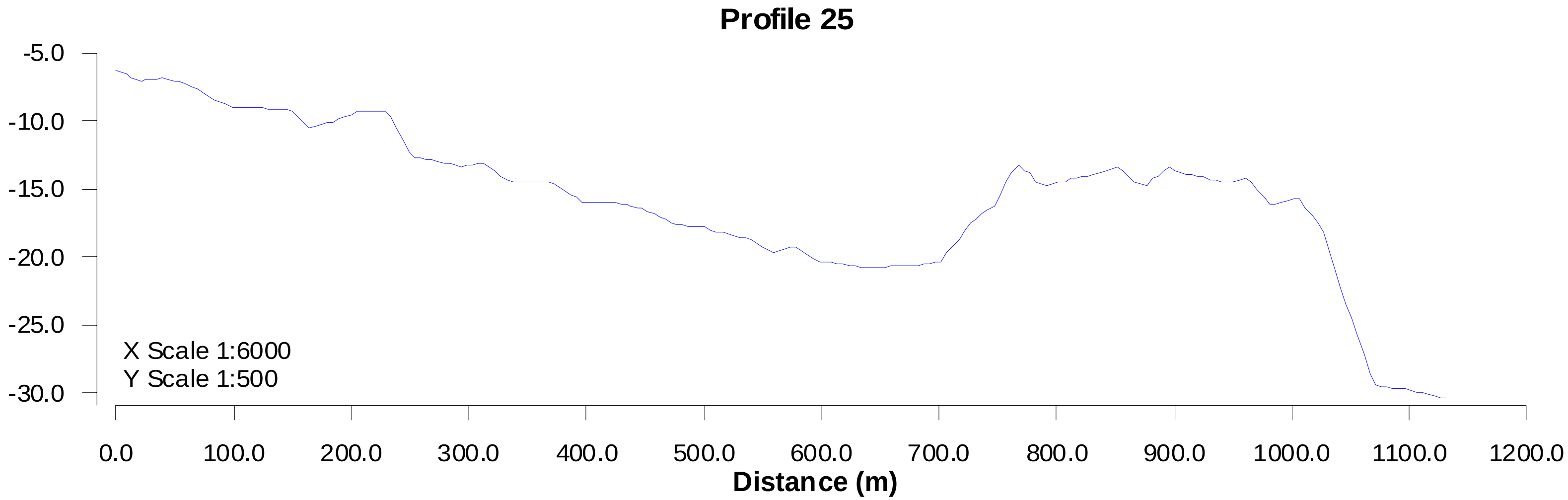
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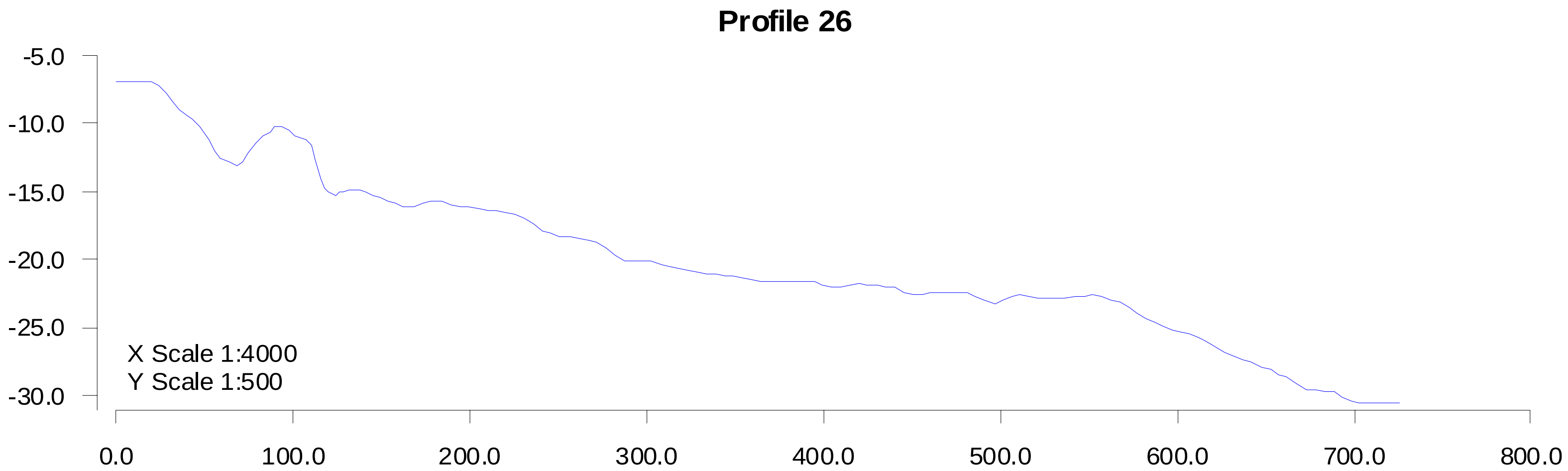
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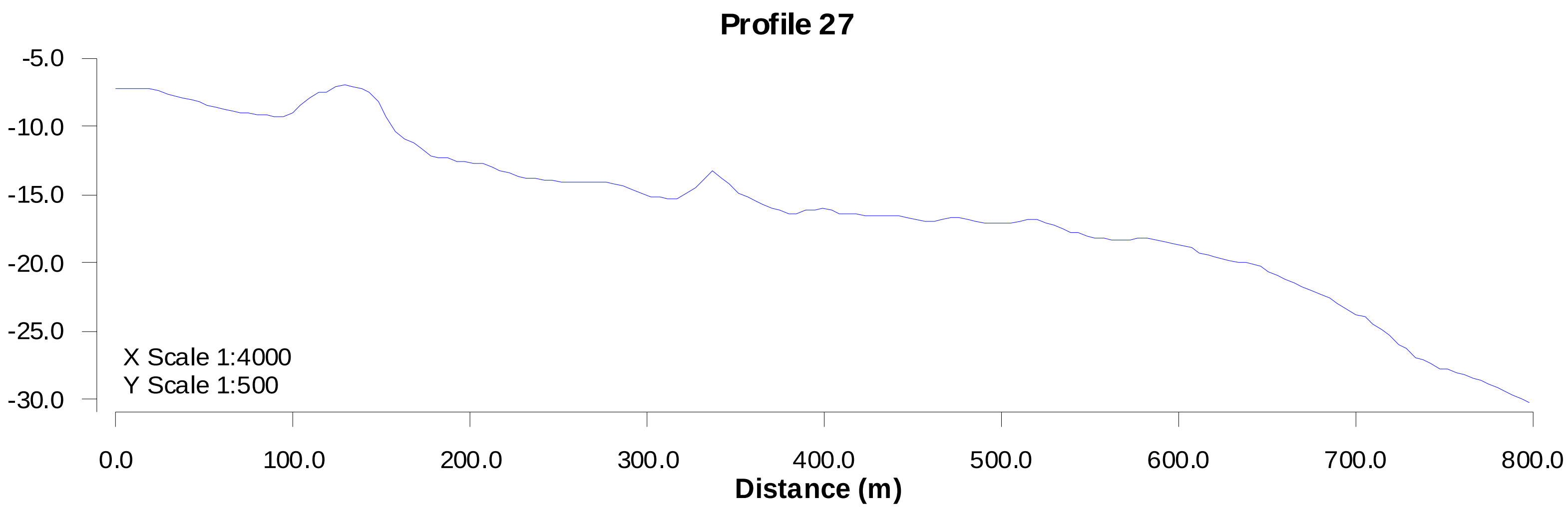
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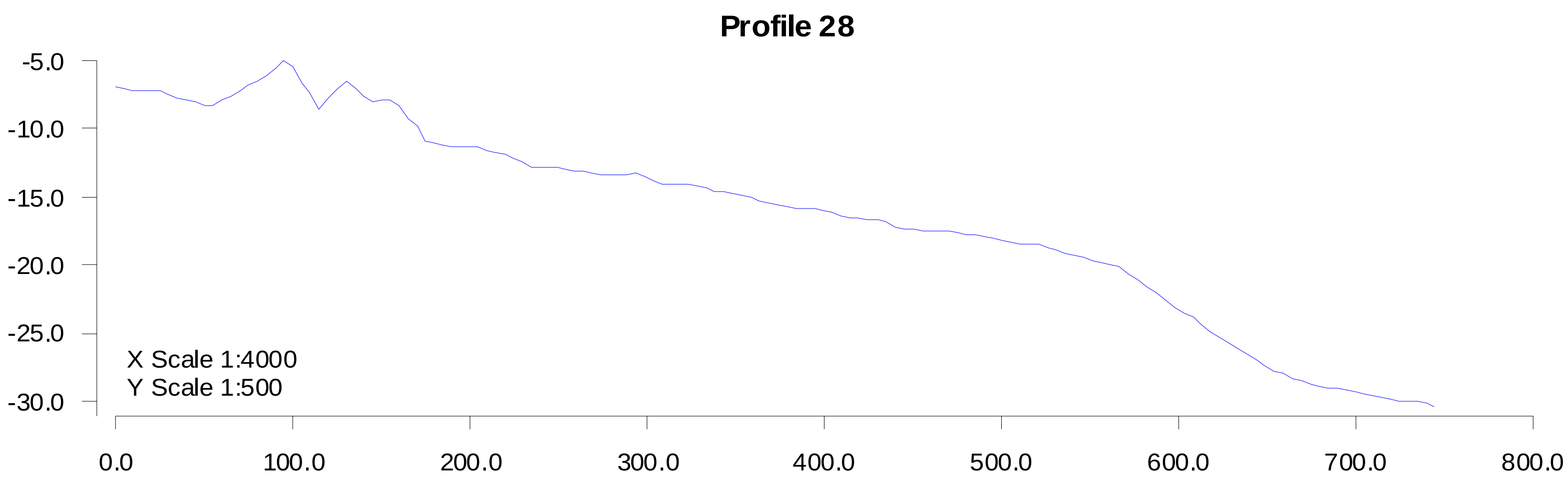
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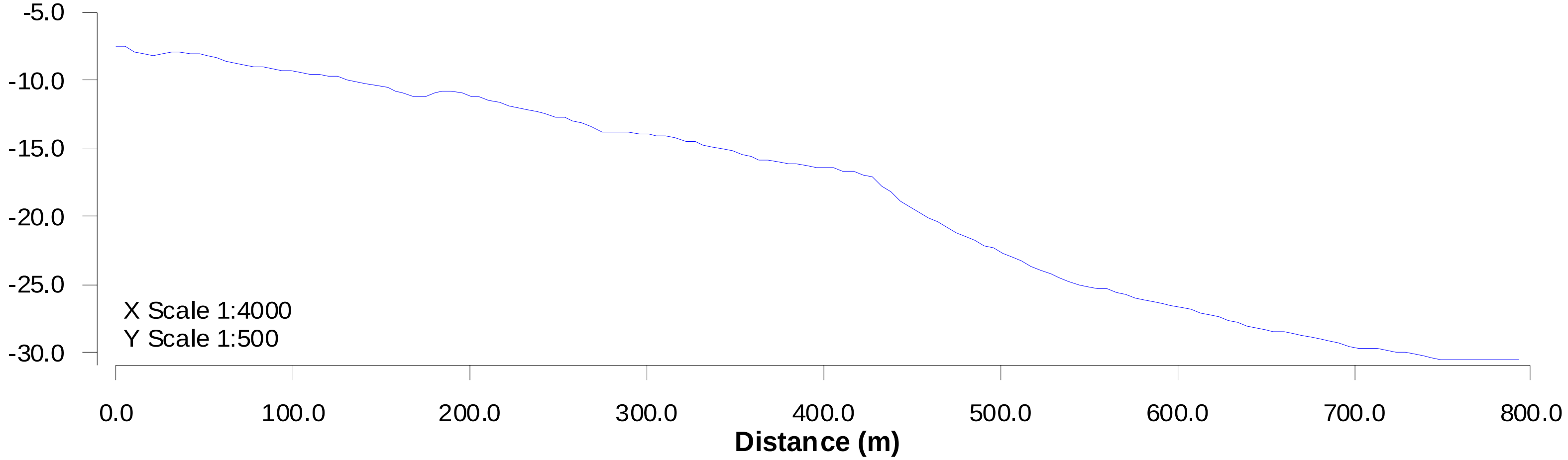

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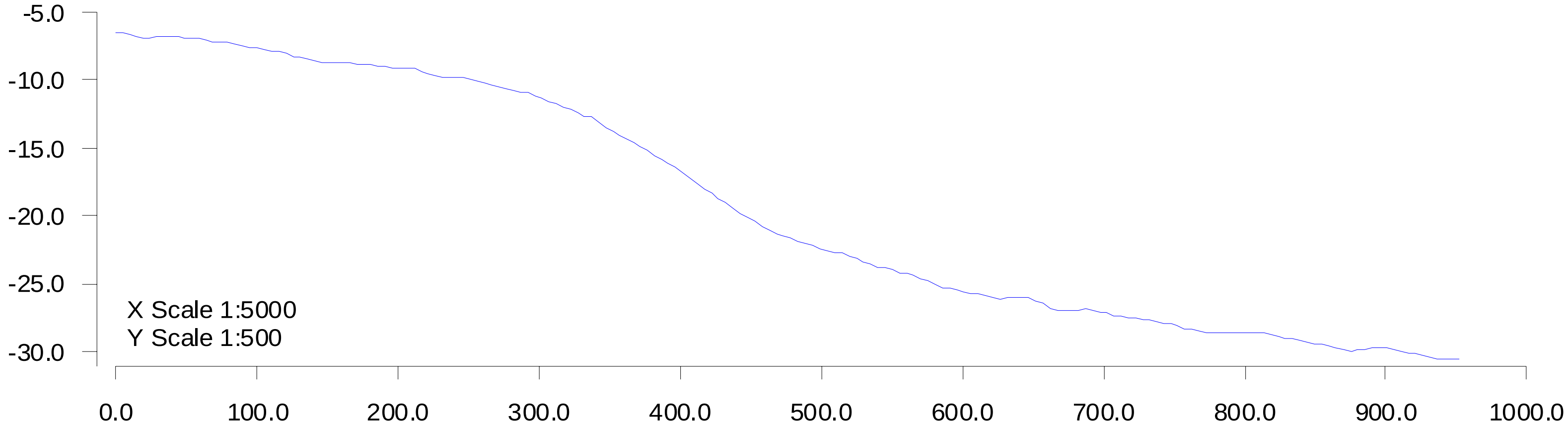

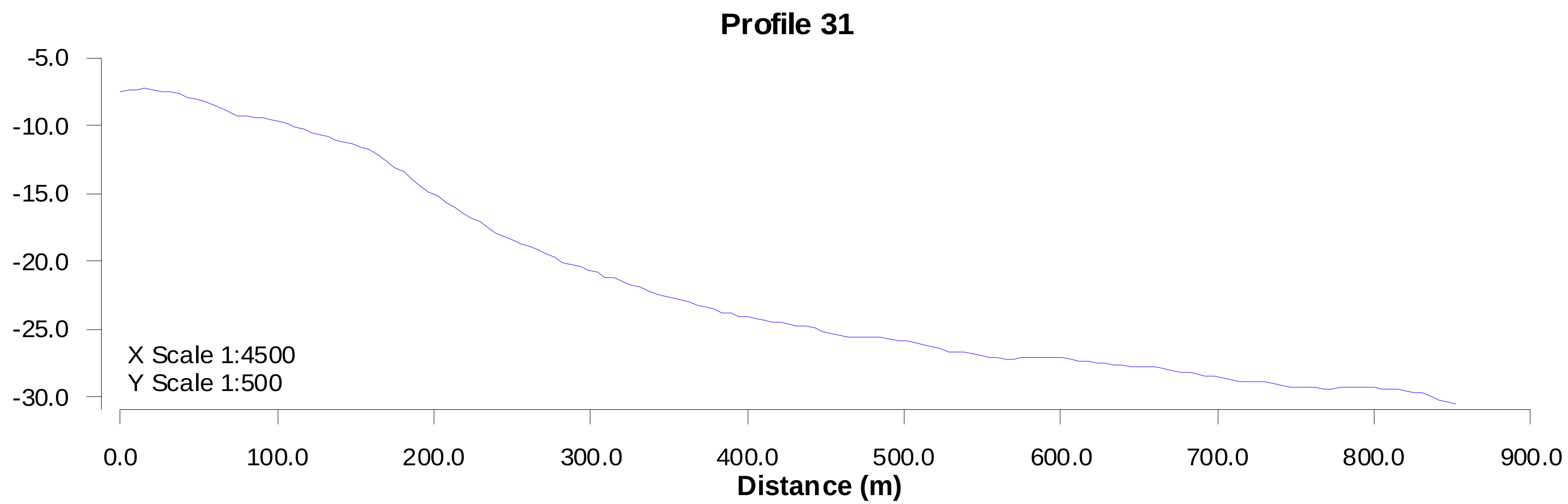
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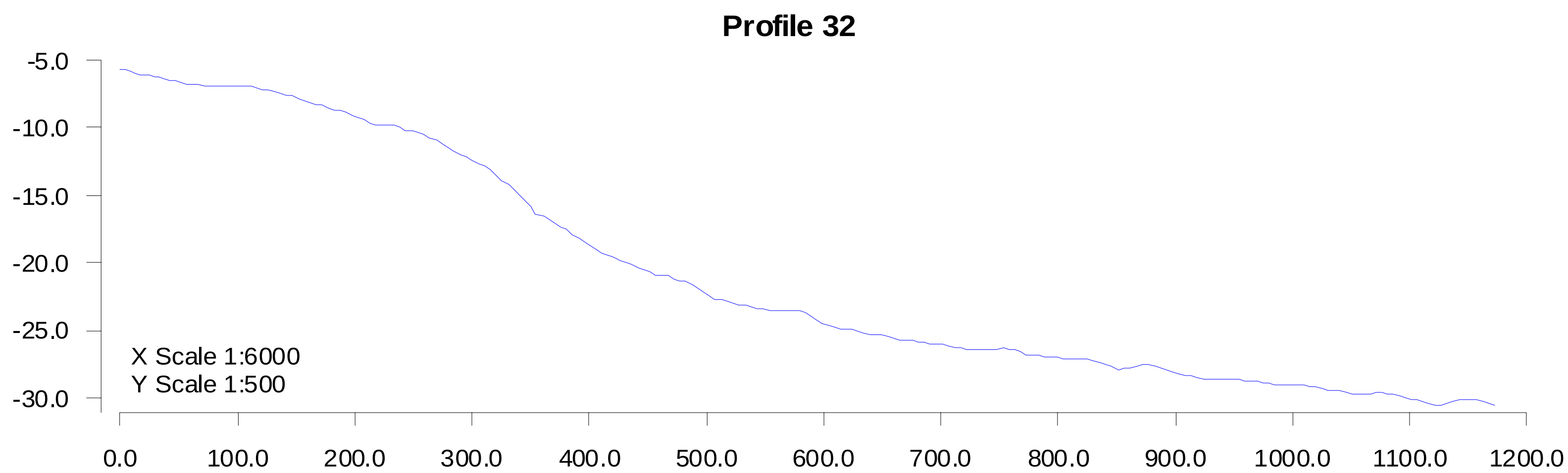
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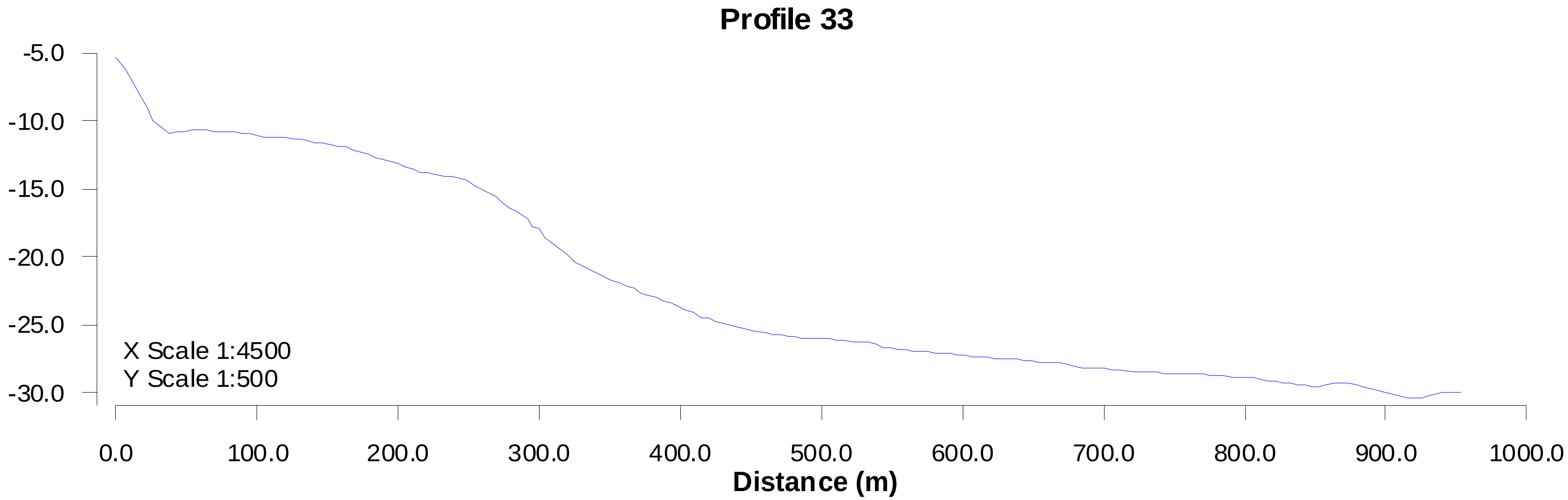
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Y Scale 1:500
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300.0
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500.0
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700.0
800.0
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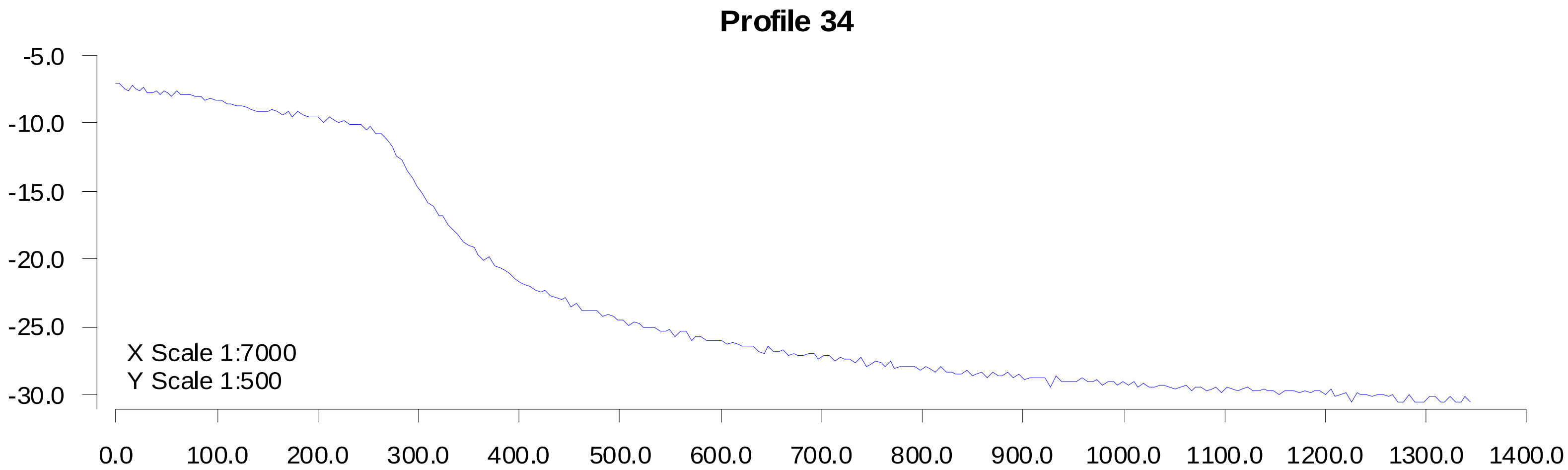
1000.0
Distance (m)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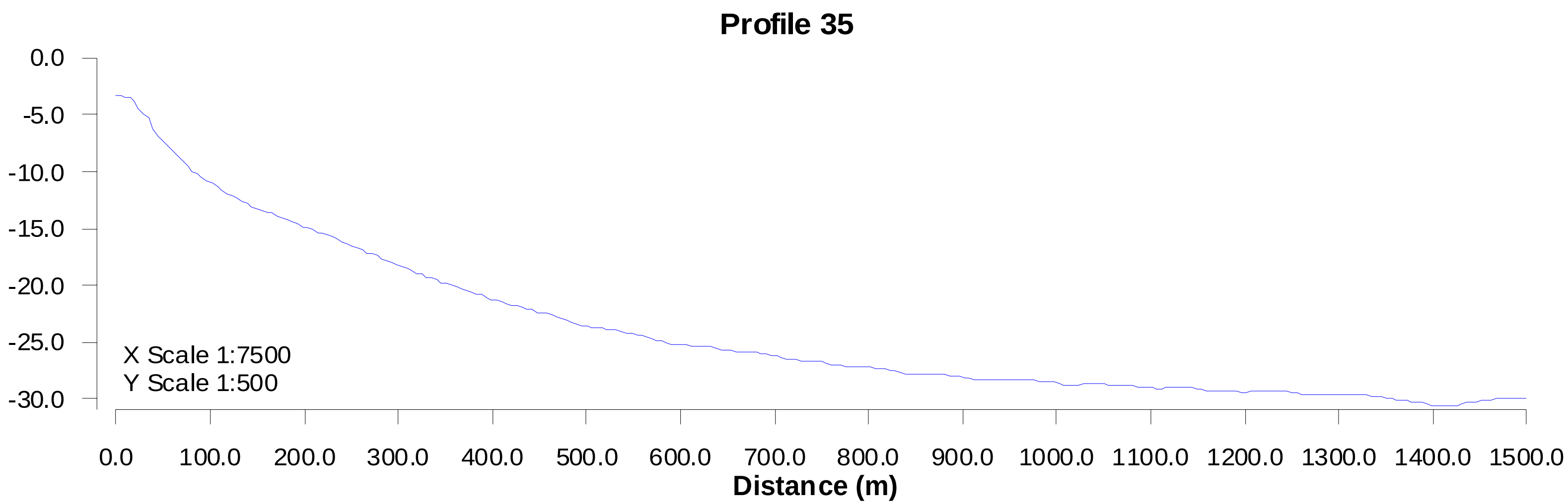
1400.0



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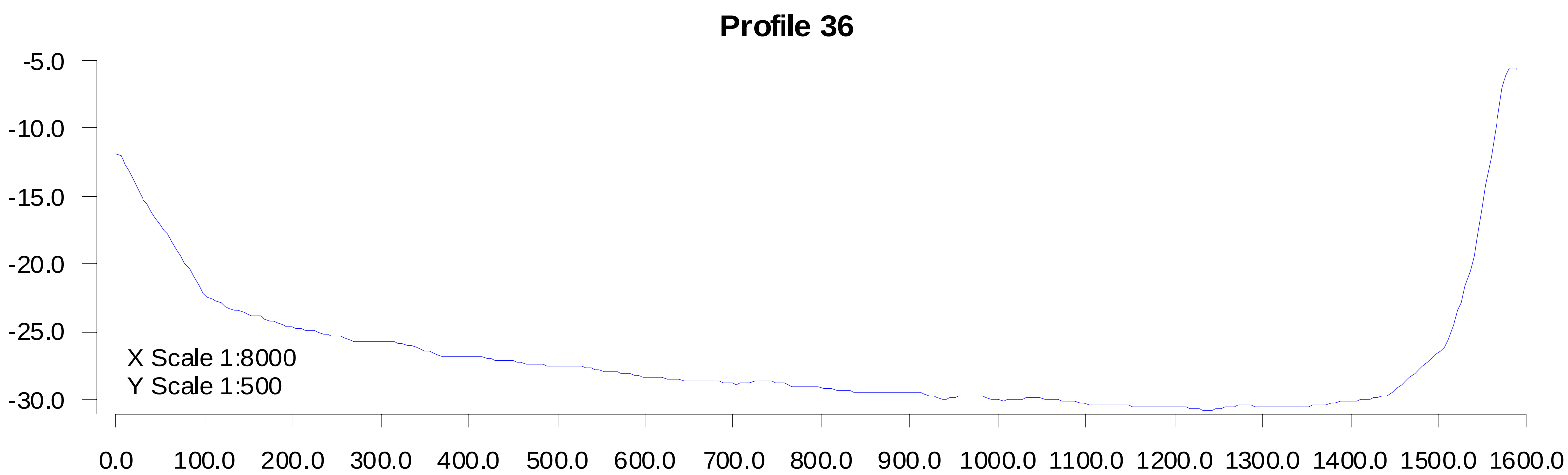
Distance (m)



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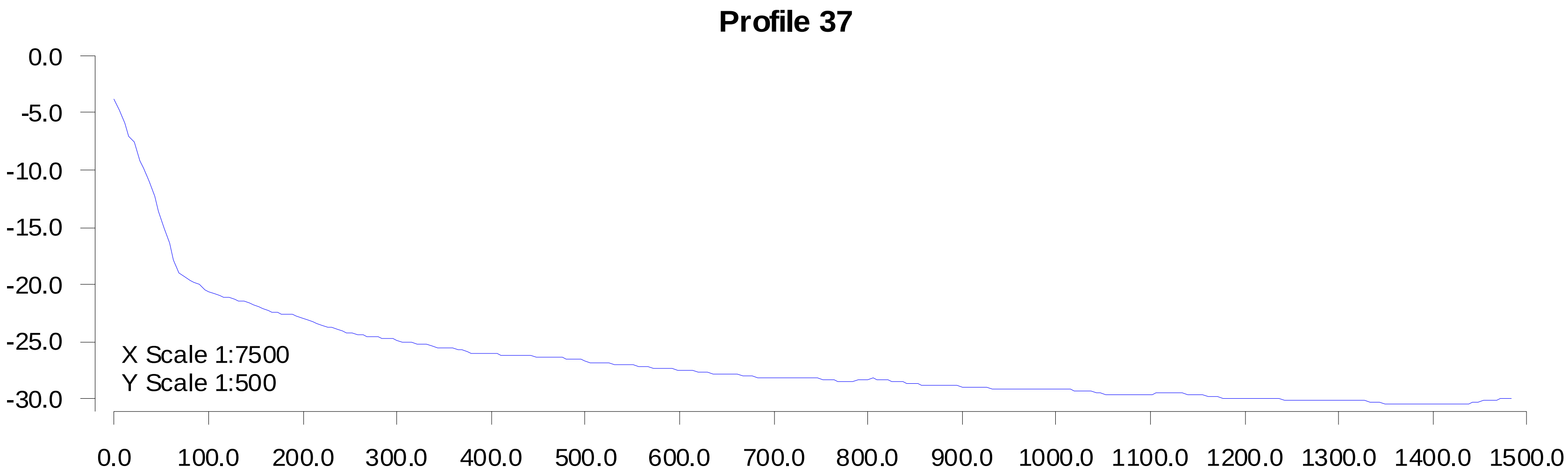
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800.0
900.0
1000.0
1100.0
1200.0
1300.0
1400.0
1500.0

Annex 2

Table 1. Description of diving stations in the borrow area, December, 2006.

Sedimentology Laboratory Analysis (UWI)
Grain Size
Composition

Table 1. Description of diving stations in the borrow area, December, 2006.

Coordinates		Stations	Samples	Depth (m)	Md (mm)	Bottom Description and laboratory information
X (UTM WGS 84)	Y (UTM WGS 84)					
315381.48	1983855.80	5	M5	20.6	0.52	Sandy bottom. Course sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a low density. Sediment thickness: 0.67 m
315371.84	1984040.68	6	M6	20.2	0.42	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a low density. Sediment thickness: > 1.5 m
315155.60	1983892.05	9	M7	19.0	0.48	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a low density. Sediment thickness: > 1.5 m
315163.13	1984067.23	10	M8	18.0	0.47	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a low density. Sediment thickness: > 1.5 m

314980.15	1983963.83	11	M9	19.0	0.48	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a very low density. Sediment thickness: > 1.5 m
314975.85	1984140.91	12	M10	19.0	0.43	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a low density. Sediment thickness: > 1.5 m
314762.42	1984018.72	14	M12	19.0	0.41	Sandy bottom. Medium sand. Beige-white color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
314781.49	1984169.21	15	M13	18.4	0.46	Sandy bottom. Medium sand. Beige-white color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
314569.76	1984240.88	18	M16	15.0	0.41	Sandy bottom. Medium sand. Beige-white color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
314365.50	1984261.39	20	M18	13.0	0.39	Sandy bottom. Medium sand. Beige-white color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m

314316.92	1984112.81	21	M19	20.2	0.35	Sandy bottom. Medium sand. Beige-white color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
314290.47	1984466.37	22	M20	12.6	0.32	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
314060.62	1984363.81	23	M21	13.9	0.30	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
314128.14	1984084.34	24	M22	20.0	0.38	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a very low density. Sediment thickness: > 1.5 m
313900.23	1984033.00	25	M23	18.2	0.36	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a very low density. Sediment thickness: > 1.5 m

313991.80	1984193.76	33	M24	16.0	0.48	Sandy bottom. Medium sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
313861.80	1984270.70	26	M25	13.8	0.34	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
313530.23	1983672.86	27	M26	20.0	0.27	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and coral were observed in a very low density. Sediment thickness: > 1.5 m
313705.54	1983877.83	32	M27	20.0	0.13	Sandy bottom. Fine sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a very low density. Sediment thickness: > 1.5 m
313620.60	1984162.21	31	M28	13.0	0.39	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a very low density. Sediment thickness: > 1.5 m
313258.41	1983486.29	29	M29	18.0	0.44	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a very low density. Sediment thickness: > 1.5 m

313759.24	1984053.85	34	M30	18.0	0.48	Sandy bottom. Medium sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
313358.73	1983724.51	36	M32	16.3	0.51	Sandy bottom. Course sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
313212.56	1983587.26	37	M34	16.0	0.32	Sandy bottom. Medium sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
313119.53	1983284.72	38	M35	21.3	0.2	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
313080.49	1983401.83	39	M36	19.0	0.14	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
313017.21	1983578.45	40	M37	14.0	0.11	Sandy bottom. Fine sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
312956.75	1983058.01	41	M38	21.0	0.28	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a very low density. Sediment thickness: > 1.5 m

312912.54	1983274.57	42	M39	16.0	0.11	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
312870.11	1983442.71	43	M40	13.4	0.13	Sandy bottom. Fine sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
312764.97	1982802.13	44	M41	24.0	0.25	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae and corals were observed in a very low density. Sediment thickness: > 1.5 m
312763.66	1983081.16	45	M42	18.0	0.17	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
312766.56	1982959.02	47	M44	20.0	0.16	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
312573.44	1982689.80	48	M45	21.0	0.13	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
312579.01	1982925.23	49	M46	17.5	0.14	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m

312399.66	1982755.50	51	M48	18.2	0.12	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 1.5 m
315276.01	1983988.65	54	M51	20.0	0.42	Sandy bottom. Medium sand. Beige-white color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
314898.17	1984078.37	56	M52	19.0	0.47	Sandy bottom. Medium sand. Beige-white color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
314681.51	1984266.46	57	M53	15.0	0.48	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
314204.08	1984170.33	58	M54	19.0	0.42	Sandy bottom. Medium sand. Beige-black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
314414.33	1984402.82	59	M55	14.0	0.37	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m

314172.88	1984242.40	60	M56	16.0	0.41	Sandy bottom. Medium sand. Beige-black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
313985.30	1984115.94	61	M57	18.0	0.42	Sandy bottom. Medium sand. Beige-black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
313804.83	1984141.25	62	M58	16.0	0.27	Sandy bottom. Medium sand. Beige-black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
313726.53	1983940.50	63	M59	17.0	0.36	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
313593.77	1984025.99	64	M60	16.0	0.17	Sandy bottom. Fine sand. Beige-black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
313523.08	1983780.36	65	M61	18.0	0.5	Sandy bottom. Medium sand. Beige-black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m

313390.00	1983854.39	66	M62	16.0	0.33	Sandy bottom. Medium sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
313354.64	1983604.16	67	M63	18.0	0.67	Sandy bottom. Course sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
313169.31	1983661.29	68	M64	16.0	0.16	Sandy bottom. Course sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
313055.37	1983489.80	69	M65	16.0	0.14	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
312962.01	1983193.77	70	M66	20.0	0.19	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
312866.62	1983362.12	71	M67	16.0	0.11	Sandy bottom. Fine sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m

312802.42	1983177.94	72	M68	16.0	0.87	Sandy bottom. Course sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
312688.04	1982867.36	73	M69	19.5	0.18	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
312643.12	1983079.33	74	M70	17.0	0.12	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
312422.02	1982983.87	75	M71	13.0	0.13	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
312781.79	1983354.84	B17	M82	12.0	0.099	Sandy bottom. Very fine sand. Beige-white color. Very low density of benthic organisms (mollusks, Halimeda algae and gorgonians). Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m
312257.78	1982838.97	B20	M83	15.0	0.13	Sandy bottom. Fine sand. Beige-Black color. Absence of benthic organisms. Spread skeleton remains of calcareous algae were observed in a very low density. Sediment thickness: > 3.3 m

REPORT ON ACTIVITIES CARRIED OUT BY THE MARINE GEOLOGY UNIT, UWI MONA, FOR THE PALISADOES PROJECT

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Background

On 12 December, 2006, the Marine Geology Unit (MGU) submitted a proposal and quotation to assist in the analysis of samples to be collected on the Palisadoes in connection with the Palisadoes Rehabilitation study being carried out by the National Works Agency. Minor revisions were made to the proposal at the request of the consultants and the proposal was accepted, and work initiated on December 15.

Under the terms of the submission 200 samples were to be analysed for grain size distribution, of which 30 samples, selected by the consultant, were to be analysed further for carbonate percentage by weight, by thin-sectioning, for mineralogical composition. In the event ninety seven samples were received from the consultant, the last being delivered on January 2, 2007. Of these 25 were chosen by the consultant for further analysis, 10 being requested on a priority basis.

Grain Size Analysis

Grain size analyses were carried out on all ninety seven samples received.

Methods

Sample splits of 100-130 g were placed through a nest of thirteen (13) sieves, decreasing in half phi (½ Φ) intervals from - 2.0 Φ (4 mm) to 4.0 Φ (62 µm). The nest was placed on a mechanical shaker for 10 minutes. The initial weight of each sample was recorded prior to sieving and the weight of each fraction of the sediment retained in each sieve was weighed, using a digital balance with precision of 0.01 g. The raw data obtained was used to plot frequency distribution curves and calculate statistical parameters of mean, sorting and skewness. The results are displayed in Table 1.

Carbonate Percentages

Ten samples were requested for analysis on a priority basis and twenty five were analysed altogether.

Methods

Samples were analysed chemically by acid digestion. Two to three grams of each sample were weighed, placed in dishes and treated with concentrated hydrochloric acid, mixed with an equal volume of water, for fifteen minutes. More acid was added after this time to ensure complete dissolution of the contained carbonate. The samples were then washed and reweighed after oven drying and the percentage of carbonate calculated from the results. Three cuts of each sample were processed and the mean carbonate percentage obtained from the three results. For five of the samples the mean was determined from two results after rejecting the third as being outside the limits of the parameters used for quality control Table 2). Relatively wide variation in results for each sample were probably caused by the inclusion in some of *Halimeda* plates (carbonate), that were much larger than the sample mean grain size and so tended to be unevenly distributed between the three cuts used for each sample. The following 4 samples were re-analysed for quality control:

M36, M41, M72, L08

The results for these replace those given in the original report in Table 2 below.

Thin Section Analysis of Composition

Ten samples were requested on a priority basis by the consultant and twent five were requested altogether. The first ten thin sections were completed and delivered on January 27, 2007. These were analysed and the final results emailed to the consultant on January 31, 2007. The results are attached as Table 3.

Methods

Thin sections of grain mounts were prepared by the subcontractor, Optical identification of grains was carried out using a petrographic microscope, 200 grains being identified for each sample. The crystalline entry for each sample includes crystalline and microcrystalline material too fine grained for adequate identification.

Grain size analysis, Sediment samples. Palisadoes Study										
	Marine	**Land**								
X (UTM WGS 84)	**Y (UTM WGS 84)**	**Y (UTM WGS 84)**	**Lab #**	**Samples**	**Depth (m)**	**Mean (Φ)**	**Std Dev**	**Skewness**	**Kurtosis**	
315662.55	1983986.96		MGUL 1	M1	**17**	**1.31**	**0.46**	**0.35**	**6.39**	
315614.41	1983834.63		MGUL 2	M2	**18**	**0.66**	**0.57**	**-0.95**	**5.82**	
315575.53	1984127.47		MGUL 3	M3	**21**	**1.47**	**0.51**	**-0.54**	**10.12**	
315518.72	1984011.63		MGUL 4	M4	**20.3**	**1.33**	**0.47**	**0.30**	**10.04**	
315381.48	1983855.8		MGUL 5	M5	**20.6**	**0.93**	**0.46**	**-0.43**	**6.49**	
315371.84	1984040.68		MGUL 6	M6	**20.2**	**1.26**	**0.30**	**-0.81**	**11.90**	
315155.6	1983892.05		MGUL 7	M7	**19**	**1.07**	**0.61**	**-0.77**	**5.46**	
315163.13	1984067.23		MGUL 8	M8	**18**	**1.10**	**0.70**	**-2.38**	**8.87**	
314980.15	1983963.83		MGUL 9	M9	**19**	**1.06**	**0.72**	**-1.02**	**5.35**	
314975.85	1984140.91		MGUL 10	M10	**19**	**1.23**	**0.64**	**-2.01**	**8.80**	
314972.26	1984201.29		MGUL 11	M11	**17**	**1.16**	**1.20**	**-0.92**	**3.20**	
314762.42	1984018.72		MGUL 12	M12	**19**	**1.28**	**0.56**	**-1.70**	**8.75**	
314781.49	1984169.21		MGUL 13	M13	**18.4**	**1.11**	**0.76**	**-1.43**	**5.85**	
314782.96	1984325.99		MGUL 14	M14	**16.4**	**1.04**	**0.90**	**-1.03**	**4.12**	
314554.06	1984082.18		MGUL 15	M15	**21.5**	**1.48**	**0.53**	**-0.62**	**8.62**	
314569.76	1984240.88		MGUL 16	M16	**15**	**1.27**	**0.59**	**-1.59**	**7.86**	

Sediment samples. Palisadoes Study										
	Marine	**Land**								
X (UTM WGS 84)	**Y (UTM WGS 84)**	**Y (UTM WGS 84)**	**Lab #**	**Samples**	**Depth (m)**	**Mean (Φ)**	**Std Dev**	**Skewness**	**Kurtosis**	
314568.07	1984361.28		MGUL 17	M17	**13**	**1.59**	**0.60**	**-1.68**	**9.68**	
314365.5	1984261.39		MGUL 18	M18	**13**	**1.36**	**0.51**	**-1.46**	**8.49**	
314316.92	1984112.81		MGUL 19	M19	**20.2**	**1.51**	**0.56**	**-0.96**	**7.57**	
314290.47	1984466.37		MGUL 20	M20	**12.6**	**1.64**	**0.66**	**-1.23**	**8.88**	
314060.62	1984363.81		MGUL 21	M21	**13.9**	**1.76**	**0.57**	**-1.42**	**10.46**	
314128.14	1984084.34		MGUL 22	M22	**20**	**1.39**	**0.73**	**-1.58**	**6.08**	
313900.23	1984033		MGUL 23	M23	**18.2**	**1.46**	**0.40**	**-0.33**	**6.21**	
313991.8	1984193.76		MGUL 24	M24	**16**	**1.55**	**0.40**	**-0.16**	**8.11**	
313861.8	1984270.7		MGUL 25	M25	**13.8**	**1.90**	**0.66**	**-1.18**	**8.61**	
313530.23	1983672.86		MGUL 26	M26	**20**	**1.19**	**0.79**	**-0.05**	**4.29**	
313705.54	1983877.83		MGUL 27	M27	**20**	**1.36**	**0.60**	**-0.39**	**7.10**	
313620.6	1984162.21		MGUL 28	M28	**13**	**2.94**	**0.80**	**-1.71**	**8.28**	
313258.41	1983486.29		MGUL 29	M29	**18**	**1.06**	**0.60**	**-0.34**	**4.83**	
313759.24	1984053.85		MGUL 30	M30	**18**	**1.06**	**0.72**	**-1.02**	**5.35**	
313412.95	1984011.49		MGUL 31	M31	**13**	**2.69**	**0.90**	**-1.32**	**6.02**	
313358.73	1983724.51		MGUL 32	M32	16.3	0.98	0.99	-0.33	4.13	

Sediment samples. Palisadoes Study										
	Marine	**Land**								
X (UTM WGS 84)	**Y (UTM WGS 84)**	**Y (UTM WGS 84)**	**Lab #**	**Samples**	**Depth (m)**	**Mean (Φ)**	**Std Dev**	**Skewness**	**Kurtosis**	
313203.67	1983785.53		MGUL 33	M33	13	2.21	0.91	-0.61	4.12	
313212.56	1983587.26		MGUL 34	M34	16	1.64	1.06	-0.10	3.18	
313119.53	1983284.72		MGUL 35	M35	21.3	2.31	1.35	-1.07	3.28	
313080.49	1983401.83		MGUL 36	M36	19	2.81	0.89	-1.12	3.97	
313017.21	1983578.45		MGUL 37	M37	14	**3.16**	**0.61**	**-2.37**	**12.31**	
312956.75	1983058.01		MGUL 38	M38	21	1.82	1.41	-0.31	2.23	
312912.54	1983274.57		MGUL 39	M39	16	3.18	0.53	-2.41	14.29	
312870.11	1983442.71		MGUL 40	M40	13.4	2.97	0.79	-2.58	11.27	
312764.97	1982802.13		MGUL 41	M41	24	1.99	1.19	-0.20	2.13	
312763.66	1983081.16		MGUL 42	M42	18	2.55	1.05	-0.84	3.12	
312662.14	1983294.7		MGUL 43	M43	11	3.18	0.80	-2.00	8.06	
312766.56	1982959.02		MGUL 44	M44	20	2.67	1.10	-1.13	3.47	
312573.44	1982689.8		MGUL 45	M45	21	2.94	0.59	-1.71	9.09	
312579.01	1982925.23		MGUL 46	M46	17.5	2.79	0.84	-1.60	6.55	
312494.93	1983105.7		MGUL 47	M47	14	3.22	0.59	-1.61	6.95	
312399.66	1982755.5		MGUL 48	M48	18.2	3.08	0.64	-2.29	10.69	

Sediment samples. Palisadoes Study										
	Marine	**Land**								
X (UTM WGS 84)	**Y (UTM WGS 84)**	**Y (UTM WGS 84)**	**Lab #**	**Samples**	**Depth (m)**	**Mean (Φ)**	**Std Dev**	**Skewness**	**Kurtosis**	
315578.26	1983919.13		MGUL 49	M49	18	1.06	0.50	-1.13	6.56	
315459.45	1984078.81		MGUL 50	M50	18	1.61	0.66	-0.56	9.24	
315276.01	1983988.65		MGUL 51	M51	20	1.24	0.56	-1.43	9.54	
314898.17	1984078.37		MGUL 52	M52	19	1.10	0.70	-1.63	7.11	
314681.51	1984266.46		MGUL 53	M53	15	1.06	0.85	-1.36	5.24	
314204.08	1984170.33		MGUL 54	M54	19	1.25	0.61	-1.62	9.97	
314414.33	1984402.82		MGUL 55	M55	14	1.42	0.90	-1.22	5.69	
314172.88	1984242.4		MGUL 56	M56	16	1.28	0.71	-1.55	8.08	
313985.3	1984115.94		MGUL 57	M57	18	1.24	0.64	-1.44	8.92	
313804.83	1984141.25		MGUL 58	M58	16	1.89	0.69	-0.66	6.94	
313726.53	1983940.5		MGUL 59	M59	17	1.49	0.93	-0.05	4.54	
313593.77	1984025.99		MGUL 60	M60	16	2.57	1.19	-1.37	4.72	
313523.08	1983780.36		MGUL 61	M61	18	1.01	0.86	-0.57	5.31	
313390	1983854.39		MGUL 62	M62	16	1.58	1.33	-0.19	2.61	
313354.64	1983604.16		MGUL 63	M63	18	0.57	1.25	0.27	3.17	
313169.31	1983661.29		MGUL 64	M64	16	2.65	0.94	-0.97	3.80	

Sediment samples. Palisadoes Study										
	Marine	**Land**								
X (UTM WGS 84)	**Y (UTM WGS 84)**	**Y (UTM WGS 84)**	**Lab #**	**Samples**	**Depth (m)**	**Mean (Φ)**	**Std Dev**	**Skewness**	**Kurtosis**	
313055.37	1983489.8		MGUL 73	M65	16	2.81	0.74	-1.07	5.13	
312962.01	1983193.77		MGUL 74	M66	20	2.36	1.28	-0.61	2.38	
312866.62	1983362.12		MGUL 75	M67	16	3.23	0.59	-1.64	8.24	
312802.42	1983177.94		MGUL 76	M68	16	0.17	1.34	0.23	2.18	
312688.04	1982867.36		MGUL 77	M69	19.5	2.44	0.92	-1.26	4.88	
312643.12	1983079.33		MGUL 78	M70	17	3.06	0.91	-2.12	8.70	
312422.02	1982983.87		MGUL 79	M71	13	2.93	0.89	-1.99	7.63	
309935.67	1982860.73		MGUL 80	M72	25	2.82	1.49	-0.81	2.44	
315475.95	1984126.46		MGUL 81	M73	20	1.02	1.04	-1.02	4.29	
315280.09	1984144.98		MGUL 82	M74	19	1.46	0.80	-1.54	6.77	
315001.59	1984208.81		MGUL 83	M75	17	0.95	1.03	-1.13	3.63	
314887.74	1984273.83		MGUL 84	M76	17.6	0.17	1.34	0.23	2.18	
314768.92	1984312.51		MGUL 85	M77	16.5	1.03	0.97	-0.83	4.20	
314400.76	1984418.07		MGUL 86	M78	13.1	1.56	0.75	-1.66	7.72	
313942.82	1984322.42		MGUL 87	M79	12	1.89	0.53	0.08	6.60	
313535.87	1984097.37		MGUL 88	M80	13	2.82	1.07	-1.90	7.17	

Sediment samples. Palisadoes Study										
	Marine	Land								
X (UTM WGS 84)	**Y (UTM WGS 84)**	**Y (UTM WGS 84)**	**Lab #**	**Samples**	**Depth (m)**	**Mean (Φ)**	**Std Dev**	**Skewness**	**Kurtosis**	
313100.59	1983691.27		MGUL 89	M81	14	2.84	0.82	-1.09	4.67	
312781.79	1983354.84		MGUL 90	M82	12	3.33	0.59	-3.22	21.11	
312257.78	1982838.97		MGUL 91	M83	15	2.93	0.76	-2.06	8.55	
311888		1983322.36	MGUL 65	L1	Beach Face	1.35	0.55	-0.37	5.25	
312543.78		1983974.39	MGUL 66	L2	Dune	1.82	0.79	-0.44	4.36	
312904.92		1984244.77	MGUL 67	L3	Beach Face	1.26	0.83	0.10	3.01	
312894.9		1984265.39	MGUL 68	L4	Dune	1.10	0.76	0.37	3.69	
313771.18		1984885.65	MGUL 69	L5	Dune	1.39	0.50	1.22	8.25	
314711.06		1984903.28	MGUL 70	L6	At North of the road	-0.54	1.03	0.50	2.89	
314704.88		1984874.16	MGUL 71	L7	Beach Face	-0.42	0.86	-0.56	3.26	
314709.21		1984880.4	MGUL 72	L8	Beach Face	0.15	0.76	-1.26	3.69	L8 (25/12/06)
318633.45		1985200.08	MGUL 92	L9	Beach Face	-0.73	0.21	0.42	7.68	L8 30/12/06
315384.25		1984621.21	MGUL 93	L10	Beach Face	-1.68	0.18	2.12	5.95	
315813.14		1984568.96	MGUL 94	L11	Beach Face	0.42	0.77	0.31	5.99	
315828.88		1984580.91	MGUL 95	L12	Duna	-0.71	0.40	0.38	3.53	

Sediment samples. Palisadoes Study										
	Marine	Land								
X (UTM WGS 84)	Y (UTM WGS 84)	Y (UTM WGS 84)	Lab #	Samples	Depth (m)	Mean (Φ)	Std Dev	Skewness	Kurtosis	
316674.32		1984766.76	MGUL 96	L13	Beach Face	0.38	0.42	-1.79	9.02	
317399.15		1984991.32	MGUL 97	L14	Beach Face	1.32	0.81	0.38	3.23	

TABLE 1. Grain size analyses for samples submitted from the Palisadoes Project.

SAMPLE #	DISH	D PLUS S	D POST HCL	% CARB	TOTALS	MEAN %	BEST 2	MEAN 2
M05	207.33	210.33	208.57	58.67				
	203.55	206.68	204.89	57.19				
	203.37	206.47	204.89	50.97	166.82	55.61		
M18	207.3	209.44	208.9	25.23				
	203.52	206.15	205.51	24.33				
	203.35	205.52	205	23.96	73.53	24.51		
M19	204.5	206.73	206.12	27.35				
	203.46	206.1	205.51	22.35				
	203.04	205.7	205.03	25.19	74.89	24.96		
M35	207.5	210.74	210.3	13.58				
	203.38	207.65	207.12	12.41				
	203.39	206.1	205.76	12.55	38.54	12.85		
M36	204.51	208.62	208.21	9.98				
	203.47	207.28	206.86	11.02				
	203.05	207.49	207.05	9.91	30.91	10.30		
M37	207.32	210.22	209.9	11.03				
	203.54	206.44	206.1	11.72				
	203.37	207.44	206.94	12.29	35.04	11.68		
M41	207.48	212.47	211.94	10.62				
	203.35	209.07	208.51	9.79				
						10.47		
	203.41	209.60	208.92	10.99	31.40			
M46	207.32	209.63	209.36	11.69				
	203.55	207.36	206.93	11.29				
	203.37	205.64	205.38	11.45	34.43	11.48		

M50	207.51	212.15	210.85	28.02				
	203.38	206.39	205.56	27.57				
	203.4	206.59	205.63	30.09	85.69	28.56		
M51	204.52	207.68	206.43	39.56				
	203.47	206.61	205.34	40.45				
	203.06	206.38	205.15	37.05	117.05	39.02		
M55	204.39	207.29	206.28	34.83				
	203.69	207.75	206.27	36.45				
	202.99	206.8	205.52	33.60	104.88	34.96		
M59	207.35	210.97	210.45	14.36				
	203.55	206.56	206.13	14.29				
	203.37	206.69	206.24	13.55	42.20	14.07		
M60	204.51	206.84	206.45	16.74				
	203.45	206.01	205.66	13.67				
	203.03	206.61	206.17	12.29	42.70	14.23		
M65	207.52	210.64	210.37	8.65				
	203.38	206.4	206.23	5.63				
	203.41	206.55	206.27	8.92	23.20	7.73	17.57	8.79
M69	207.51	210.56	210.32	7.87				
	203.39	206.39	206.26	4.33				
	203.41	206.89	206.61	8.05	20.25	6.75	15.91	7.96
M71	204.51	209.29	208.74	11.51				
	203.47	207.73	207.22	11.97				
	203.05	206.28	205.89	12.07	35.55	11.85		

M72	204.39	210.11	208.68	25.00				
	203.69	208.10	206.97	25.62				
	202.99	207.19	205.99	28.57	79.20	26.40		
L01	204.39	208.16	207.88	7.4				
	203.68	206.89	206.63	8.1				
	202.99	206.66	206.38	7.6	23.2	7.7		
L02	204.52	207.61	207.43	5.83				
	203.48	206.57	206.43	4.53				
	203.05	206.06	205.91	4.98	15.34	5.11		
L03	207.32	209.38	209.22	7.77				
	203.53	206.04	205.90	5.58				
	203.37	205.34	205.20	7.11	20.45	6.82		
L04	204.54	206.59	206.49	4.88				
	203.48	205.54	205.49	2.43				
	203.06	205.16	205.13	1.43	8.73	2.91	3.86	1.93
L05	207.53	209.46	209.40	3.11				
	203.40	205.45	205.35	4.88				
	203.42	205.53	205.46	3.32	11.30	3.77	6.43	3.21
L06	204.39	207.52	206.99	16.93				
	203.69	206.77	206.35	13.64				
	202.49	205.51	205.05	15.23	45.80	15.27		
L08 (30TH)	207.33	211.45	211.18	6.55				
	203.54	209.20	208.87	5.83				
	203.37	209.38	209.03	5.82	18.21	6.07		

L11	204.37	207.69	207.52	5.12					
	203.67	205.78	205.61	8.06					
	202.99	205.95	205.82	4.39	17.57	5.86		9.51	4.76

TABLE 2. Estimates of carbonate percentage in twenty five samples submitted from the Palisadoes Project.

TABLE 3. Composition of sand grains in ten sediment samples submitted from the Palisadoes Project.

M18 *(MGUL 18)*	
CONSTITUENT	%
total carbonate	17.07
crystalline	17.48
opaque	0.81
Rock fragments	10.57
amphibole	0.81
feldspar	2.85
quartz	50.41

M 19 *(MGUL 19)*	
CONSTITUENT	%
total carbonate	21.57
crystalline	0.00
opaque	7.84
Rock fragments	0.00
amphibole	0.00
feldspar	2.45
quartz	68.14

M 36 *(MGUL 36)*	
CONSTITUENT	%
total carbonate	7.01
crystalline	0.00
opaque	0.00
Rock fragments	0.00
amphibole	1.40
feldspar	4.67
quartz	86.92

M 41 *(MGUL 41)*	
CONSTITUENT	%
total carbonate	11.50
crystalline	8.00
opaque	3.50
Rock fragments	6.50
amphibole	2.00
feldspar	6.00
quartz	62.50

M 46 *(MGUL 46)*	
CONSTITUENT	%
total carbonate	9.95
crystalline	0.00
opaque	2.99
Rock fragments	0.00
amphibole	0.00
feldspar	0.00
quartz	87.06

M60 *(MGUL 60)*	
CONSTITUENT	%
total carbonate	18.91
crystalline	6.47
opaque	1.49
Rock fragments	2.99
amphibole	0.50
feldspar	1.49
quartz	68.16

L3 *(MGUL 67)*	
CONSTITUENT	%
total carbonate	12.27
crystalline	0.00
opaque	0.45
rock fragments	1.82
amphibole	1.82
feldspar	2.27
quartz	81.36

L 4 *(MGUL 68)*	
CONSTITUENT	%
total carbonate	7.98
crystalline	11.41
opaque	30.42
rock fragments	14.45
amphibole	5.70
feldspar	3.80
quartz	26.24

L5 *(MGUL 69)*	
CONSTITUENT	%
total carbonate	9.5
crystalline	0
opaque	0.5
rock fragments	16.5
amphibole	1
feldspar	3.5
quartz	69

L11 *(MGUL 94)*	
CONSTITUTENT	%
total carbonate	1.96
crystalline	0.00
opaque	0.00
rock fragments	0.00
amphibole	0.98
feldspar	7.84
quartz	89.22

Final results compiled and checked by Edward Robinson, February 11, 2007

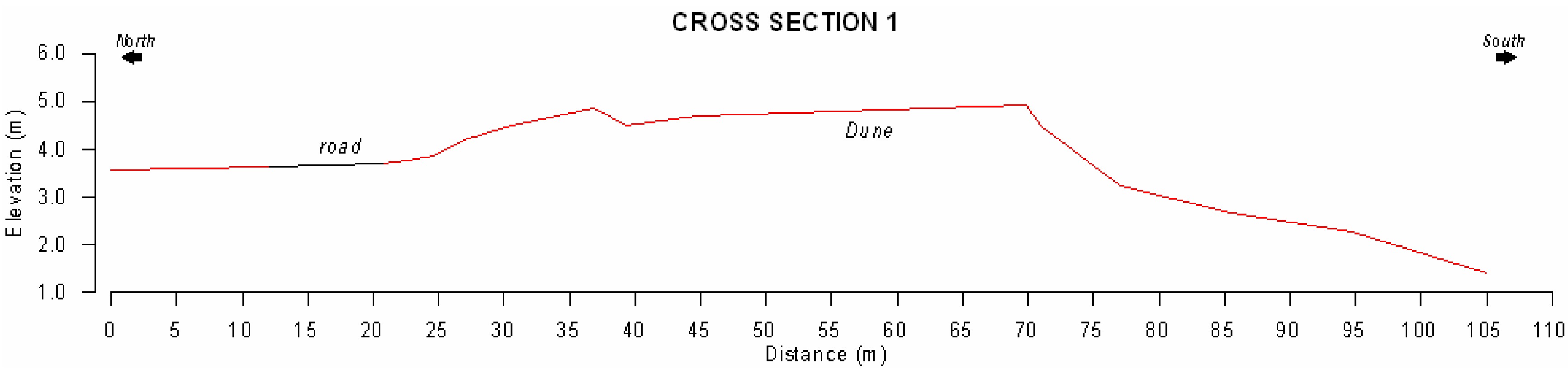
Annex 3

- Cross Sections (Survey Department data. Only in digital format).

- Profile of the Cross Sections (Prepared by Cuban Team)

- Measurement of the Coastline (Survey Department Data. Only in digital format)

- Excavation Profile of the Critical Sector (Prepared by the Cuban Team)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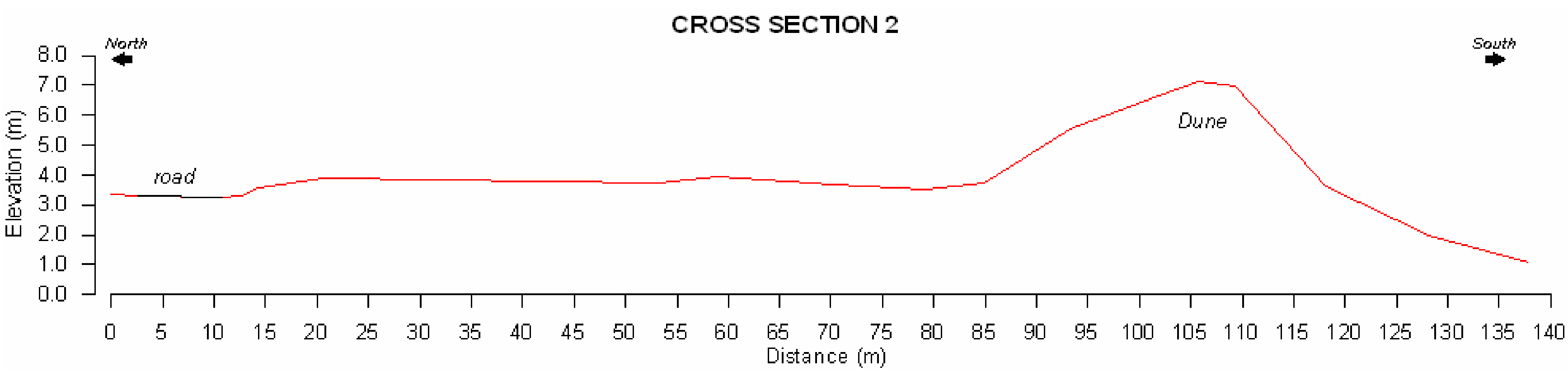
5.0
4.0
3.0
2.0
1.0
Elevation (m)
road
Dune
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110
Distance (m)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South
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6.0
5.0
4.0
3.0
2.0
1.0
0.0
Elevation (m)
road
Dune
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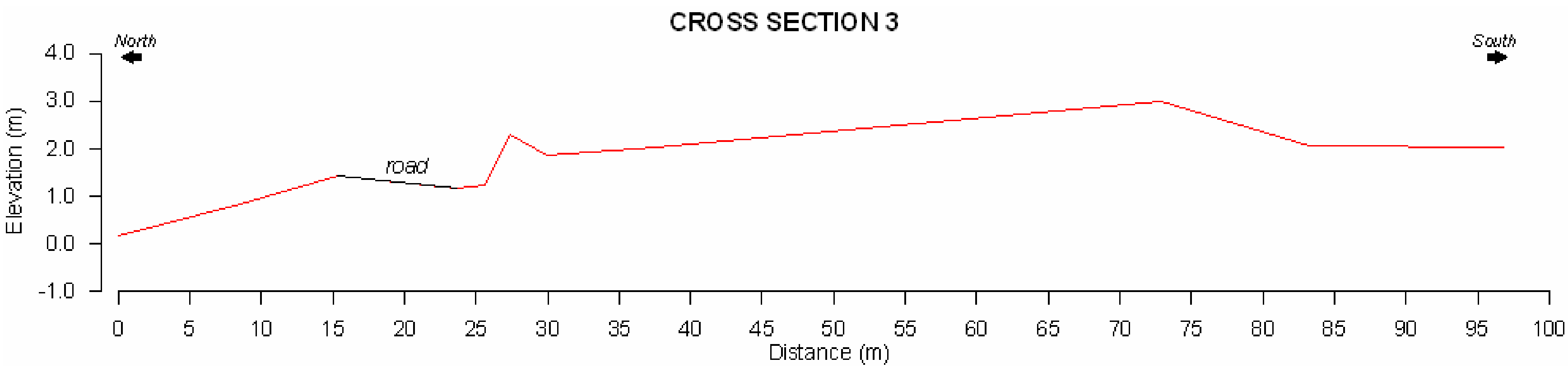
Distance (m)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South
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Distance (m)
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25
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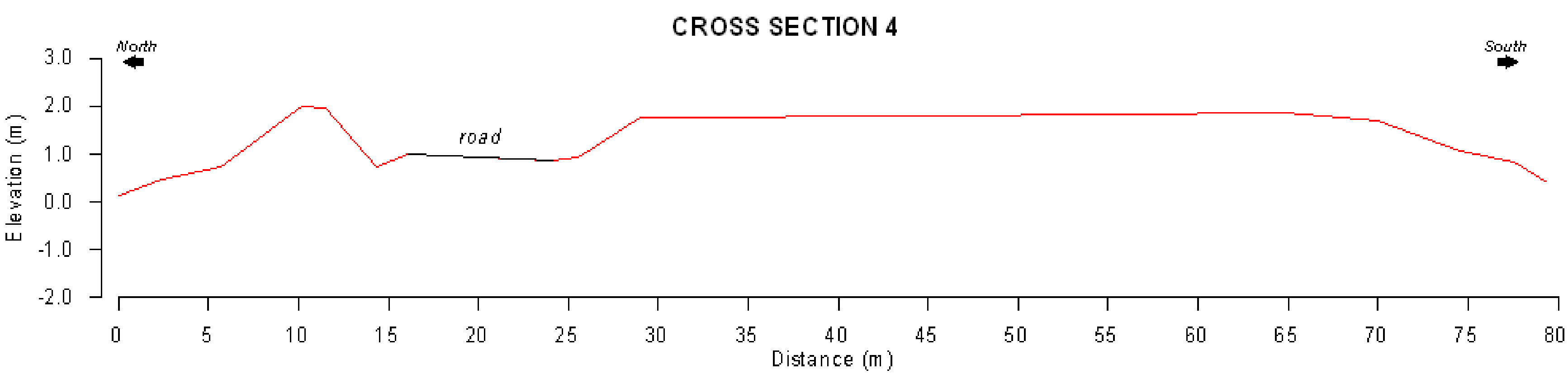
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South
road
Elevation (m)
Distance (m)
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-2.0
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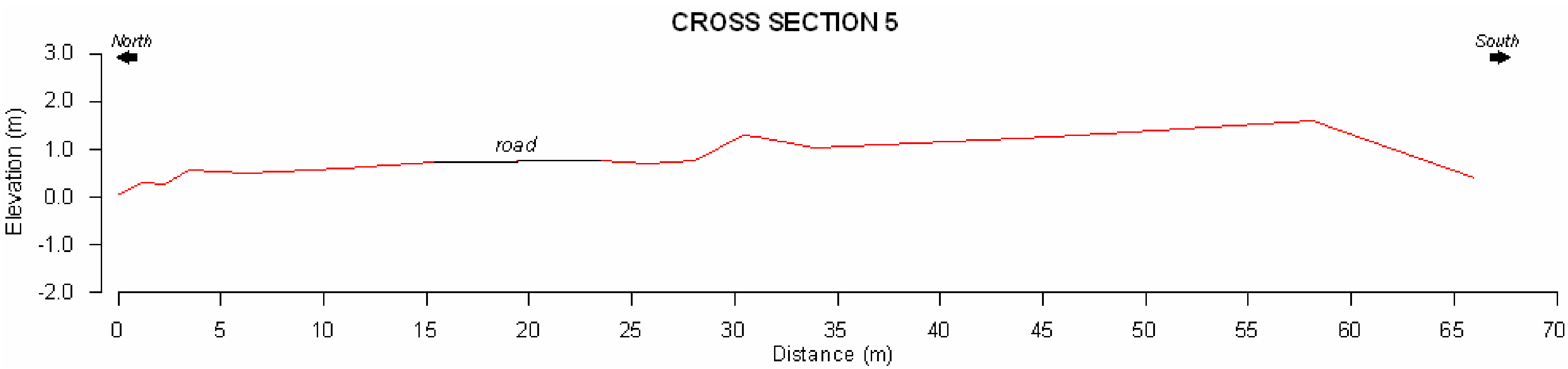
15
20
25
30
35
40
45
50
55
60
65
70
75
80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North
South
Elevation (m)
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2.0
1.0
0.0
-1.0
-2.0
road
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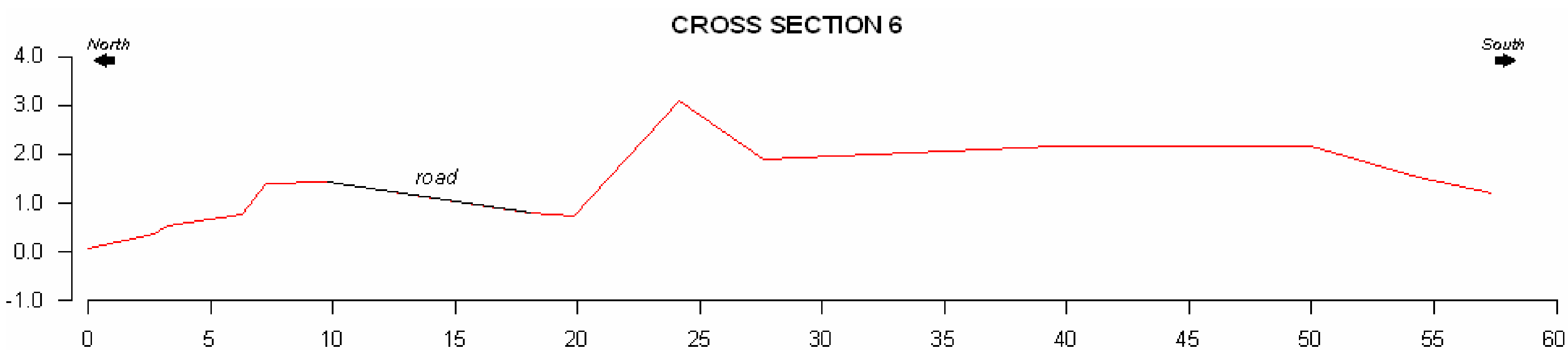
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Distance (m)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South
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2.0
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-1.0
road
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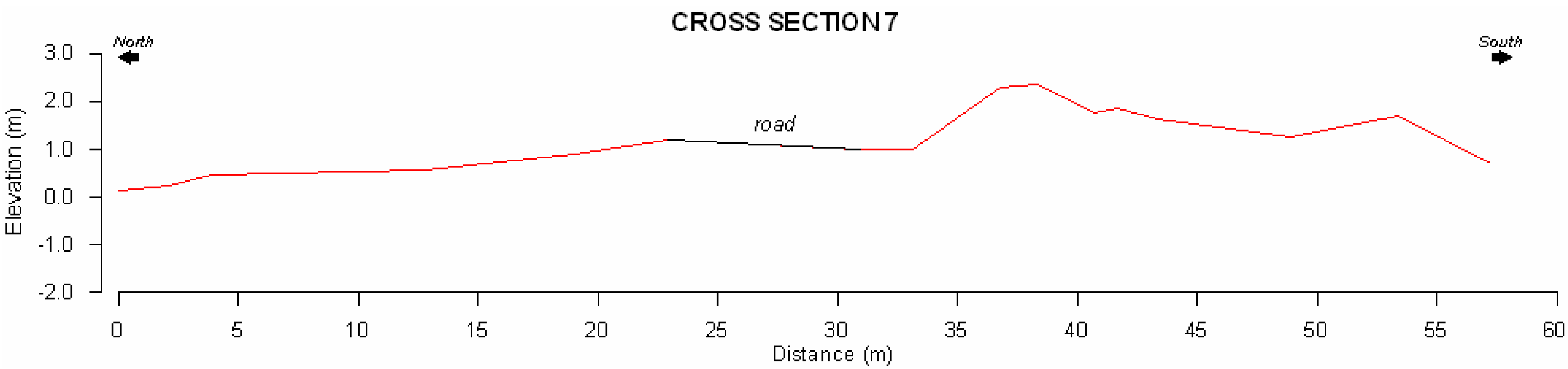
35
40
45
50
55
60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Elevation (m)
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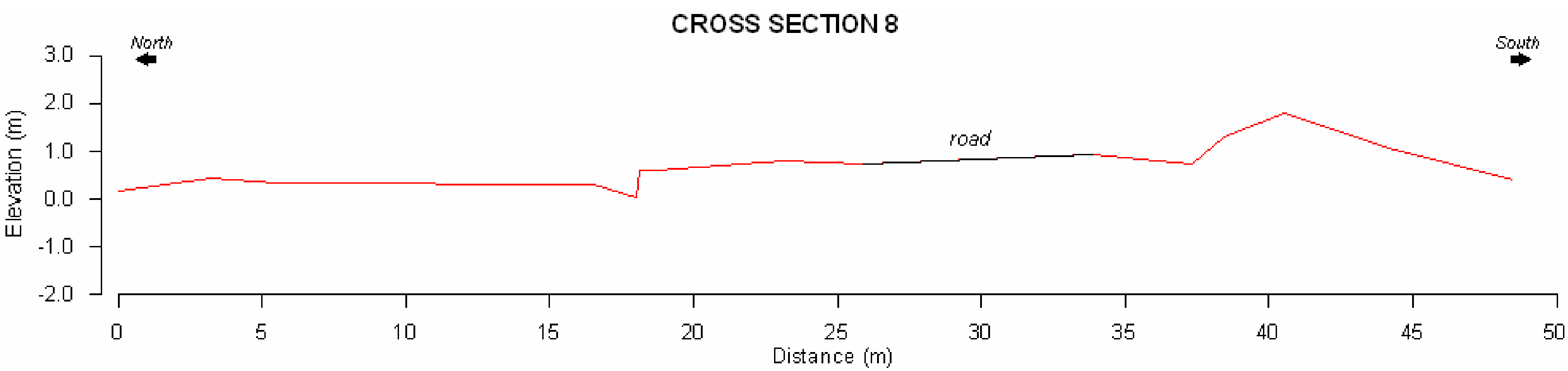
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
55
60
Distance (m)


CROSS SECTION 8
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South
road
Elevation (m)
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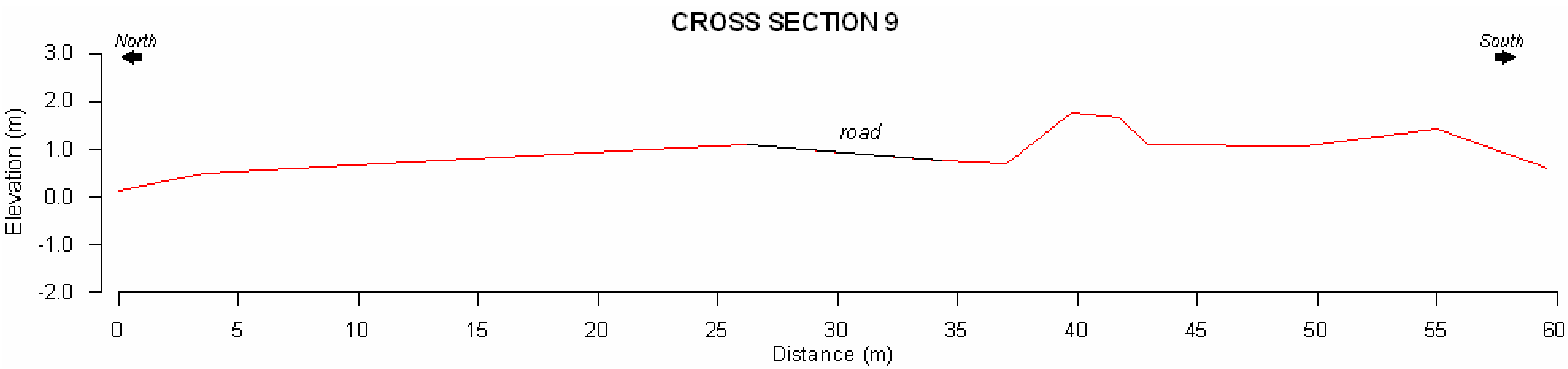
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
Distance (m)


CROSS SECTION 9
North
South
road
Elevation (m)
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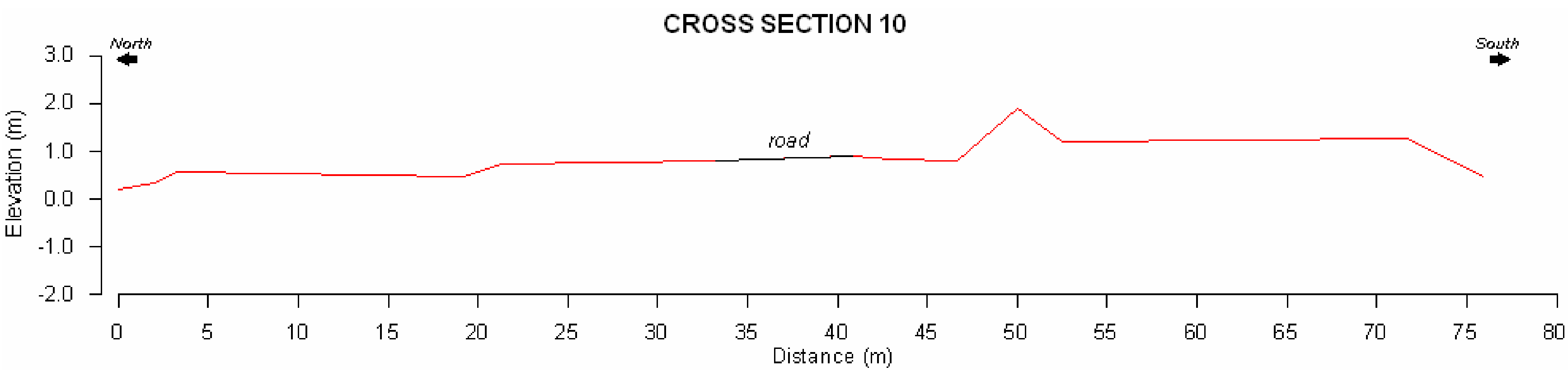
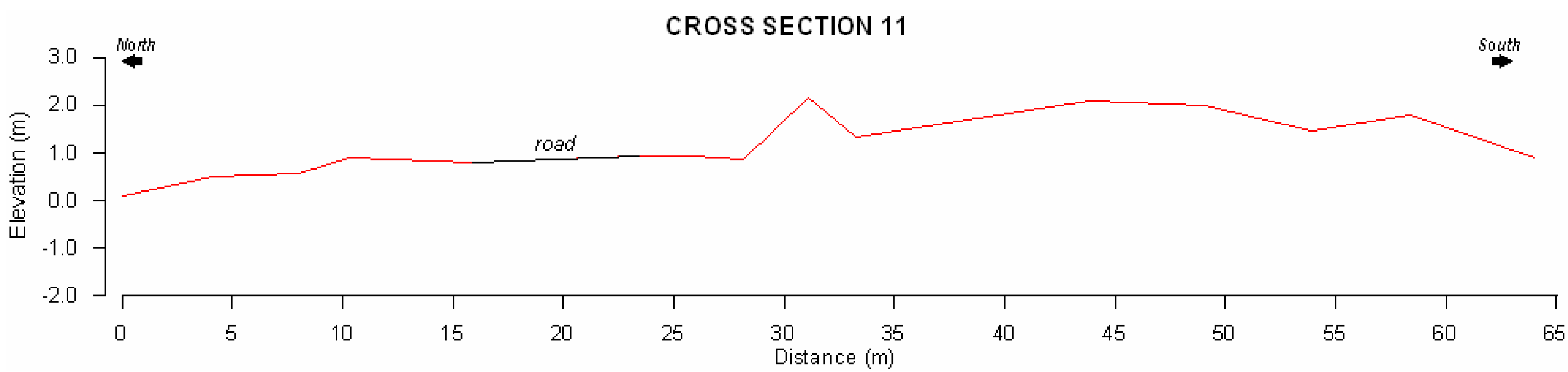
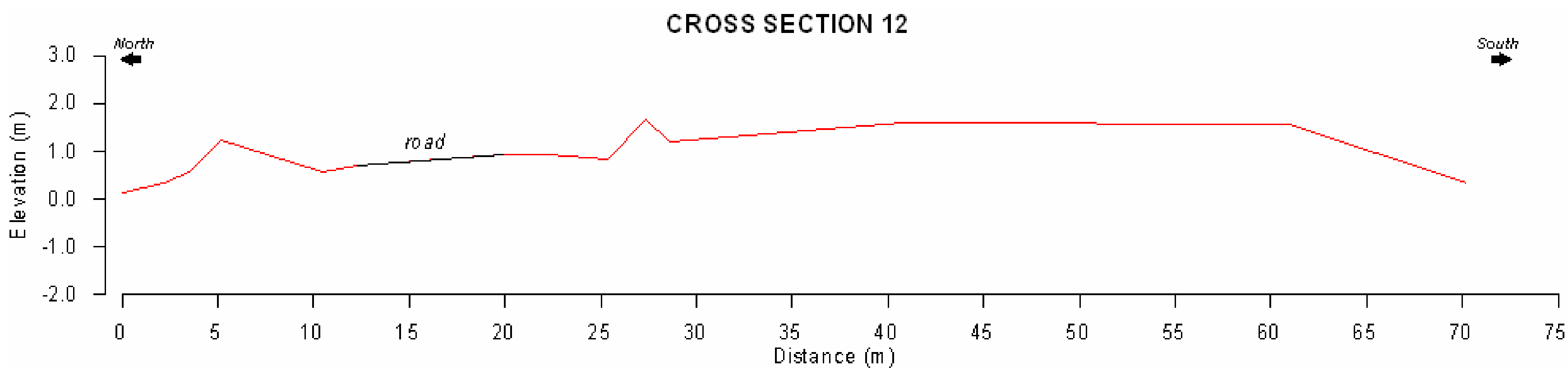
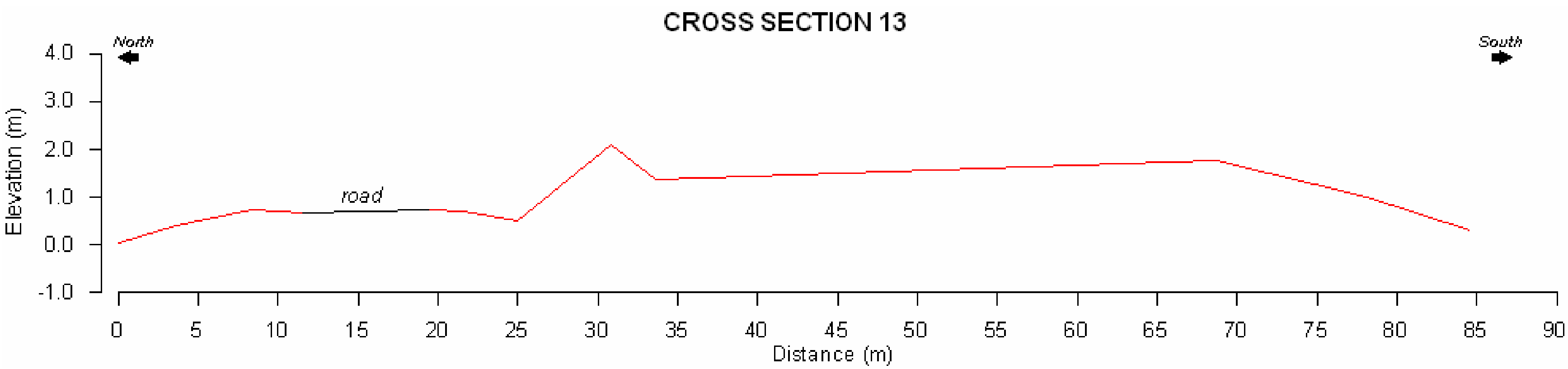
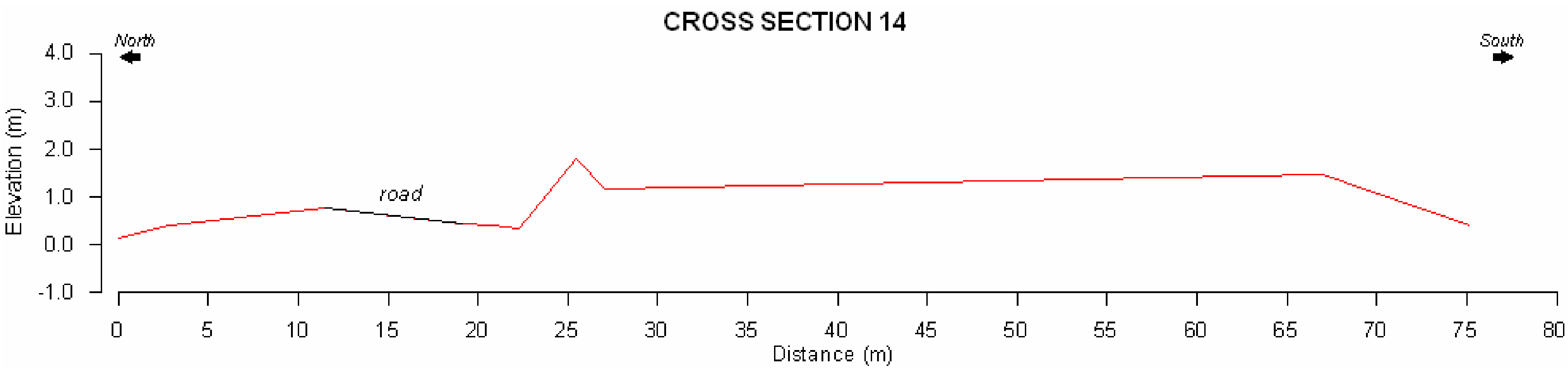
2.0
1.0
0.0
-1.0
-2.0
0 5 10 15 20 25 30 35 40 45 50 55 60
Distance (m)

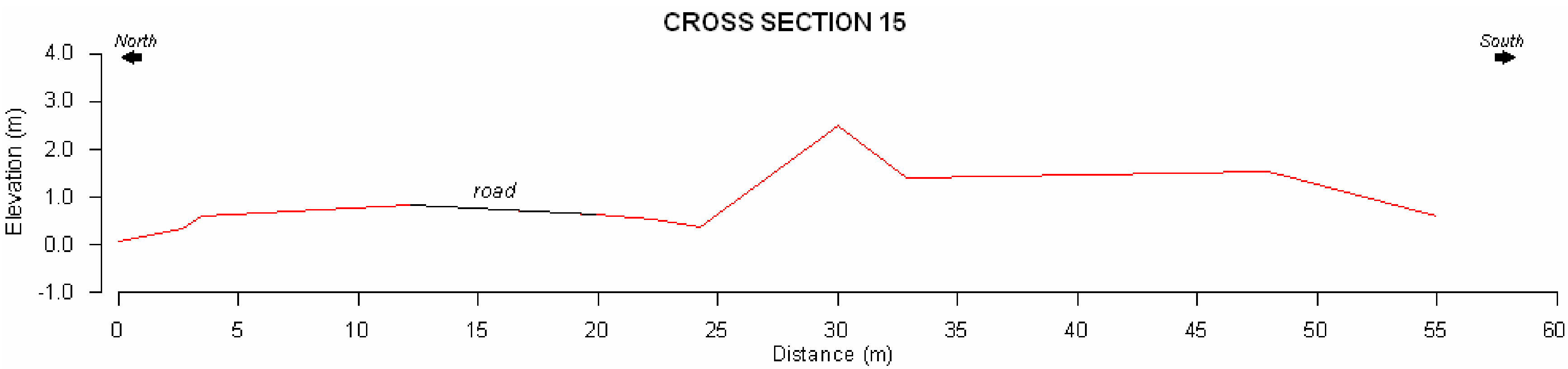

CROSS SECTION 10
North
South
road
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80
Distance (m)

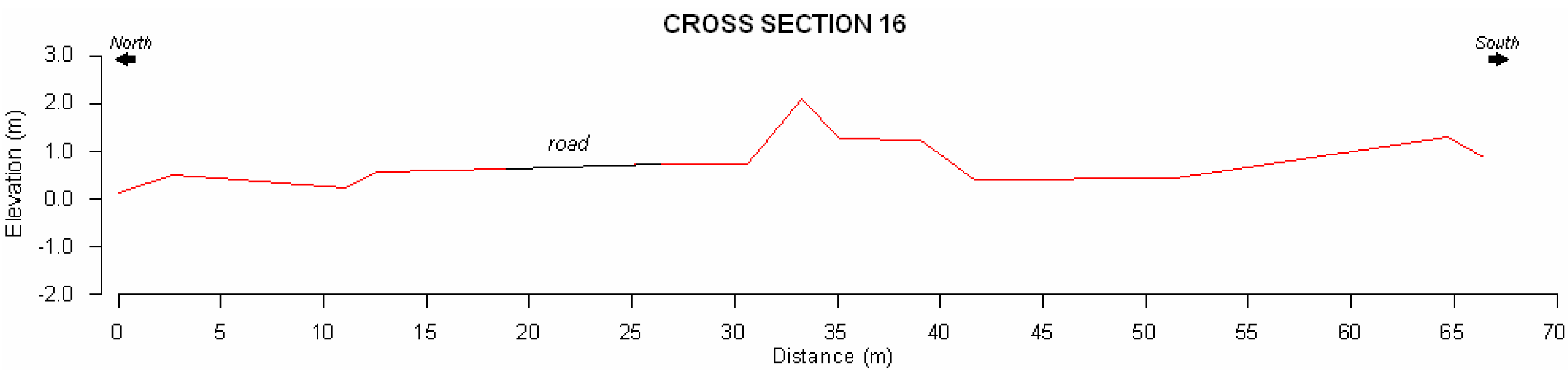

CROSS SECTION 11
North
South
road
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Distance (m)

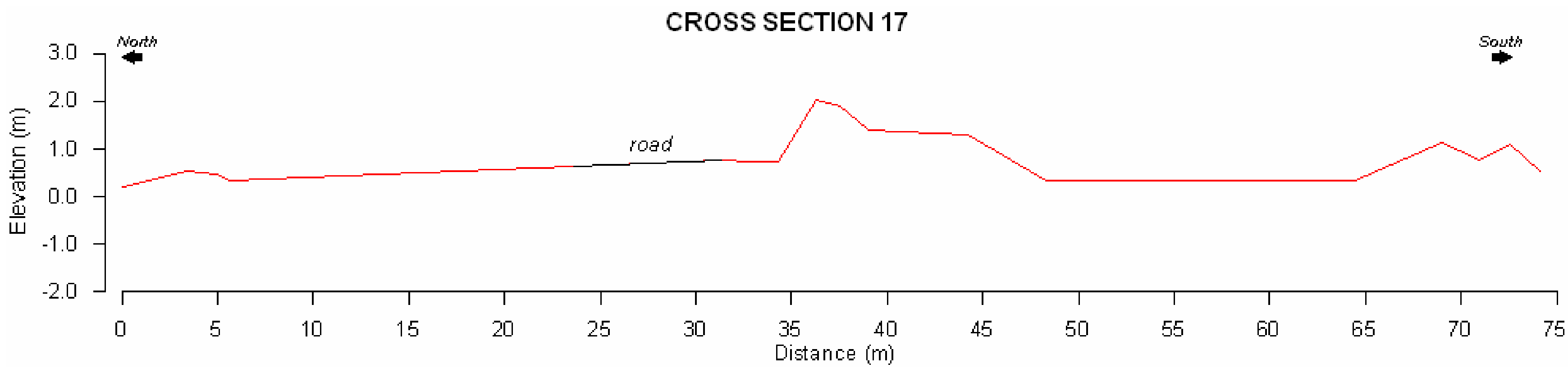

CROSS SECTION 12
North
South
road
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Distance (m)

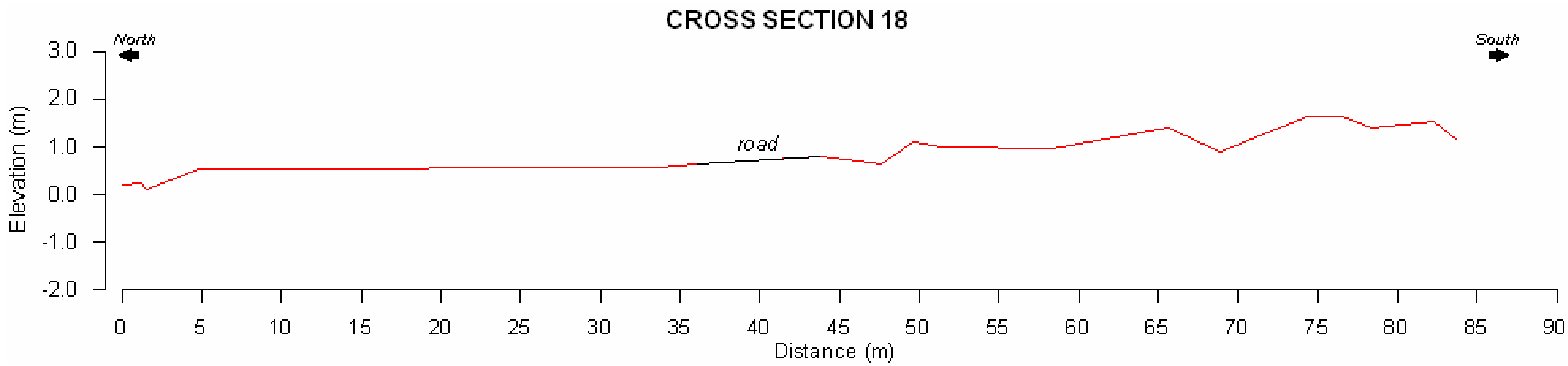

CROSS SECTION 13
North
South
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Distance (m)

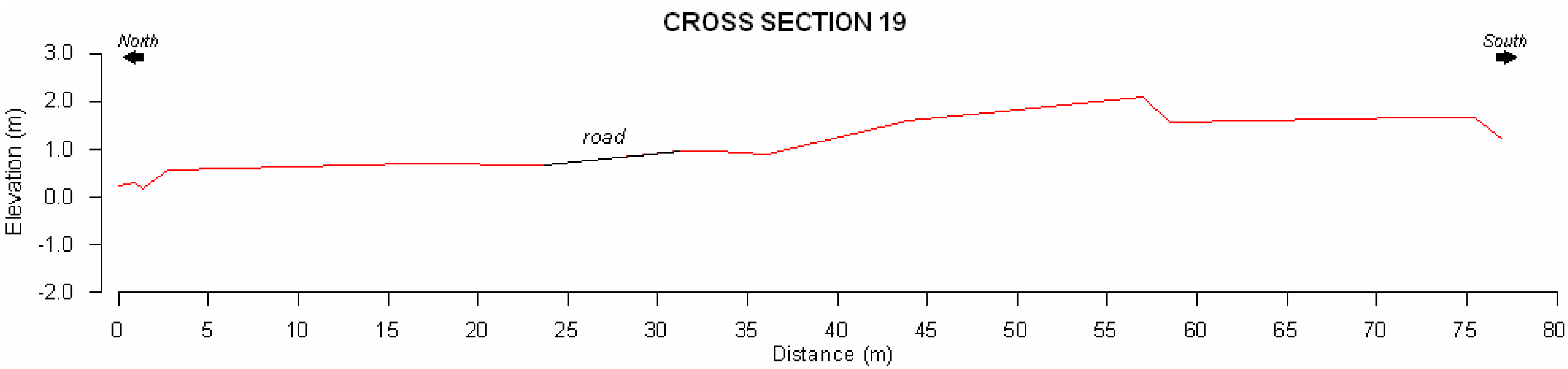

CROSS SECTION 14
North
South
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Distance (m)

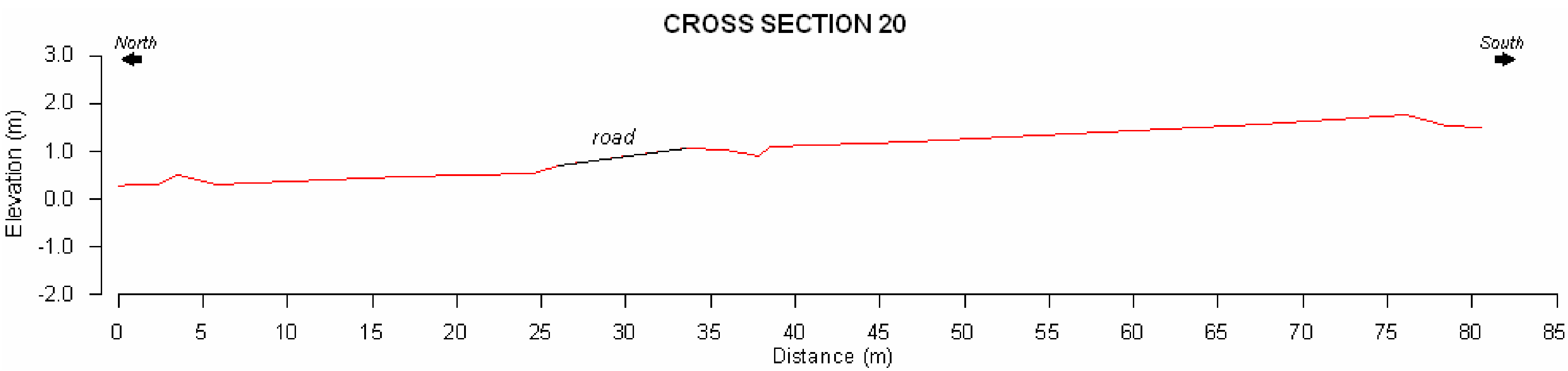

CROSS SECTION 15
North
South
road
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
0
5
10
15
20
25
30
35
40
45
50
55
60
Distance (m)

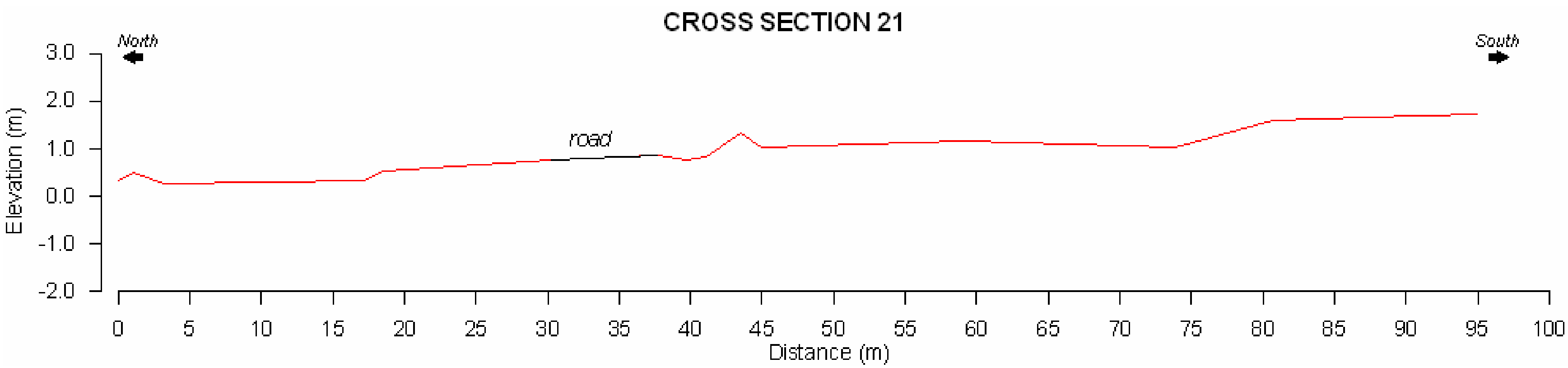

CROSS SECTION 16
North
South
road
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Distance (m)

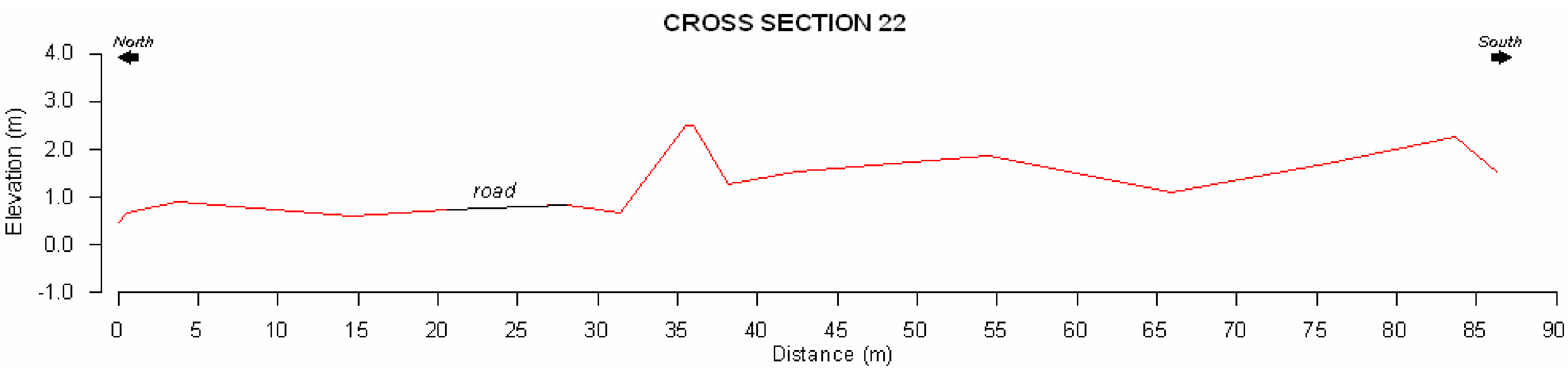

CROSS SECTION 17
North
South
road
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Distance (m)

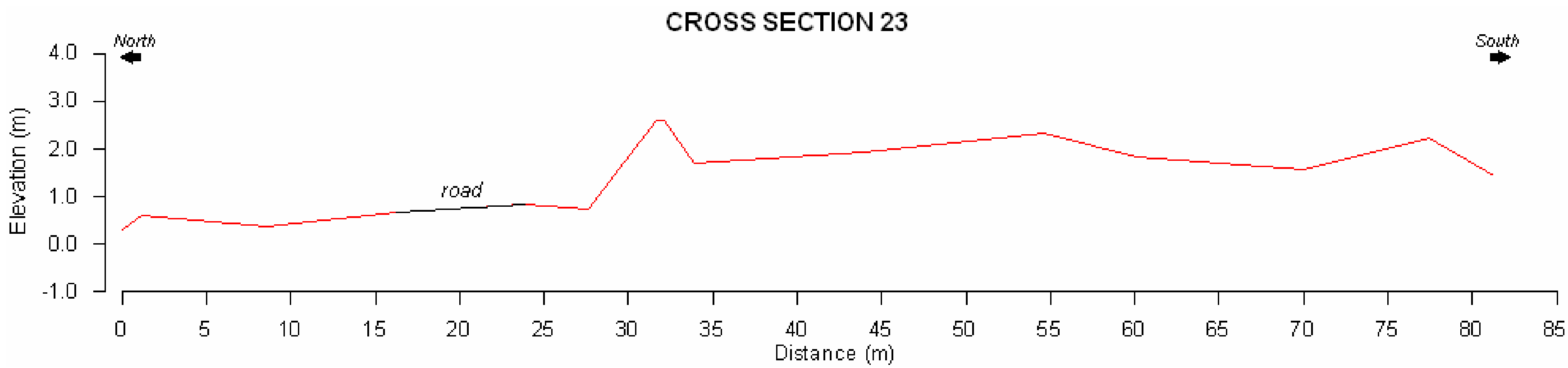

CROSS SECTION 18
North
South
road
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Distance (m)


CROSS SECTION 19
North
South
road
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
Distance (m)

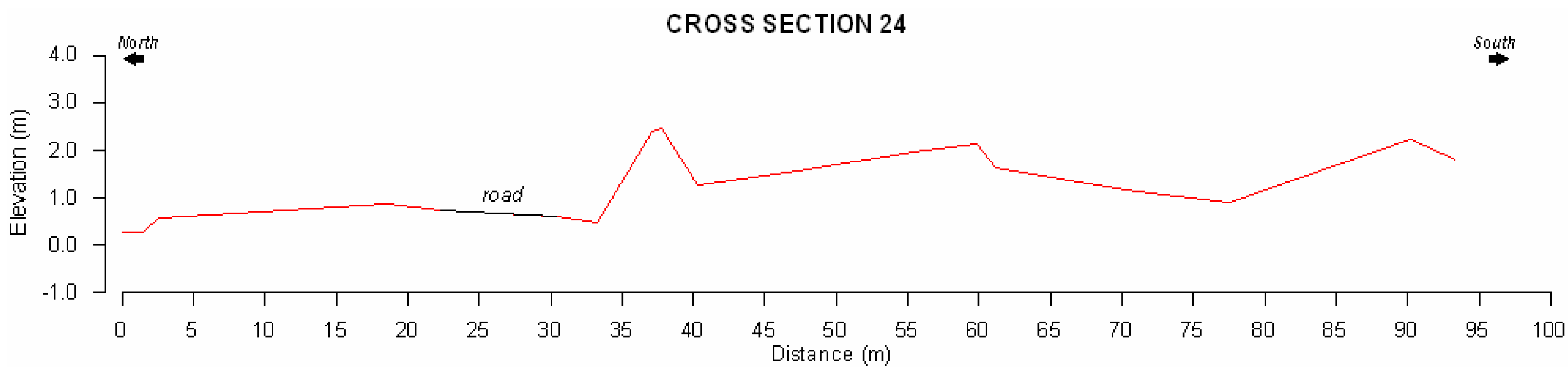

CROSS SECTION 20
North
South
road
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Distance (m)


CROSS SECTION 21
North
South
Elevation (m)
3.0
2.0
1.0
0.0
-1.0
-2.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Distance (m)

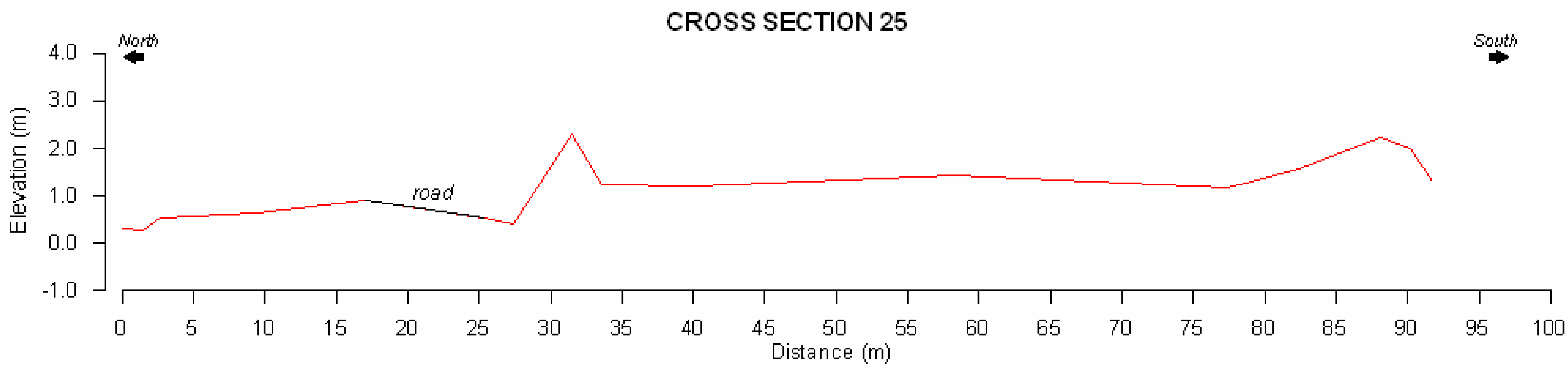

CROSS SECTION 22
North
South
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
Distance (m)



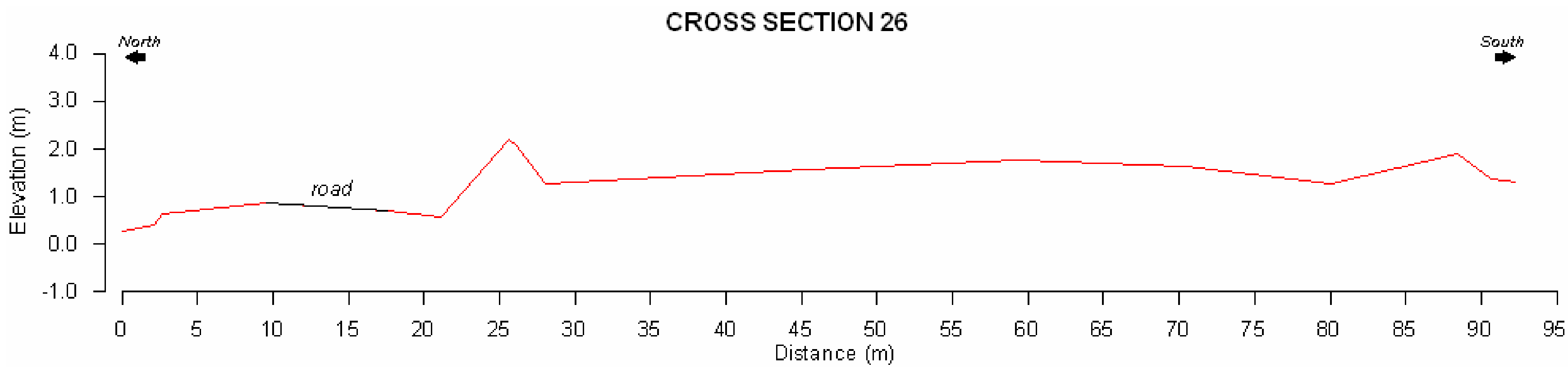
CROSS SECTION 23
North
South
road
Elevation (m)
Distance (m)



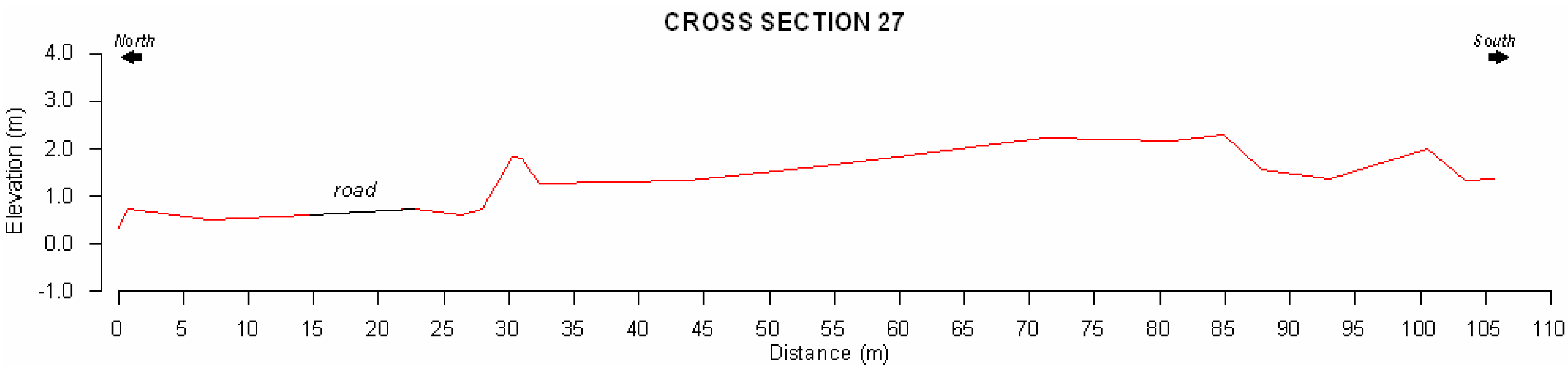
CROSS SECTION 24
North
South
road
Elevation (m)
Distance (m)



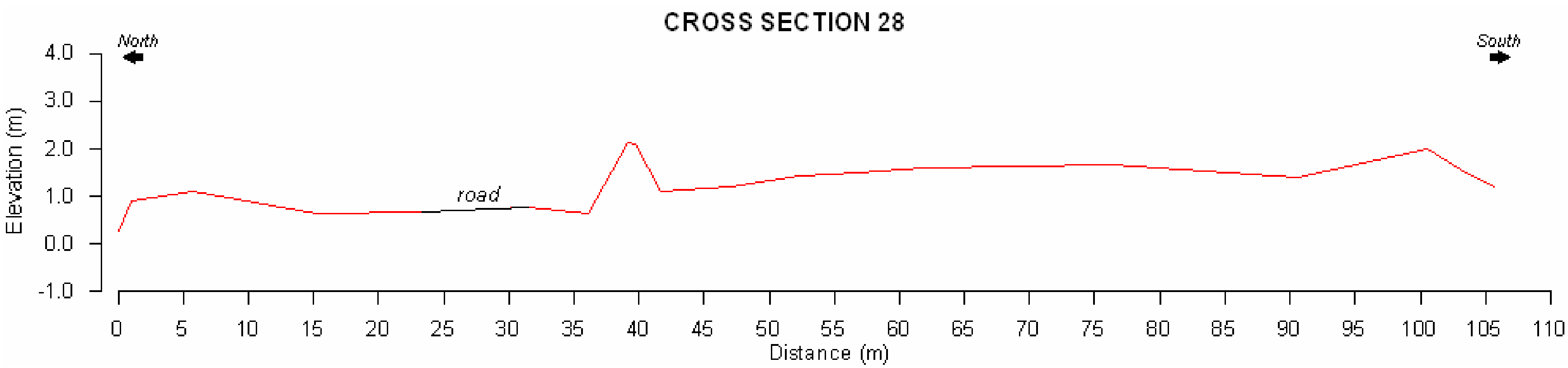
CROSS SECTION 25
North
South
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Distance (m)



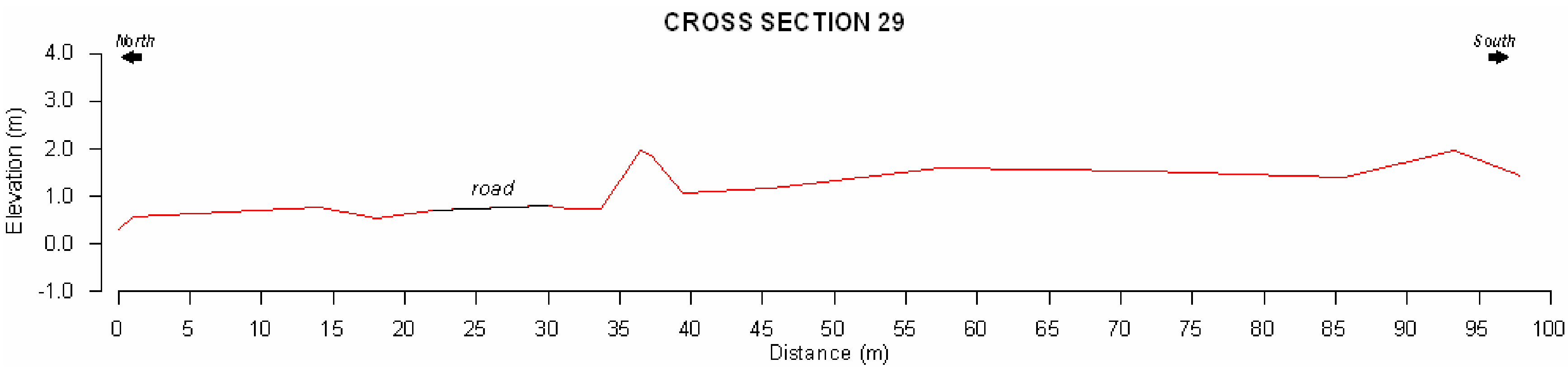
CROSS SECTION 26
North
South
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Distance (m)

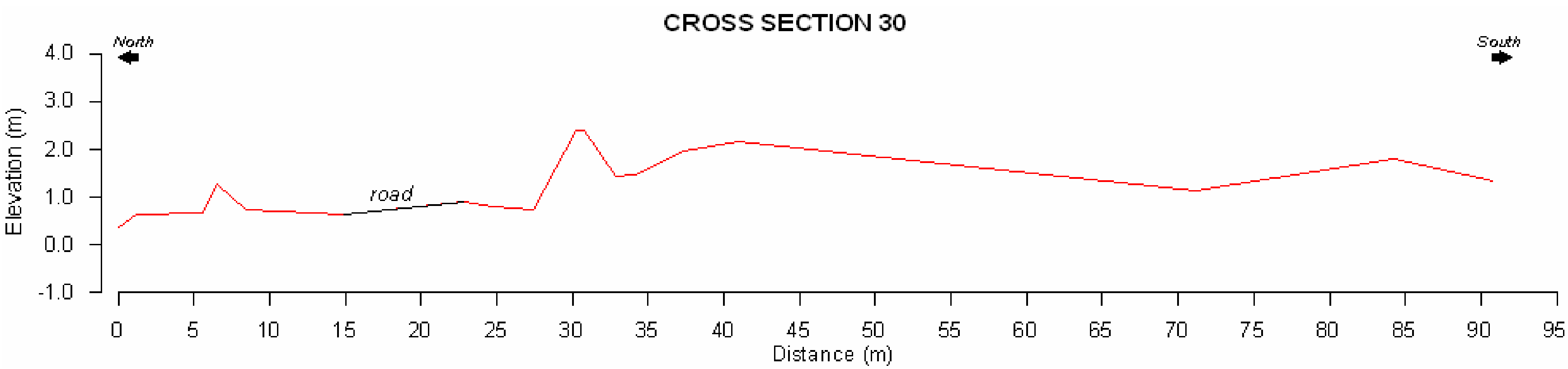


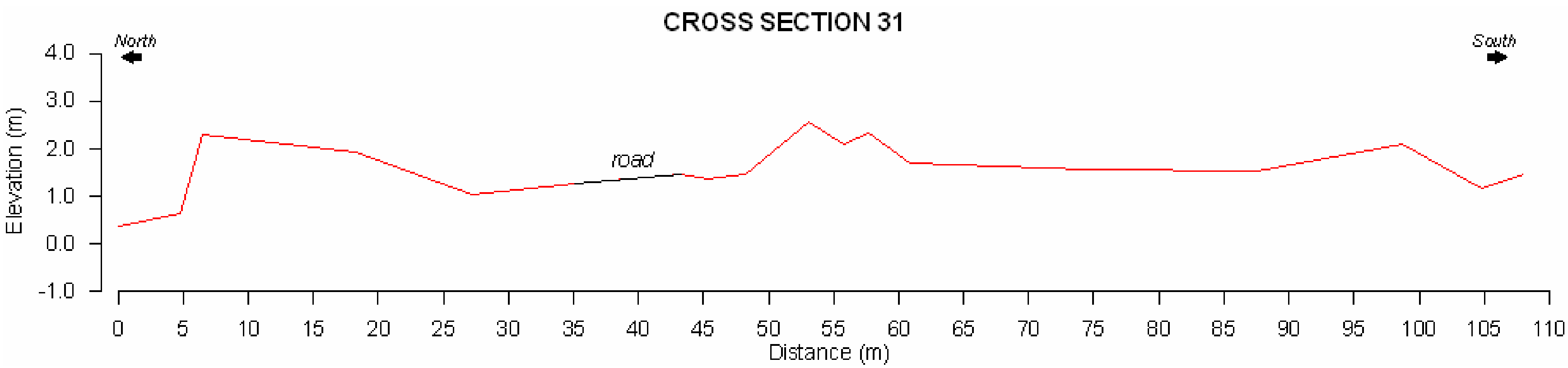
CROSS SECTION 27
North
South
Elevation (m)
Distance (m)
road
4.0
3.0
2.0
1.0
0.0
-1.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110

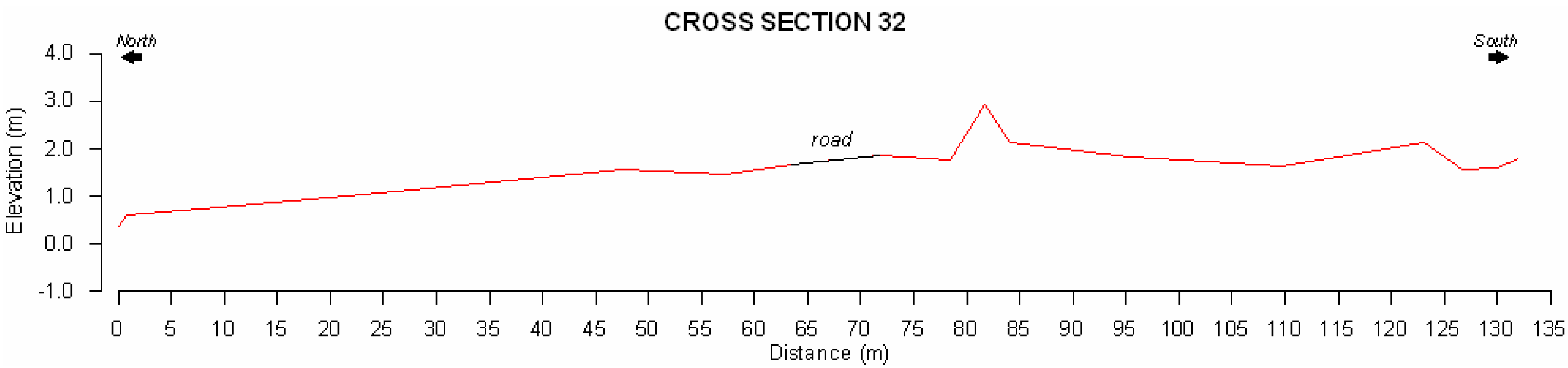


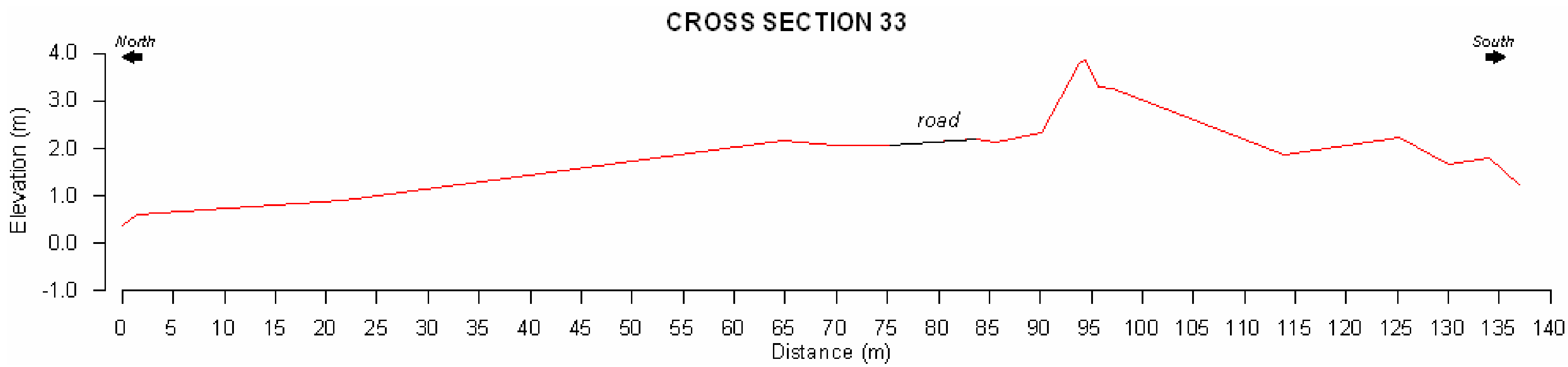
CROSS SECTION 28
North
South
Elevation (m)
Distance (m)
road
4.0
3.0
2.0
1.0
0.0
-1.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110

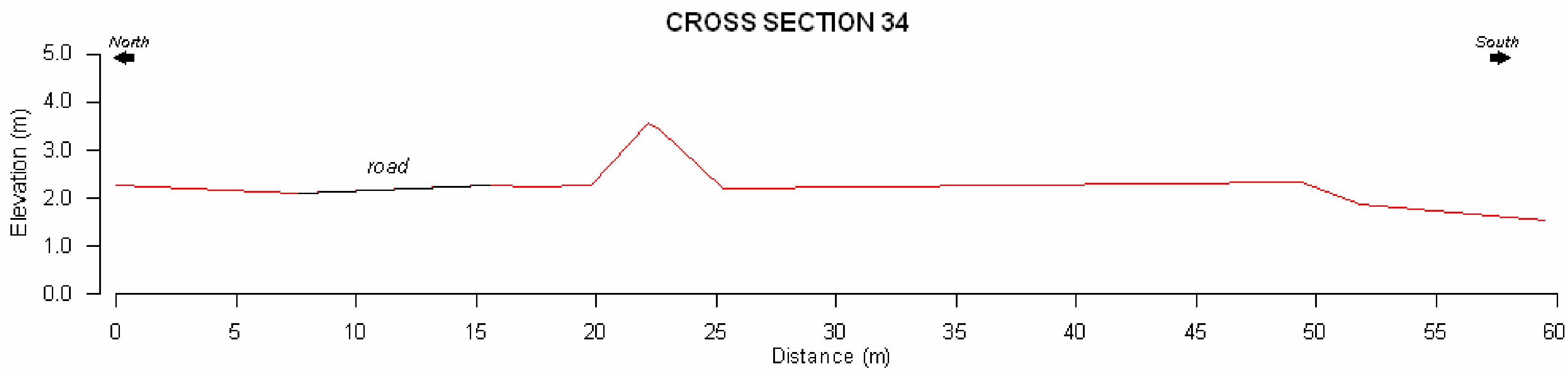

CROSS SECTION 29
North
South
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Distance (m)

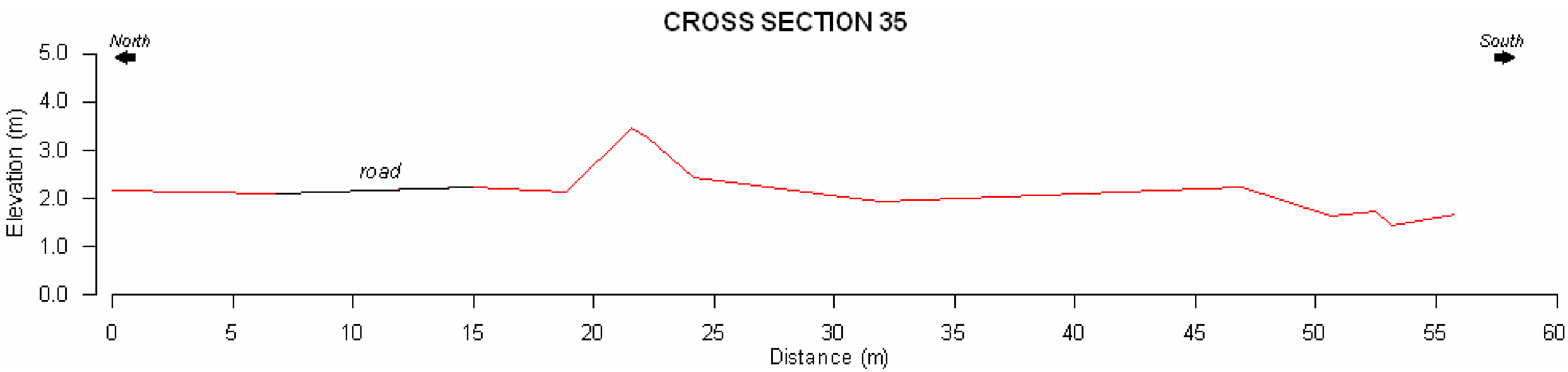

CROSS SECTION 30
North
South
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
Distance (m)

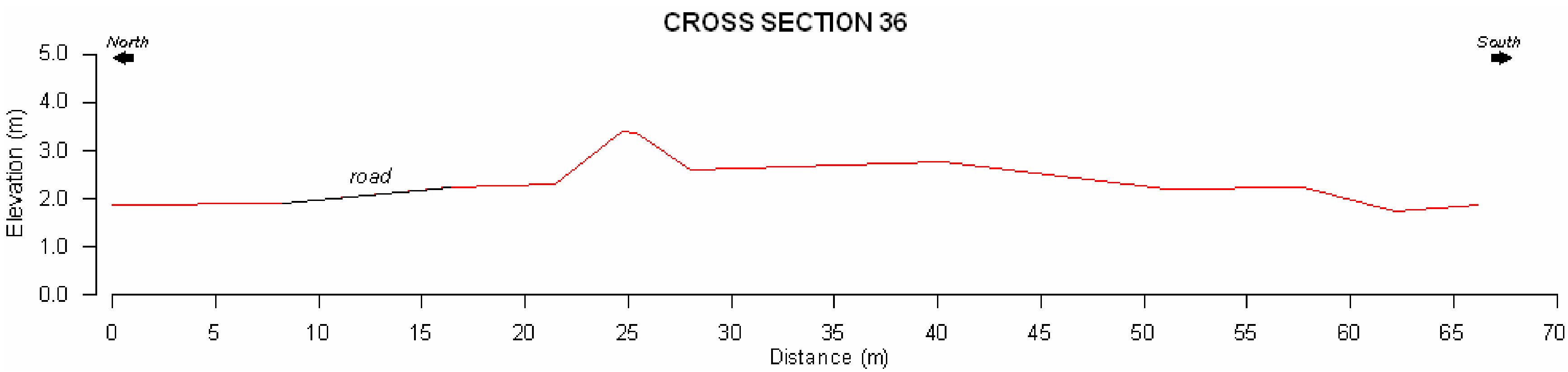

CROSS SECTION 31
North
South
road
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110
Distance (m)

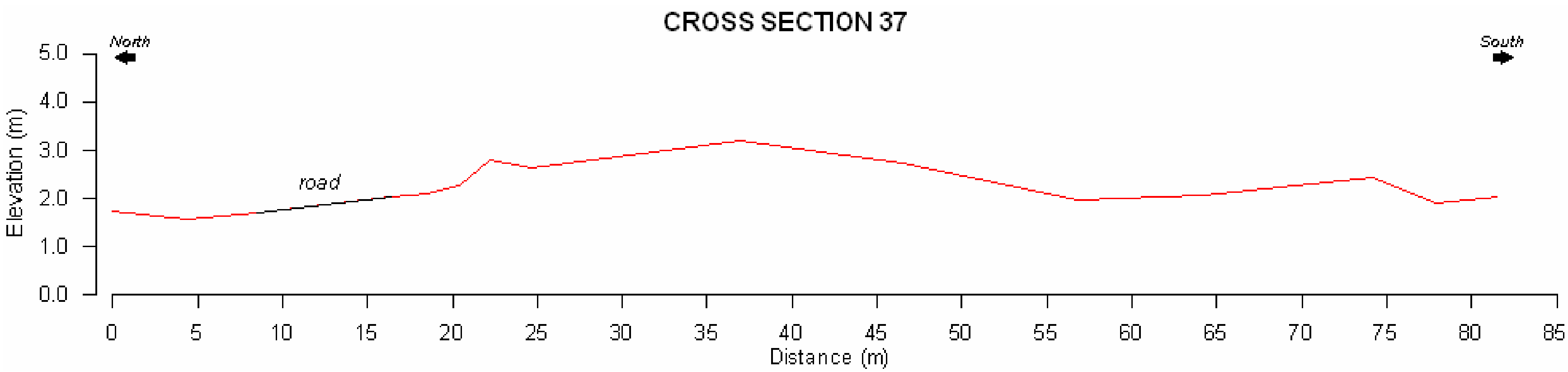

CROSS SECTION 32
North
South
road
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135
Distance (m)

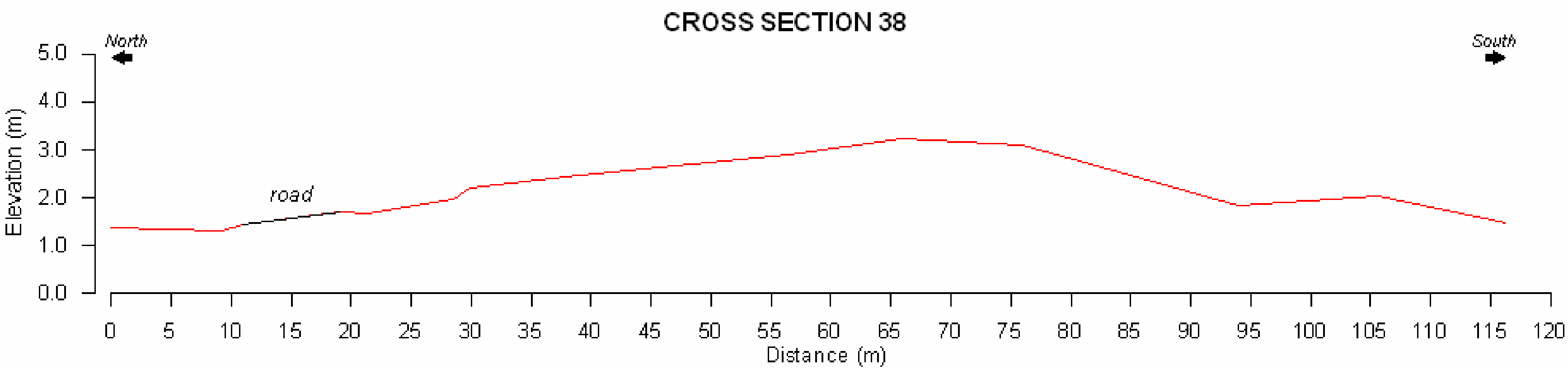

CROSS SECTION 33
North
South
road
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
Distance (m)

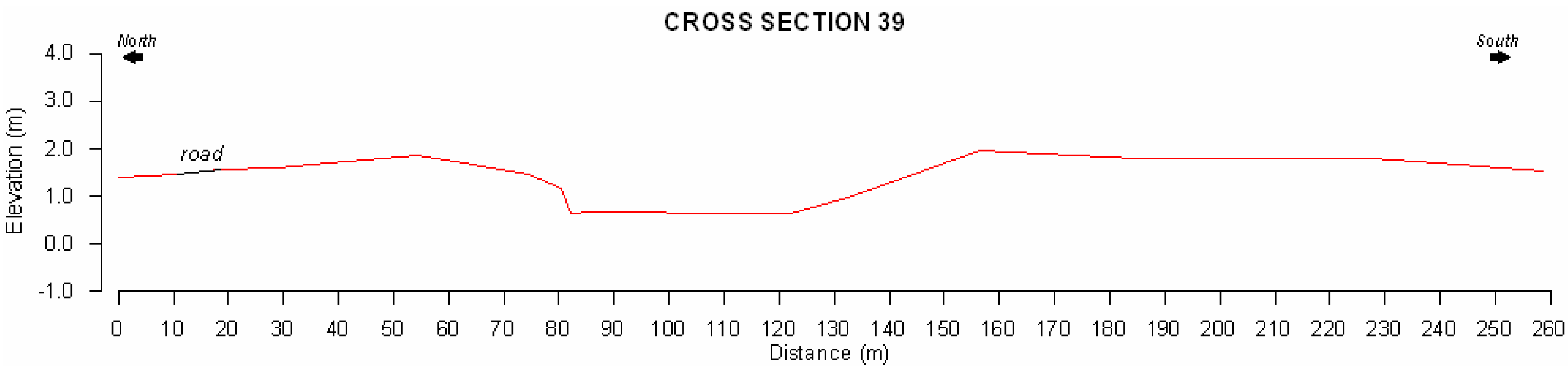

CROSS SECTION 34
North
South
road
Elevation (m)
5.0
4.0
3.0
2.0
1.0
0.0
0
5
10
15
20
25
30
35
40
45
50
55
60
Distance (m)

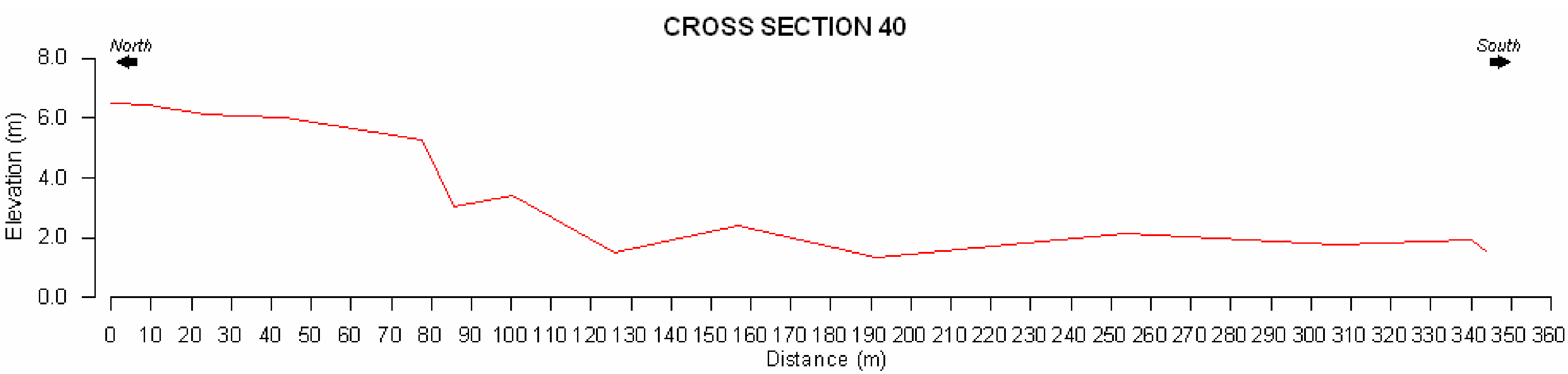

CROSS SECTION 35
North
South
Elevation (m)
5.0
4.0
3.0
2.0
1.0
0.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
Distance (m)

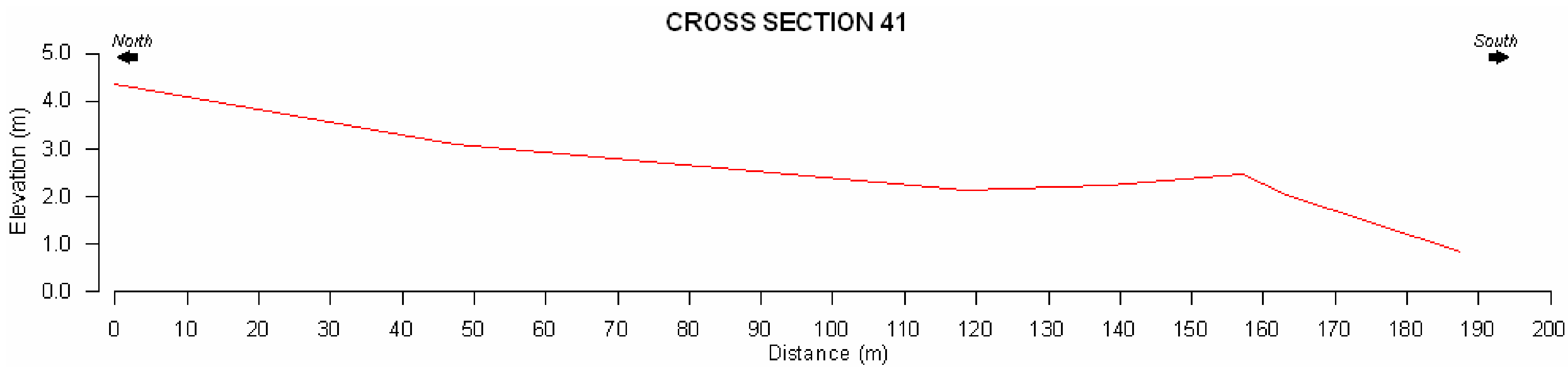

CROSS SECTION 36
North
South
Elevation (m)
5.0
4.0
3.0
2.0
1.0
0.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
Distance (m)

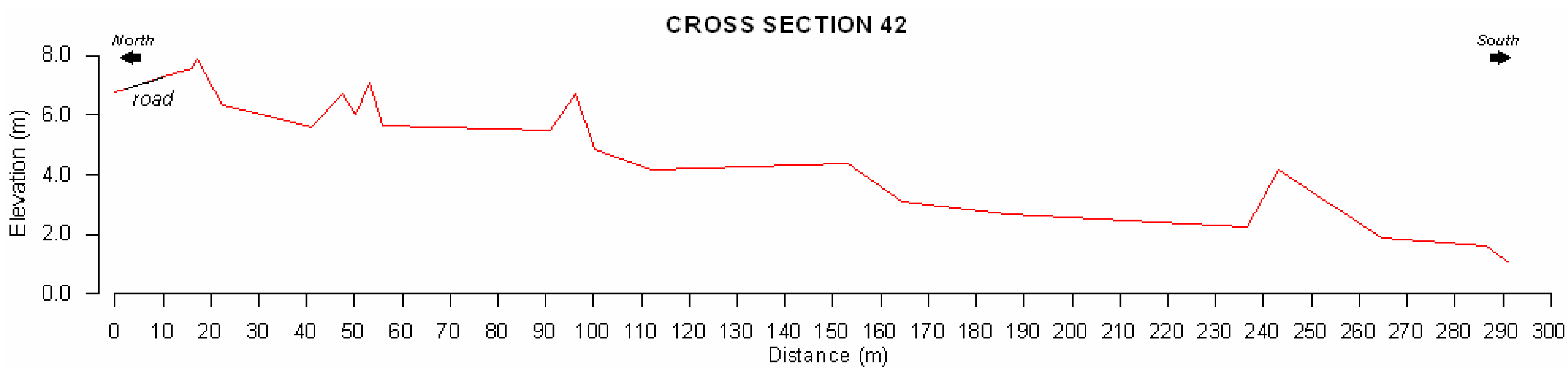

CROSS SECTION 37
North
South
Elevation (m)
5.0
4.0
3.0
2.0
1.0
0.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
Distance (m)

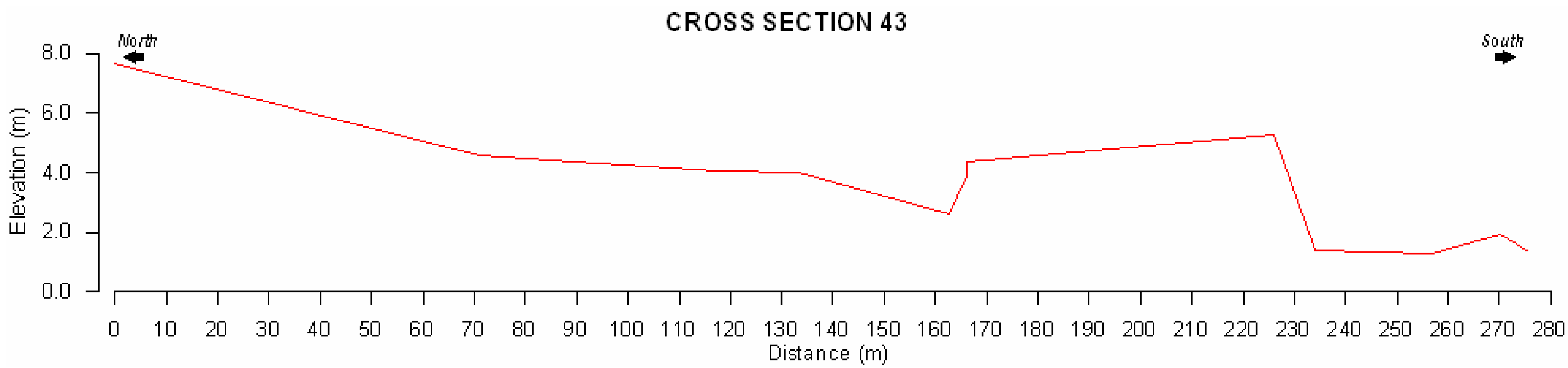

CROSS SECTION 38
North
South
Elevation (m)
5.0
4.0
3.0
2.0
1.0
0.0
road
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
Distance (m)

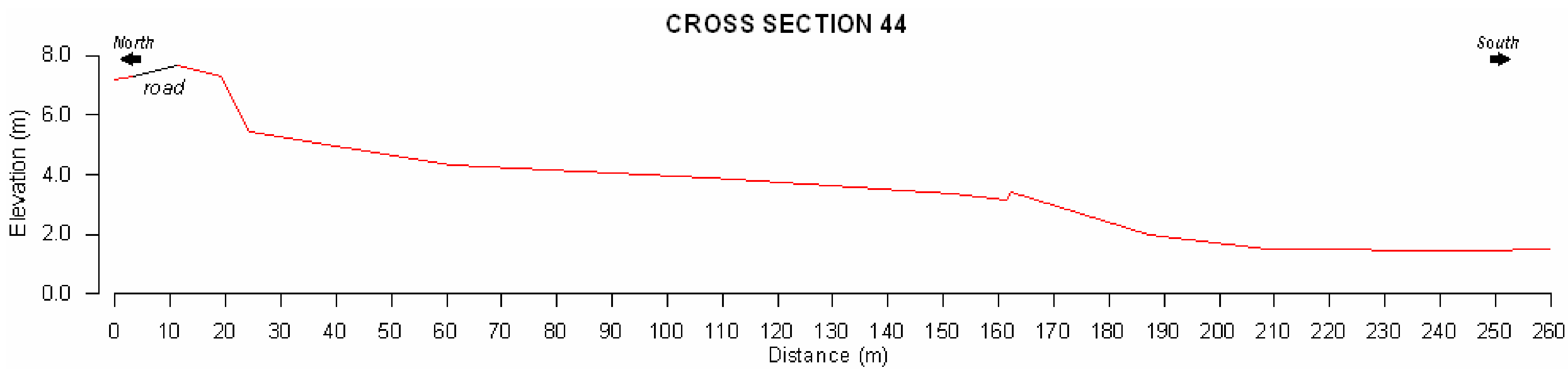

CROSS SECTION 39
North
South
road
Elevation (m)
4.0
3.0
2.0
1.0
0.0
-1.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260
Distance (m)

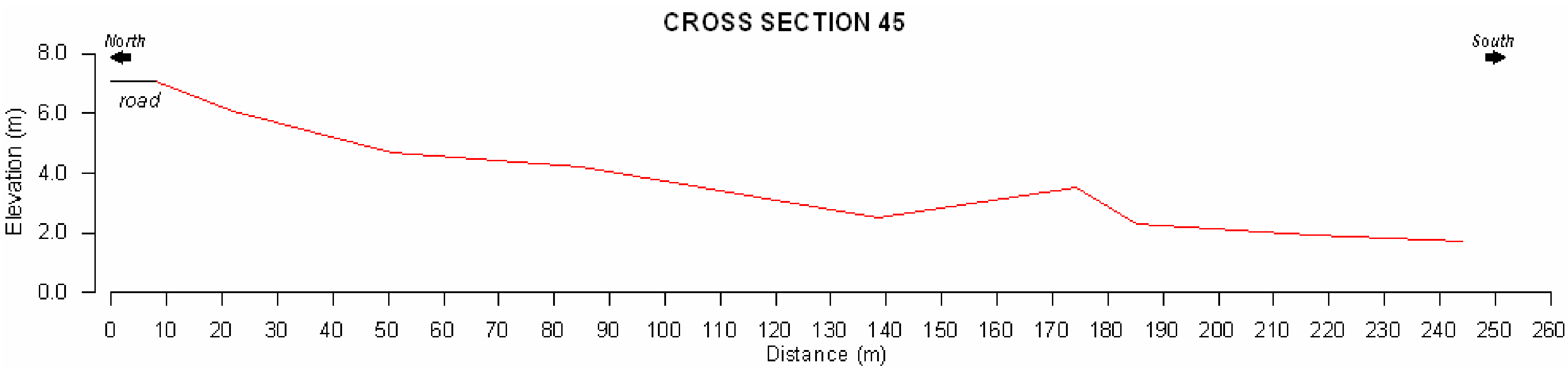

CROSS SECTION 40
North
South
Elevation (m)
8.0
6.0
4.0
2.0
0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360
Distance (m)

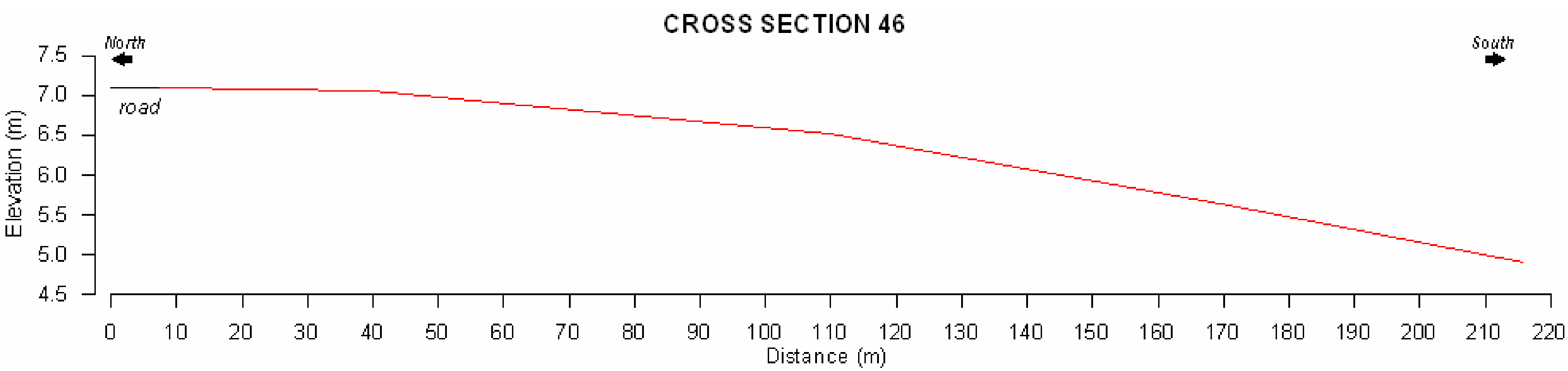

CROSS SECTION 41
North
South
Elevation (m)
5.0
4.0
3.0
2.0
1.0
0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Distance (m)

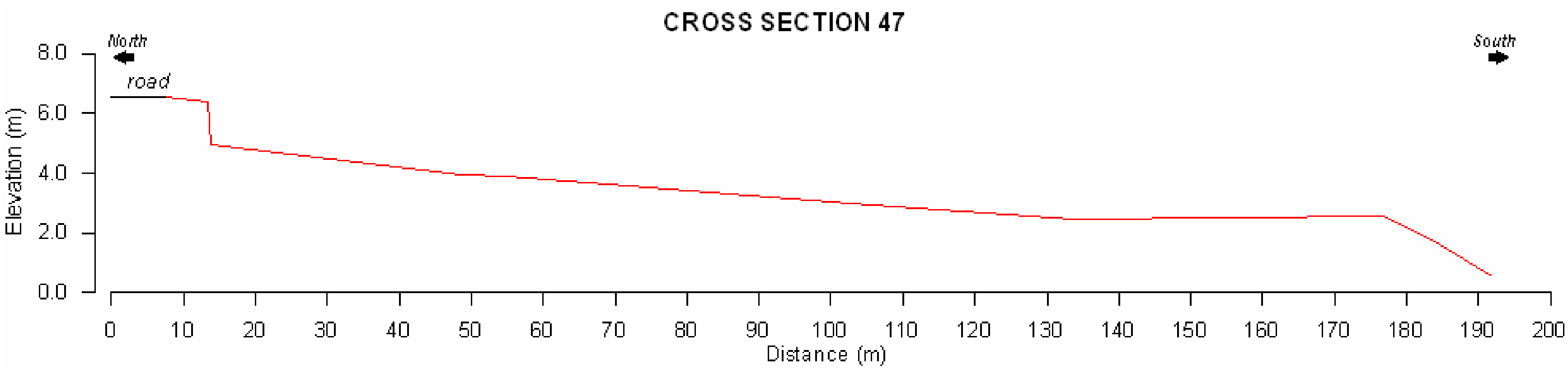

CROSS SECTION 42
North
South
road
Elevation (m)
8.0
6.0
4.0
2.0
0.0
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300
Distance (m)

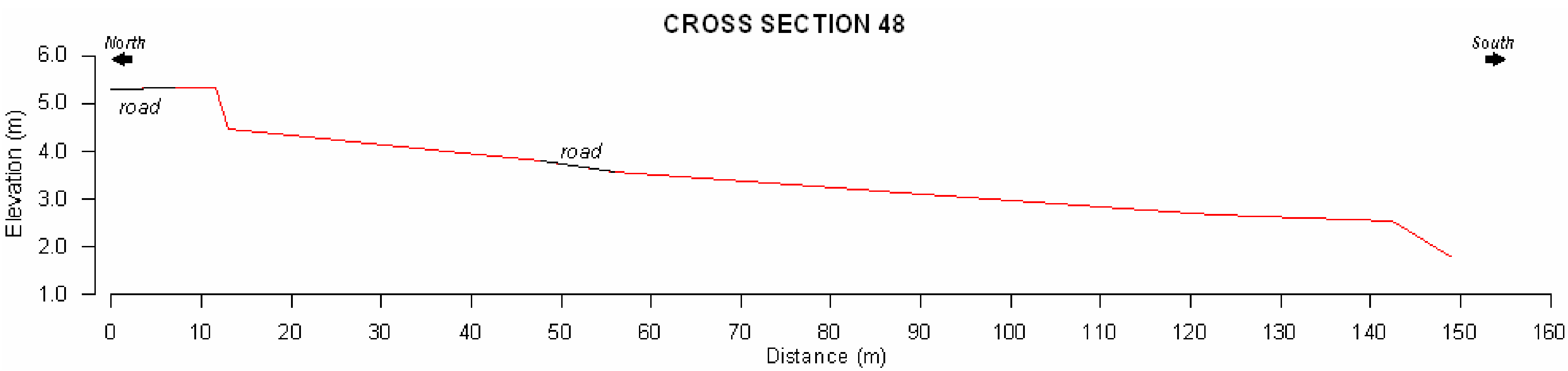

CROSS SECTION 43
North
South
Elevation (m)
8.0
6.0
4.0
2.0
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
Distance (m)

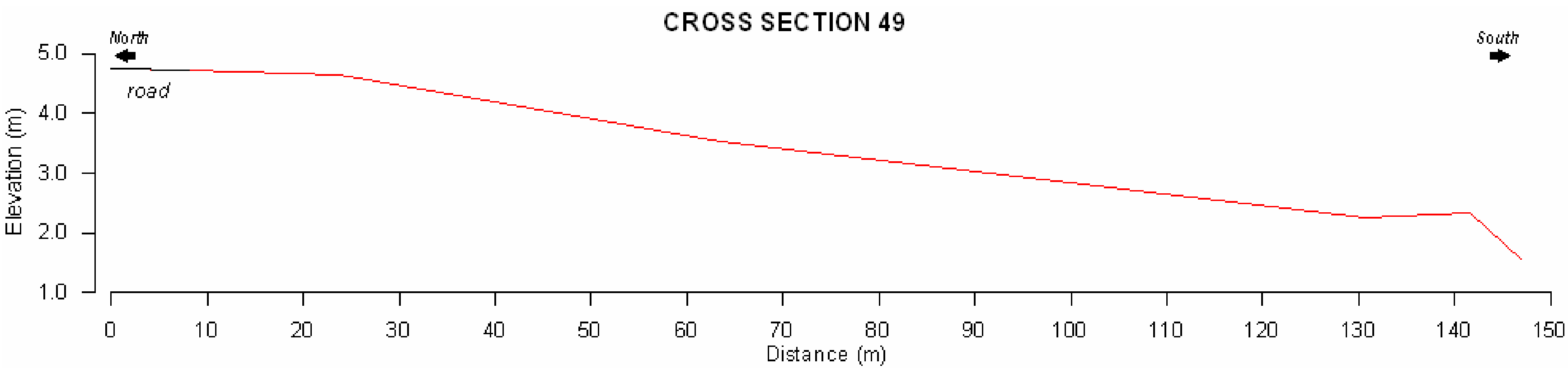

CROSS SECTION 44
North
South
road
Elevation (m)
8.0
6.0
4.0
2.0
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
Distance (m)


CROSS SECTION 45
North
South
road
Elevation (m)
Distance (m)
8.0
6.0
4.0
2.0
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260


CROSS SECTION 46
North
South
road
Elevation (m)
Distance (m)
7.5
7.0
6.5
6.0
5.5
5.0
4.5
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220


CROSS SECTION 47
North
South
road
Elevation (m)
8.0
6.0
4.0
2.0
0.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
Distance (m)


CROSS SECTION 48
North
South
road
road
Elevation (m)
6.0
5.0
4.0
3.0
2.0
1.0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
Distance (m)



CROSS SECTION 49
North
South
road
5.0
4.0
3.0
2.0
1.0
Elevation (m)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Distance (m)

Annex 4

Meteorological Service Report. Wind information.

Wind Data for Norman Manley International Airport (Obtained from the Climate of Jamaica). Prepared by Jeffrey Spooner, Meteorological Service.

3.1 INTRODUCTION

Jamaica lies in the Global belt of North East Trades. Although the trades are predicted by thermal as well as dynamic atmospheric circulation models in the Caribbean they can be explained as emanating from the Azores - Bermuda high pressure
ridge. Over the oceans these winds have average direction of 050 to 060 degrees (measured clockwise from geographical North) in winter and 070 degrees in the summer, and attain constancy of 80%
(1). However because Jamaica is near the Western extremity of the Azores - Bermuda High, the trades in the vicinity of the island is between 070 and 090 degrees). Deviations from this constancy occur mainly when land masses disrupt the basis flow and during winter, when a frequent procession of temperate latitude systems move from mainland U.S.A. to the Atlantic at a sufficiently low latitude thereby weakening and or displacing the High.

By day the trade flow adds vectorially with local thermal breezes. The resultant is known by the misnomer, "Sea Breeze", even though the magnitude of the basic flow is thought to be the greater. By night the trade flow that reaches land is (a) weakened by local land breezes (b) cancelled altogether in some areas or (c) blocked by mountains. The Sea Breeze and its night-time counterpart is thought to be the major control for background showers (showers which do not appear to be associated with synoptic scale systems). It also ensures a reasonable degree of comfort to plant and animal life by reducing near the ground (a) temperature gradients during the day and (b) high humidities at nights. (Fig. 3-1) shows the local wind regime (trades plus land and sea breezes). Directions for wind observations at Morant Point and Negril Point were estimated and are not as accurate or reliable as can be obtained at instrumental stations.

3.2 Data

There are now ten anemographs in the Meteorological Service Network. All have been erected at a height of 33 feet - the suggested international height. Data for Palisadoes and Montego Bay Airports were read from anemograms by trained observers. At Morant Point and Negril Point lighthouses auxiliary observers estimate the direction. The Kingston wind-run data (2) was recorded on a Robinson type anemometer which was situated at the old Public Works Building at Port Royal Street at a height of 691/2 feet. (Wind-run data gives the total miles of wind passing a point. Average speed over any desired period can be computed).

At the airports speed and direction are averaged over a specified ten minute period every hour. However, "if the wind changes markedly in the ten minute period, an average over the period after the change is used". The direction is taken on a thirty-two (32) point compass and reduced to a sixteen (16) point compass for data processing. North, South, East and West represent winds from a specified 30 degrees of the compass each, whereas the other twelve points represent 20 degrees each. All speeds are in knots, and distance in nautical miles.

3.3 Sea and Land Breeze Regime

During the day, for a given insolation, the land becomes warmer than water (due to the higher heat capacity of water), thus reducing the pressure over the land relative to that over water. The resulting pressure and temperature differences form solenoids in a circulation which move air from sea to land near the surface. The strength, time of onset and cessation depend therefore mainly on the surface temperature and pressure differences, and partly on the height to which the differences penetrate. Such a thermal model predicts inflow all around a heated island by day. The breeze from sea to land which so develops, adds vectorially with the basic flow trades). In Jamaica the resultant wind is called Sea Breeze.

In the summer months of June to September, the sea breeze will normally begin by 1000 L.S.T. (1500 G.M.T.) and die down soon after sunset about 1800 L.S.T. (2300 G.M.T.) - a duration of about 9 hours. Maximum speeds usually occur about 1400 L.S.T. shortly after the temperature maximum. The Sea Breeze is thought to affect all low lying areas.

Table 3 - 1
Daily Mean Total Miles of Wind
Taken at Port Royal Street at Elevation 69 1/2 Feet

25 Year Normal 1908 – 1932

Year	Jan.	Feb.	Mar.	Apr.	May	Jun	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Mean for the year
1908	125	151	157	167	203	209	169	162	139	128	116	119	154
1909	120	148	152	156	175	191	183	152	126	135	117	129	149
1910	133	146	135	150	172	185	177	136	127	140	109	115	144
1911	119	144	150	195	179	293	243	226	196	153	168	172	186
1912	214	242	229	201	244	312	244	248	177	162	196	145	218
1913	169	188	264	175	169	273	233	219	185	161	136	161	194
1914	189	210	178	198	223	240	283	232	216	169	128	157	202
1915	173	180	183	190	237	206	217	207	173	126	96	96	174
1916	149	166	183	169	180	196	197	216	139	143	168	162	172
1917	151	173	211	160	204	201	215	184	203	164	129	153	179
1918	203	175	170	199	167	213	260	220	189	148	162	161	188
1919	174	194	196	172	251	262	216	233	183	157	139	147	194
1920	175	181	196	302	191	256	273	197	181	164	180	189	207
1921	113	165	171	166	190	243	242	175	156	184	150	136	178
1922	161	196	198	229	286	238	265	179	168	187	146	167	201
1923	147	167	235	180	244	315	259	226	183	173	143	143	201
1924	191	167	204	176	206	233	227	151	150	142	112	152	176
1925	196	137	143	160	249	238	202	198	158	163	159	157	180
1926	216	185	167	221	190	233	215	189	131	132	100	101	173
1927	145	150	168	160	199	236	225	175	136	153	125	134	167
1928	149	193	206	227	213	252	257	168	184	156	130	147	190
1929	179	206	210	188	241	287	243	165	152	167	151	157	196
1930	174	153	219	195	235	248	249	204	221	162	131	162	196
1931	158	166	188	181	182	194	185	204	179	167	133	163	175
1932	150	170	196	187	202	233	204	164	164	146	213	136	180
Daily Avge. for 25 years	163	174	188	188	209	239	227	193	169	155	141	146	183
Hourly Avge.	6.8	7.3	7.8	7.8	8.7	10.0	9.5	8.0	7.0	6.5	5.9	6.1	7.6

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Table 3-2(a)
Palisadoes 1956 - 1970
Hourly Occurrences

	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM
Jan.	78	66	105	830	983	573	267	431	210	86	84	262	438	637	854	1164	1859
Feb.	76	47	86	871	1450	855	298	323	114	56	38	153	272	474	601	870	1552
Mar.	57	33	70	973	1714	1126	364	381	122	53	37	156	257	360	574	823	1828
Apr.	56	40	64	522	1348	1121	436	413	124	55	58	159	249	351	513	741	2290
May	61	41	78	949	2040	1232	349	214	72	21	16	105	255	402	549	709	1835
Jun.	63	40	96	1754	3041	1296	98	21	7	5	8	77	131	253	250	297	1203
Jul.	102	61	115	1293	2424	1191	102	67	30	18	28	113	249	330	453	481	1870
Aug.	81	63	81	1093	1985	1130	192	155	56	22	27	107	301	404	485	659	2087
Sept.	70	54	86	1037	1703	935	318	200	39	17	22	135	285	385	516	709	2129
Oct.	63	46	73	972	1439	812	307	321	98	48	33	126	358	458	570	827	2377
Nov.	74	39	63	381	669	519	296	462	195	91	65	162	342	528	916	1324	2505
Dec.	113	50	62	536	708	394	252	518	277	90	84	226	399	535	917	1504	2262
TAL	894	580	979	11211	19504	11284	3279	3506	1344	562	500	1781	3536	5117	7198	10108	23797

Table 3-2(b)
Palisadoes 1963 - 1970
Hourly Occurrences

	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	CALM
Jan.	224	286	764	1711	392	279	149	85	16	4	12	20	12	26	20	126	1778
Feb.	345	424	736	1113	274	198	88	98	22	14	15	19	18	19	37	218	1781
Mar.	259	497	1034	1223	236	216	111	115	21	12	8	27	26	18	45	203	1892
Apr.	192	693	1029	1005	210	214	104	104	22	20	11	16	13	10	16	105	1996
May	120	649	1000	895	216	230	159	124	41	27	19	18	11	8	18	76	2309
Jun.	84	425	956	814	269	191	152	125	41	34	20	27	9	8	12	21	2450
Jul.	54	478	1124	1147	277	207	154	91	19	9	10	11	4	-	6	18	2333
Aug.	126	612	961	679	234	231	191	139	28	25	27	11	5	11	15	36	2602
Sept.	157	481	683	558	255	264	227	190	55	33	32	34	19	19	16	59	2663
Oct.	124	499	679	495	215	232	207	170	69	46	40	40	30	13	42	94	2916
Nov.	391	347	820	1365	348	233	140	102	25	10	6	13	8	11	28	243	1668
Dec.	306	331	785	1853	452	252	102	61	9	1	6	6	4	2	12	176	1594
TOTAL	2402	5722	10571	12958	3378	2747	1784	1404	368	235	206	242	159	145	267	1375	25982

At nights local breezes will develop as a result of (a) the ocean being warmer than the land (the diurnal change f sea temperature is small) thereby initiating a movement of air from land to sea - land breeze, (b) cool downslope or mountain winds.

Mountain breezes occur because at nights and especially after a day of rain the mountains and surrounding air cools rapidly, and being more dense than air at the same horizontal level, move downslope. In coastal areas land breeze is likely to be a combination of the two breezes especially where mountains are near the coast.

Land breeze is experienced in coastal areas mainly at nights when the sea breeze does not persist. This cool night breeze can be of help to farming at foothills and in plains facing mountains, ensuring eight to ten hours of lower than normal temperature for that elevation. In valleys however cool downslope breezes tend to cause ponding which may be harmful or helpful depending on th type of crop.

3.4 Analysis of Wind Rose Data

The analysis will be limited since the cardinal points represent a greater arc of the compass than other points and because data from the Lighthouses were estimated.

Palisadoes

At Palisadoes the Sea Breeze (trades plus local thermal sea breeze) is evident year round but is strongest in June

((Table 3-1) wind-run data for Kingston - 3 miles due North over water). The predominant direction is ESE (105 to 125 degrees)

(Table 3-2(a)). Direction East, (075 - 105 degrees) represents days when the magnitude of the trade is relatively greater than normal, directions South-east (125 - 145 degrees) represents days when the magnitude of the local sea breeze is greater than normal (Fig. 3 (2a-21)). Winds from the East-South-East are strongest all months even though North (345 to 015 degrees) winds have a higher frequency of occurrence in November, December and January. An interesting point to note is that winds from the North occur in June (Fig. 3-2f). But June has the lowest frequency of winds occurring from the North. The four months- May, June, July and August record 48% of the occurrences from East-South-East and 19% from North while November, December and January record 12% from East-South-East and 36% from North.

Table 3-2

		E.S.E.	N
May, June, July, August	-	48%	19%
November, December, January	-	12%	36%

Which seems to mean that in summer the trades as well as local sea breeze are more persistent. In winter the average duration of the sea breeze is less, resulting in a higher frequency of North winds.

Light Winds (1-3 Knots and Calms)

Very light winds occur most nights from North West through North (305-010 degrees). (Figure 3-2m) shows that 4328 of 8586 occasions or 50.5% of the times when light winds were reported, they were from these directions. Calms also occur mainly at nights and in April and November. (Table 3-2 (last column)).

In June the sea breeze persists until late evenings or sometimes throughout the night, thus reducing or cancelling the influence of the mountain wind. April and November then represent the transition months between persistent cool night winds from the hills and warm sea breeze from the East-South-East.

Finally, it should be noted that one of the reasons why the trade winds near the surface are not evident at Palisadoes and Kingston at nights all year round may be because of the 2000 to 3000 foot hills to the east-north-east of these areas and not because the land breeze is strong enough to cancel or even weaken the trades.

Appendix 3

GSI-JFCU Hydrographic Compensation Agreement

Geophysical Service Incorporated
Hydrography Compensation Agreement

Rules and Procedures for the Protection of Fishing Interest in the Conduct of Off-Shore Hydrographic Operations

WHEREAS all Petroleum existing in its natural state in the strata in Jamaica (including the seabed and sub-soil of its archipelagic waters, territorial sea, its continental shelf and Exclusive Economic Zone) is vested in the Government of Jamaica

AND WHEREAS by the Petroleum Act, the Petroleum Corporation of Jamaica ("PCJ") is granted the exclusive right to explore and develop the aforesaid Petroleum resources and in that regard to enter into agreement or arrangements with contractors for the exploration and development of such Petroleum resources.

AND WHEREAS on the 15th day of June, 2006, PCJ entered into Production Sharing Agreements with Rainville Energy Limited, of 400, 400-5th Avenue SW, Calgary, Alberta T2P 0L6 of ("Rainville") to undertake certain Petroleum Operations (including Seismic Operations) in certain areas, namely Blocks 9,13,14 on the Block Chart attached hereto as Schedule 1.1.

AND WHEREAS Rainville has engaged Geophysical Service Incorporated ("GSI") to undertake a seismic survey of Blocks 9, 13, 14 as part of the agreed work programme included in the proposed Seismic Operations.

AND WHEREAS GSI has engaged NCS Subsea Inc. to undertake a Hydrographic Survey offshore of the southwest coast of Jamaica. The scope of this survey will be to:

1. Identify hazards to navigation.
2. Determine bathymetric trends within the area in advance of a future seismic survey in the area.

The Hydrographic survey will take place in Blocks 9, 13 and 14 being restricted to the portion of the seismic prospect which has less than 100 m water depth.

Hydrographic Survey Block Chart attached hereto as Schedule 1.1.

The Hydrographic Survey is expected to commence in March 2007 and be completed in May 2007.

AND WHEREAS it is recognized and acknowledged that the pre-defined lines have been determined based on geological analysis undertaken by GSI and that deviation from those lines could materially affect the efficiency of the operation and the quality of the data gathered by GSI. At the same time GSI acknowledges the importance of the fishing industry to Jamaica and hereby undertakes to operate in such a manner as to avoid or minimize disruption to fishing operations and avoid or minimize damage and/or displacement of fishing and related equipment.

AND WHEREAS notwithstanding the exercise of due care in the context of the Hydrographic Survey, though rather unlikely it is envisaged that fishing operations may be unduly disrupted and that fishing and related equipment in the area of operations may be disturbed, displaced, damaged, or destroyed during the survey.

AND WHEREAS the parties identified in Schedule 1 ("the Scheduled Parties") have had meetings and consultations among themselves and with GSI to (i) identify the concerns of the Fishing Community; (ii) develop strategies to minimize disruption to fishing activities; and (iii) establish an efficient, reliable and trustworthy system of identifying legitimate claims and providing fair and reasonable compensation to the affected parties.

AND WHEREAS the Scheduled Parties have adopted these Rules and Procedures to ensure that the Hydrographic survey can be carried out harmoniously and avoid any negative impact to fishing interests, and that where disruption is caused to fishing operations and/ or destruction, damage or displacement is caused to fishing and related equipment that due compensation will be provided by GSI.

NOW THEREFORE the Scheduled Parties hereby adopt the following rules and procedures:

1. Definitions

1.1 In these Rules and Procedures, the following terms shall have the following meanings (such meanings to be equally applicable to both the singular and plural forms of the terms defined).

"Claims Investigator" means a person contracted by GSI and or the claimant, after consultation with the Fisheries Division, Ministry of Agriculture and Lands, Government of Jamaica to investigate the validity and/or quantum of any claim submitted hereunder.

"Claims Report Form" means a document in the form set out in Schedule 4.3 hereto.

"Claims Verification Committee (CVC)" means a committee constituted in the manner set out in Schedule 7.2 hereto.

"Fishing Community" includes all fishers, companies and other firms engaged in recreational or commercial fishing in Jamaica, the Jamaica Fishermen's Cooperative Union (JFCU) Limited and other fishing cooperative societies in Jamaica and all other organizations representing the interest of fishers in Jamaica but shall not include the Fisheries Division.

"Fishing Equipment" means all implements and items used directly for and in support of fishing activities and includes but not limited to supplies and fish harvested.

"Fisheries Liaison Officer" means a Jamaican resident appointed by GSI subject to the consultation of the Fisheries Division and the Jamaica Fishermen's Cooperative Union (JFCU) Limited.

"Focal Point" means locations where incidents may be reported and claims filed for compensation as set out in Schedule 4.2 hereto.

"Hydrographic Survey" – means a survey used to identify hazards to navigation and determine bathymetric trends

"NEPA" means the National Environment and Planning Agency.

"Preliminary Report" means an initial report of an incident either by or on behalf of a claimant and is an incomplete version of the document in the form set out in Schedule 4.3 hereto.

"Release" means a release and discharge in the form set out in Schedule 4.4 hereto.

 AC

"Seismic Operations" includes, for the purposes of this document, seismic, magnetic and gravity surveys.

"Vessel Incident Report Form" means a document in the form set out in Schedule 4.1 hereto.

2. Hydrographic Survey Sample Area

2.1 Attached hereto as Schedule 1.2 is a chart of the area and proposed seismic survey lines along which the hydrographic survey will be conducted

3. Observer

3.1 The Fishing Community shall be entitled to have one (1) observer on board the hydrographic survey Vessel. Any observer provided by the Fishing Community shall be an experienced fisher and his/her appointment as observer shall be approved by the Fisheries Division and the Jamaica Fishermen's Cooperative Union (JFCU) Limited. The Fisheries Division shall be entitled to (1) observer on the Hydrographic survey vessel. All the observers from the Fishing Community will be subject to the Terms of Reference as set out in Schedule 3.1 and are expected to fill out a daily report of activities as set out in Schedule 3.2.

4. Method of Operation

4.1 The Hydrographic Survey is estimated to be carried out for about 68 days, based on daylight operations, and will be conducted in Blocks 9, 13 and 14 as shown in the Block Chart attached hereto as Schedule 1.1.

The Hydrographic Vessel will run along the pre-defined lines that will basically be parallel lines spaced every 100 m running along the strike of the Pedro bank area shown on the proposed GSI survey line chart herein after referred to as "survey lines" as shown in Schedule 1.2. The survey area will be mapped using sidescan sonar data. During the process, the vessel will be towing an Edgetech 272-TD towfish or equivalent. Refer to Schedule 2.1.

4.3 GSI hereby undertakes to operate in such a manner as to avoid or minimize disruption to fishing operations and avoid or minimize damage and/or displacement of fishing and related equipment.

4.4 During the operations Hydrographic Vessel will operate in a manner to ensure *inter alia* that

a) the survey line and Hydrographic Vessel are free from obstructions and fishing equipment.

b) "stay clear" safety warnings are provided to fishers, divers and other vessels within the zone of operation as required

c) where possible, identify the location, owners, density and numbers of fishing gear and other possible obstructions..

5. **Documenting Incidents**

5.1 In most cases, the Vessel should be able to determine if fishing equipment is tangled with the Hydrography Survey equipment. Where possible, the tangled fishing equipment shall be taken on board the Vessel and documented.

5.2 Any disruption of fishing activities, displacement, loss or damage to fishing equipment occurring during the course of the Operation (whether caused by any sampling gear or device associated with the Operation or the Hydrographic Vessel or any vessel associated with the Operation) that shall come to the knowledge of GSI (including by way of reports from the captain of vessels, the GSI/NCS representatives and any of the observers), shall be recorded by GSI and observers to the fullest extent possible on a Vessel/Observer Incident Report Form as set out in Schedule 4.1.

5.2.1 Each Vessel Incident Report Form shall be signed by the captain of the vessel in question, retained by competent authority on the Hydrographic survey vessel, and made available to the Claims Verification Committee for the purposes of verifying claims submitted by fishers.

5.3 Any fishers claiming any disruption of fishing activities, displacement, loss or damage to fishing equipment occurring during the course of the hydrographic operation (whether caused by any sampling gear or device associated with the hydrographic operation or the hydrographic vessel or any vessel associated with the hydrographic operation) must complete and submit a signed Claims Report Form as set of in Schedule 4.3, within ten (10) working days of knowledge of the incident unless precluded by extenuating circumstances. Claims Report Forms shall be available at the authorized Focal Points as listed in Schedule 4.2.

5.4 Preliminary reports may be made within four (4) working days of the knowledge of the incident by radio, telephone or other forms of telecommunication to authorized focal points. The person taking such report must complete a preliminary claims report in the form set out in Schedule 4.3 hereto and shall send such report immediately to the Fisheries Liaison Officer at the Fisheries Division Head Office. The Fisheries Liaison Officer shall, on receipt of the preliminary claims report, make a copy thereof and send such copy to GSI on receipt.

5.5 Where a preliminary report has been made by or on behalf of a claimant, such claimant shall submit a complete and signed Claims Report Form (as set out in Schedule 4.3) within 10 working days of knowledge of the incident.

6. Items of Claim

6.1 The following are the items of claim which may be made against GSI under these Rules and Procedures:

(a) displacement, loss or damage to fishing equipment;

(b) loss of use of fishing equipment;

(c) disruption of fishing activity

6.2 In relation to each item of claim, the amount payable shall be quantified in accordance with the principles set out in Schedule 7.1 and Schedule 5.

6.3 All personal injury claims may be submitted directly to GSI.

6.3.1 All claims related to personal injury should be reported to the Jamaica Constabulary Force, the Maritime Authority of Jamaica and the Fisheries Division before submitting such claims to GSI through the Fisheries Liaison Officers.

6.4 No new claims shall be made after twenty (20) working days of the completion of the Hydrographic Survey Field Operations.

6.5 Notwithstanding clause 6.4 claims received after twenty working days of the completion of the Hydrographic Survey Field Operation may be accept after consideration by the Claims Verification Committee.

7 Claims Processing

7.1 The Claims Verification Committee shall be authorized to settle individual claims of up to a limit of $250, 000 Jamaican dollars.

7.2 If the recommended settlement of any claim considered by the Claims Verification Committee is in excess of $250,000 Jamaican dollars then the said claim shall be referred to GSI for consideration. GSI will consider such claim and respond within 5 business days.

7.3 GSI shall consider the final recommendation of the CVC with respect to all claims. In the event that GSI disagrees with any or all aspects of the recommendation of the CVC then the appeals process as per clause8 shall be initiated.

7.3.1 If the claimant is not a registered and licensed fisher at the time of the incident or was fishing in contravention of that individual's license or any provision under the Fishing Industry Act (1975) and Regulations, then the claim will be rejected. Not withstanding the claimant has a grace period of 30 days after their license has expired shall be able to legitimately make a claim

7.4 Completed Claims Report Forms along with a certified copy of the claimant's fishing license must be sent to the Fisheries Division which shall verify whether:

(a) the claimant is a registered and licensed fisher;

(b) the claimant is licensed to carry out, in the area in which he was fishing, the particular type of fishing operation in which he was engaged at the time of the incident.

7.5 Completed Claims Report Forms along with a certified copy of the involved vessel(s) license(s) must be sent to the Fisheries Division which shall verify whether:

(a) the vessel is registered and licensed;

(b) the vessel is licensed to carry out, in the area in which she was fishing, the particular type of fishing operation in which she was engaged at the time of the incident.

7.6 The Claims Verification Committee shall consist of three representatives, namely:

(i) a representative of Fisheries Division (not being the Director of Fisheries) who shall chair the committee;

(ii) a representative of GSI (not being a member of the Appeals Tribunal);

(iii) a representative of the Fishing Community appointed by the Jamaica Fishermen's Co-operative Union Limited (not being the Chairman of that organization).

7.6.1 The Claims Verification Committee shall appoint an alternate in respect of each member to sit on the committee in circumstances where, by virtue of conflict of interest, illness or other reason the substantive member is unable to sit or is otherwise unavailable.

7.6.2 An alternate member shall have all the powers and duties of the substantive member in whose place he sits.

7.7 The Claims Verification Committee may seek expert advice to assist in its deliberations.

7.8 The Claims Verification Committee shall evaluate each claim and shall among other things, determine whether:

(a) the amount claimed is reasonable having regard to all the circumstances including, in particular: (i) the type of fishing operation disrupted; (ii) the fishing equipment allegedly damaged, destroyed, displaced or lost; (iii) the likely remaining useful life of the fishing equipment; (iii) and if recovered, the likelihood of any salvage value.

(b) there are other circumstances which are likely to affect or otherwise impact on the validity or *bona fides* of the claim.

(c) notwithstanding clause 7.1, the Claims Verification Committee may give due consideration to all the circumstances surrounding a claim and determine if such a claim may be considered.

7.8.1 In discharging its functions the Claims Verification Committee shall operate in accordance with the Terms of Reference given in Schedule 7.2, herein.

7.9 The Claims Verification Committee shall determine whether:

(a) the claim should be honored, and if so the amount to be offered in settlement;

(b) the claim should be rejected in whole or in part, and if so the reason(s) for such rejection.

7.10 Notwithstanding anything herein, GSI and any claimant shall be entitled at any time to contract the services of any one or more Claims Investigators for further investigation. When a claim is referred to a Claims Investigator, he shall undertake the investigation promptly and shall submit his report to the Claims Verification Committee within 30 days of the reference. If the Claims Investigator shall fail to submit his report to the Claims Verification Committee within the aforesaid 30 day period then the reference shall be null and void and the claim shall be dealt with as if no reference was ever made to a Claims Investigator. Any later report or evidence provided by the Claims Investigator shall be wholly inadmissible.

7.11 Subject to a right of appeal to the Appeals Tribunal, a claim which is approved for payment by the Claims Verification Committee and accepted by GSI and the claimant shall be paid by GSI within 10 working days after the ruling of the Claims Verification Committee. The claimant must sign a Release Form (refer to Schedule 4.4) on receipt of payment.

8. <u>Appeals</u>

8.1 If GSI or a claimant is dissatisfied with the settlement ruling made by the Claims Verification Committee then GSI or the claimant may appeal to the Appeals Tribunal by completing the Appeals Form set out in Schedule 6 within five (5) working days of receipt of the ruling of the Claims Verification Committee. The Fisheries Liaison Officer shall ensure that the relevant claims form be filed together with all documents, copied, and sent to the Appeals Tribunal.

8.2 <u>The Appeals Tribunal shall consist of the following three persons; namely:</u>

(a) The Director of Fisheries;

(b) The Chairman of the Jamaica Fishermen's Cooperative Union Limited;

(c) A representative of GSI (who shall not be the same representative on the Claims Verification Committee).

8.2.1 The Appeals Tribunal shall appoint an alternate in respect of each member to sit on the Tribunal in circumstances where, by virtue of conflict of interest, illness or other reason the substantive member is unable to sit or is otherwise unavailable.

8.2.2 An alternate member shall have all the powers and duties of the substantive member in whose place he sits.

8.2.3 The Appeals Tribunal shall be chaired by the Director of Fisheries or his alternate.

8.3 The Appeals Tribunal may seek expert advice to assist in its deliberations.

8.4 If the Appellant (whether GSI or the claimant) requires to be heard on the Appeals, then the Appeals Tribunal shall set a date which shall not be more than ten (10) working days after receiving all documents. At any such hearing, submissions not exceeding one (1) hour may be made by one or both parties. A party appearing before the Appeals Tribunal may be represented by an attorney-at-law.

8.5 If no request for a hearing is received by the Appeals Tribunal within ten (10) working days of the reference, then the Tribunal may proceed to make a determination based on the documents submitted. However, nothing herein shall prevent the Appeals Tribunal from requiring additional information or from calling upon the parties to make written or oral submissions within a prescribed time.

8.6 The Appeals Tribunal shall act as expert and not as arbitrator and its decision shall be final, binding and conclusive.

9. Amendments to this Agreement

An amendment or modification to or release from provisions of this Agreement is effective only if made in writing and signed by all parties.

10. Termination

This Agreement can be terminated by either party giving thirty (30) days written notice.

SCHEDULE 1

GSI - Jamaica Hydrographic Survey
Compensation Agreement
Parties to the Agreement

IN WITNESS WHEREOF the parties to this Agreement have set their hands and affixed their seals the day and year first hereinbefore mentioned.

SIGNED for and on behalf of
JAMAICA FISHERMEN'S COOPERATIVE UNION LIMITED
By Chairman

Havland Honeyghan

JAMAICA FISHERMEN COOPERATIVE UNION LIMITED
SEAL

In the presence of: -

Godfrey Perkins
(Petroleum Corporation of Jamaica)

SIGNED for and on behalf of
Geophysical Service Incorporated(GSI)

By Seismic Survey Coordinator

Alexey Cheremovsky

GEOPHYSICAL SERVICE INC.
400, 400 - 5 AVE. S.W.
CALGARY, ALBERTA T2P 0L6
PHONE NO. (403) 215-2720
FAX NO. (403) 215-2724

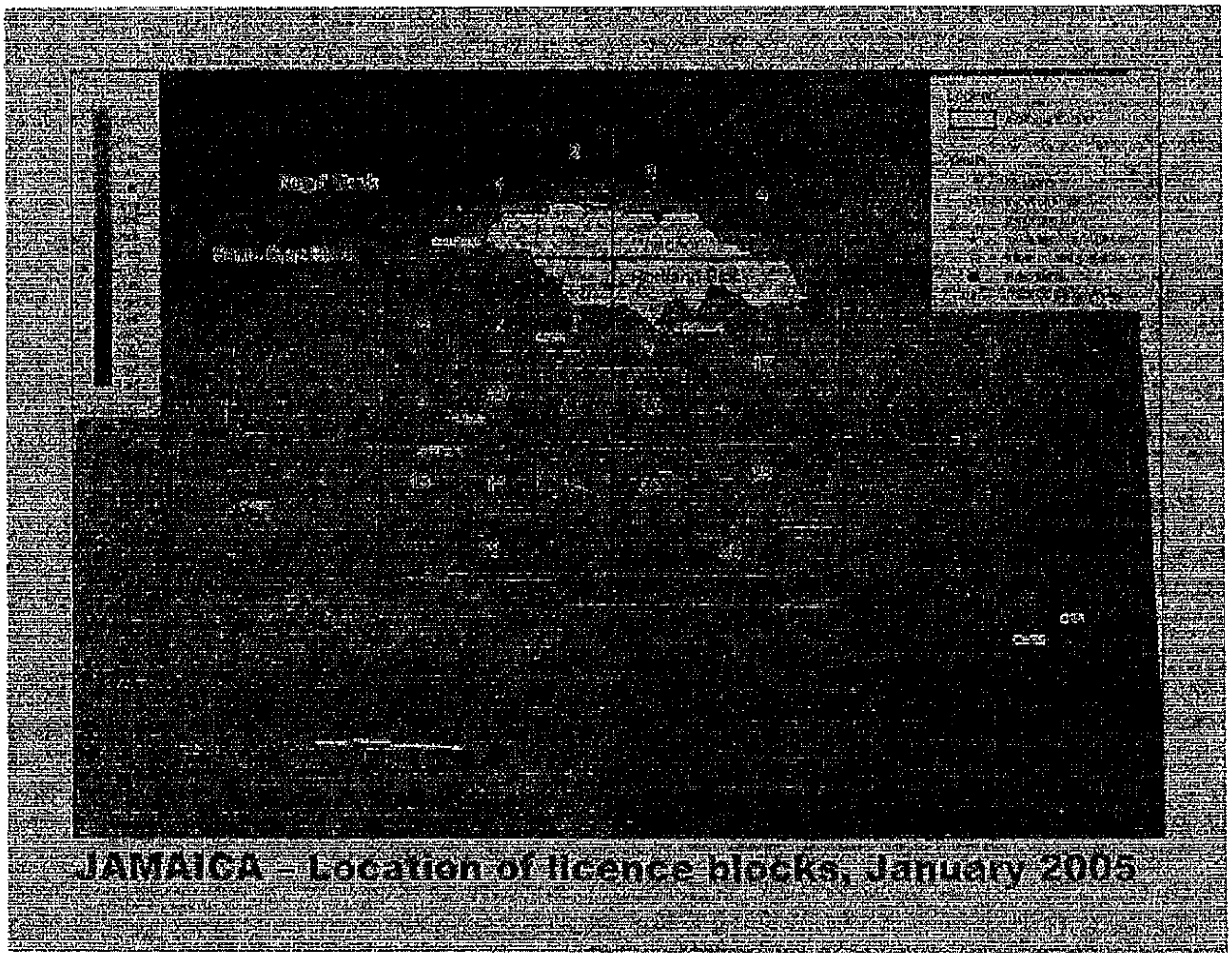
In the presence of: -

Marjorie Solomon
(Executive/ Administrative Assistant, GSI)

SCHEDULE 1.1

GSI- Jamaica Seismic Survey
Compensation Agreement

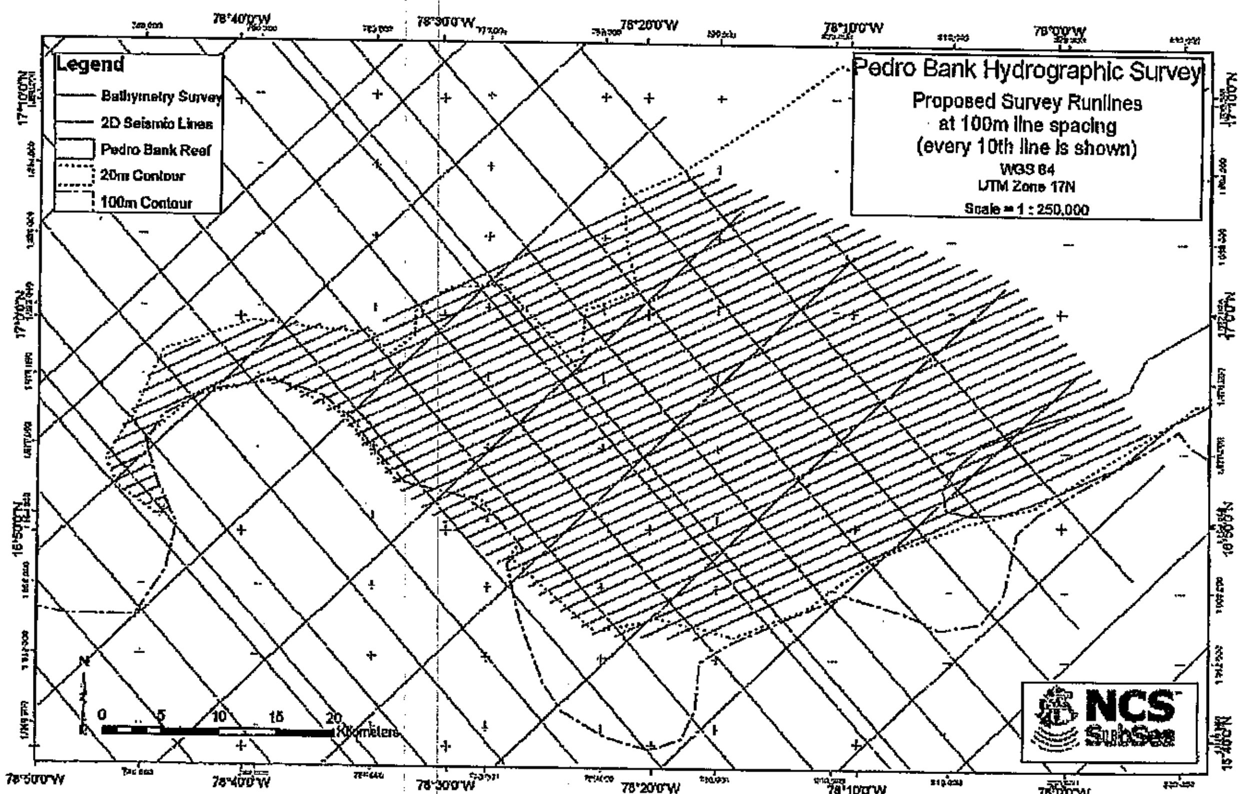
Block Chart from the Petroleum Corporation of Jamaica



SCHEDULE 1.2

GSI - Jamaica Hydrographic Survey
Compensation Agreement

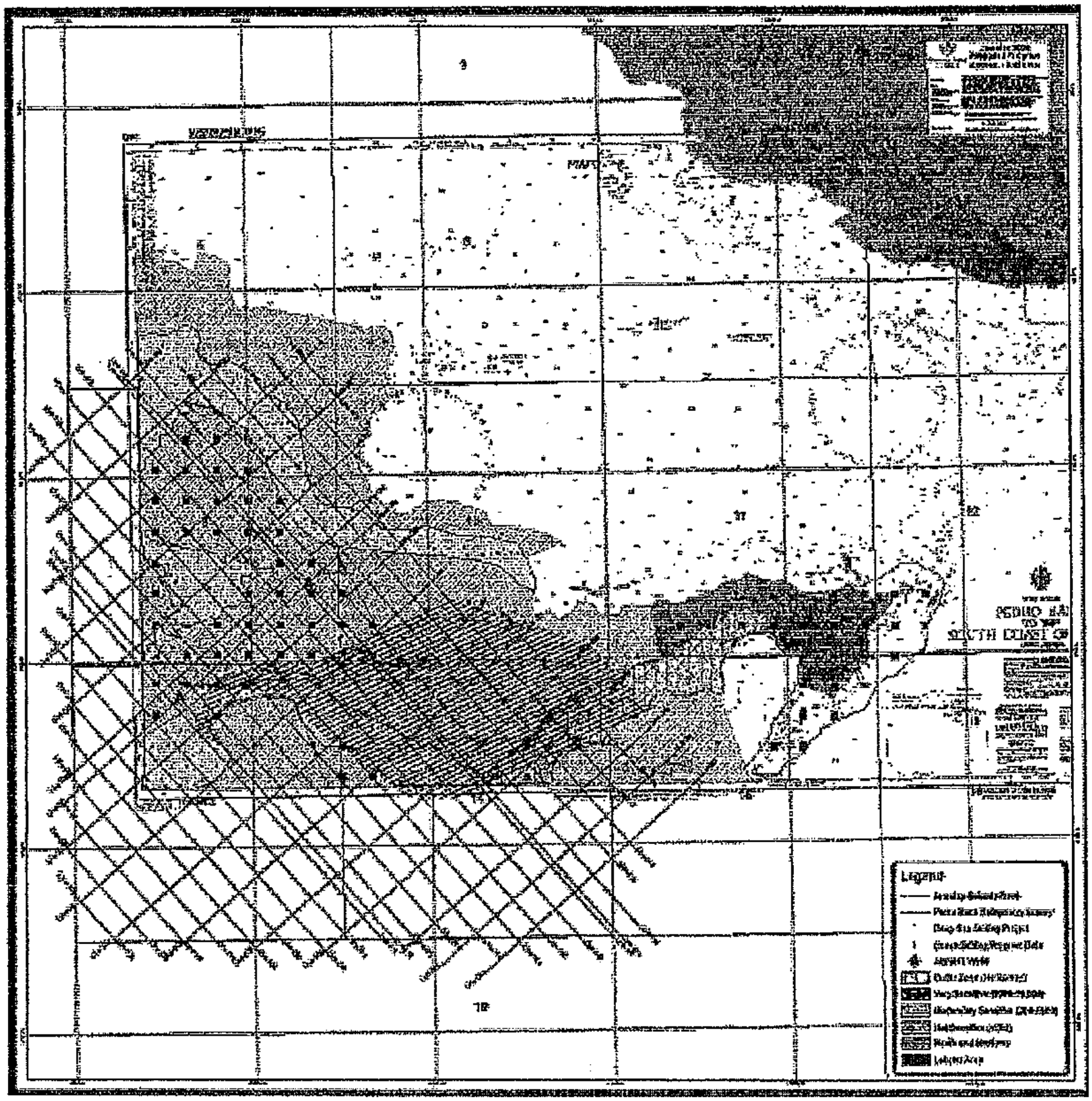
Hydrographic Survey Line Chart
Prepared by GSI



SCHEDULE 1.3

GSI - Jamaica Hydrographic Survey
Compensation Agreement

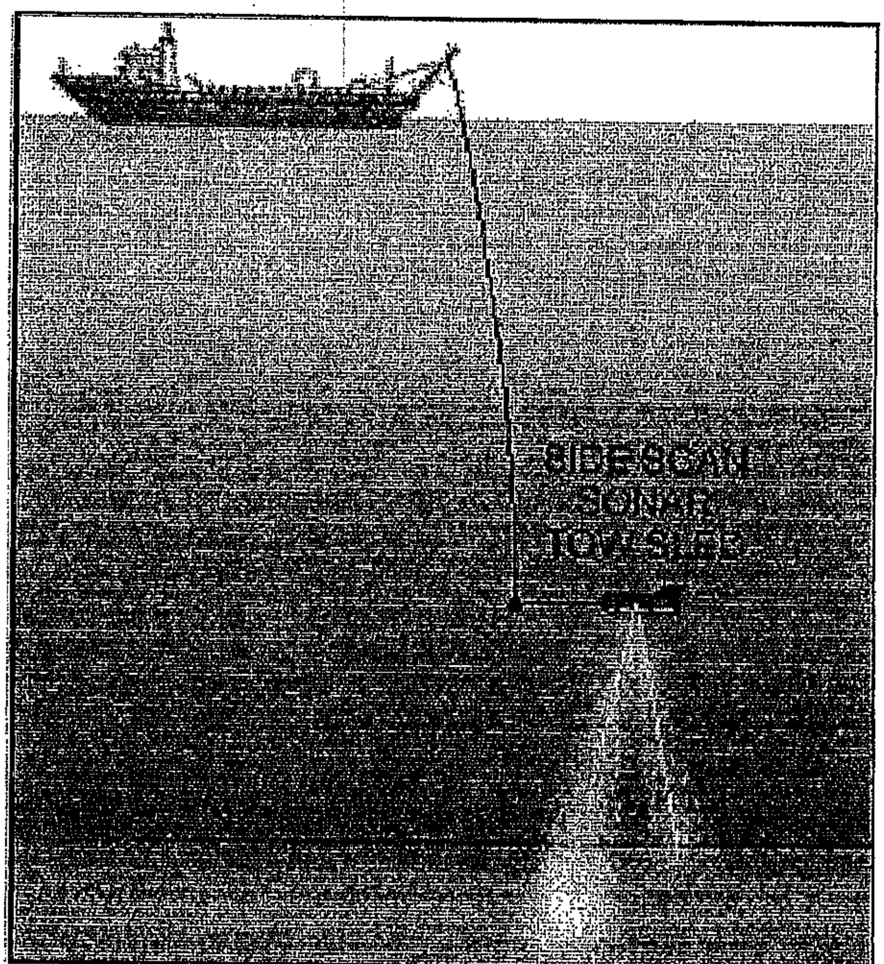
Seismic and Hydrographic Survey Line Chart
Prepared by GSI



SCHEDULE 2.1

GSI - Jamaica Hydrographic Survey
Compensation Agreement

Diagrammatic Representation of Sidescan Sonar and Towfish



SCHEDULE 3.1

GSI - Jamaica Hydrographic Survey Compensation Agreement

Terms of Reference for Fisher Representative Observer (FRO) And Fisheries Division Observer (FDO)

The FRO's/FDO's shall function in accordance with the following;

- Be on 24 hour call.
- Be engaged in watches as much as is practicable during survey operations
- Cooperate with Vessel Reps to conduct trap/fishing activity census.
- To engage in all necessary communication with fishers and assist in communications where necessary.
- Participate in identification/ recording of fishing vessels, fishing activities, fishing devices, and/or any fishing gear encountered or retrieved onboard the vessel.
- Participate in recording of incidents and completing of the required incident reports.
- Report all incidents involving disruption of fishing operations and/or destruction, damage or displacement to fishing equipment to the Fisheries Division. The transmission of the daily incident reports to the Fisheries Division/JFCU Limited shall be facilitated by the GSI Representative onboard the Hydrographic Survey Vessel.
- Provide Daily reports to the Fisheries Division and JFCU Limited. The transmission of the daily reports to the Fisheries Division/JFCU Limited shall be facilitated by the GSI Representative onboard the Hydrographic Survey Vessel.
- FRO's/FDO's shall be available to provide any necessary evidence to the Claims Verification Committee and/or the Appeals Tribunal.
- Any other functions as determined by the Fisheries Division and the JFCU Ltd.

SCHEDULE 3.2

GSI - Jamaica Hydrographic Survey
Compensation Agreement Observer Daily Report Form

Name of Observer	Organization	Date Boarded		Vessel Report Date				
		Day	Month	Year	Day	Month	Year	
Signature:								

Sea and Weather Conditions								
Visibility							AM	PM
						Wave Height (m)		
Good >5km		Medium< 5km		Poor<1km		Wind Speed		
						Wind direction		
						Vessel speed		

Activity Log								
Line # worked	Towfish Depth	Start		Stop		Time (GMT)		Fishing Activity
		Latitude	Longitude	Latitude	Longitude	Start	Stop	Yes/No

Tick the appropriate box below that describes the fishing activity observed											
None		Fish Traps		Lobster		Conch		Long liner		Other	
If other specify >											

Impact on Hydrographic Operation?	No >		Yes >		
If Yes Describe >					
Impact on Fishers Operation?	No >		Yes >		
If Yes Describe >					

Was there any communication between your vessel and fisher folk?	No >		Yes >	
If Yes Describe				
Daily Trip Summary				

SCHEDULE 4.1

GSI - Jamaica Hydrographic Survey
Compensation Agreement

Vessel/Observer Incident Report Form

Ref no.__________

Time and Date of incident: ______________________________

Location of incident: ______________________________

Description of incident and type of fishing equipment involved:

Picture(s) relevant to the incident (fishing equipment and any other pictures)

Number of pictures taken and their respective reference numbers (i.e., vessel report forms reference number/ P [number assigned to specific picture(s)]):

____

Comments or details of incident:

Details of Survey Operation Vessel(s) involved in incident

Name of Vessel: __________________________

Name of the Captain: ________________________

Name of Observer(s): ____

Details of fishing vessel involved in incident

Fishing Vessel Name/Registration Number: ________________________

Name of Captain/Owner: ______________________________________

Fishing Licence number: ______________________________________

Report filed by: __________________________ Job Title: _______________________________

Signature: _________________________

SCHEDULE 4.2

GSI - Jamaica Hydrographic Survey
Compensation Agreement

Focal Points

Location	Contact	Telephone	Days Open
Alligator Pond Fisheries Division Sub-office	Stephen Smalling – Fisheries Instructor	965 -4313/397-2614	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)
Rocky Point, Clarendon Fisheries Division Sub Office	Quie Thompson Fisheries Instructor	427-2944	Mon –Thur (8:30am-5:00pm)
Black River Fisheries Division Sub-office	Howard Simpson Fisheries Instructor	965-2276/ 374-1036	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)
Coast Guard Base, Black River	Petty Officer	909-9802	Everyday (24hrs.)
Coast Guard Base, Pedro Cay, Middle Cay	Petty Officer	909-8807	Everyday (24hrs.)
Fisheries Division	Errol Bartley, Anginette Murray or Simone Cordice – Fisheries Officers	923-8811-3	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)
Great Bay Fisheries Division Sub-office	Stephen Smalling Fisheries Instructor	965-3411/413-7263	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)
Old Harbour Bay Fisheries Division Sub-office	Leroy Morgan Fisheries Instructor	708-4465/375-1241	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)
Jamaica Fisherman's Cooperative Union	Ionie Henry Manager	968-0411	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)
Old Harbour Bay Cooperative	Errol Cameron Chairman	428-0206	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)
Whitehouse, Westmoreland Fisheries Division Sub-office	Howard Bromfield (Chief Fisheries Instructor) / H. Simpson (Fisheries Instructor)	963-5123/ 963-3076/ 374-1036	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)
Whitehouse, Westmoreland Gillings Gully Fishermen's Cooperative	Havland Honeyghan Chairman	866-9688 /963-5063/ 963-5053	Mon –Thur (8:30am-5:00pm) Fri (8:30am -4:00pm)

SCHEDULE 4.3

GSI- Jamaica Hydrographic Survey
Compensation Agreement
Claims Report Form

Ref. No. ___________ Date: _________________

GENERAL INFORMATION

Tick where appropriate

Preliminary Report ____ Final Report ____

Report made by: Phone ___ Radio ___ In Person ____

Name of person filing report if other than claimant?

____

Report filed at (Focal Point)____

CLAIMANT'S PARTICULARS

Claimant's Name __________________________ Alias ________________________

Claimant's Address____

____

Claimant's ID/Fishing license No. __________________

Telephone contact ________________________ ___________________________

E-mail ____________________

Which fishing area do you operate from?

____

What type of fishing do you do? ____

Are you the owner, part owner or operator of a fishing vessel? Please tick appropriate box

Owner ___ Part owner ____ Operator___

If no, give the name of owner _______________________________

If part owner give the name of the other part owner(s)___________________________

If an operator give the name of the owner __________________________________

AC

Fishing Lic. No. of owner(s)

____

Vessel Name ______________________ Vessel registration #

____

Type of vessel license

____

Name of vessel operator __________________________________

Name of crew members

____

____

____

NATURE OF CLAIM

Please indicate by ticking the appropriate statement;

(1) My fishing operation was disturbed ___

Date/ time fishing operation disturbed

____

What type of fishing where you doing at the time you were disturbed?

____

____

____

As best as possible give the location or last known location of the fishing operation

____

____

____

____

____

____

From Block Chart provided list the block(s) within which you were engaging in your fishing operation (the focal point representative will provide the block chart and assist claimant in answering this question) ________________________

How was the operation disturbed?

____

____

____

____

____

Indicate the type of equipment (i.e. Fish trap, net, long line etc.) being used or about to be used at the time of

disturbance____

Indicate the number of traps or line or weight/ length of netting being used/set or about to be used/set at the time of

disturbance____

As a result of the disturbance how much fishing time was lost?

____

What is the estimated loss of earning associated with this disturbance?

$__________________

(2) My vessel was damaged ___

Date/ time fishing vessel was damaged

____

Were you fishing at the time of Damage? Yes_____ No____

If yes, what type of fishing where you doing at the time the vessel were damaged?

____

____

____

As best as possible give the location or last known location of the fishing vessel at the time of damage

From Block chart provided list the block(s) within which you were engaging in your fishing operation (the focal point representative will provide the block chart and assist claimant in answering this question)________________________

Describe the events leading to the damage of the fishing vessel?

What type of damage did the vessel suffer?

Is the vessel still working and in your estimation can it be repaired?

Where is the vessel now?

Is there any evidence of the damage (photograph, engineer's report etc?) Yes ____

No____

If yes, please attach certified copy in support of this claim

List in the table below any other loss or damage to equipment (e.g. am /fm radio, compass, G.P.S etc.) or supplies (e.g. Fuel, food, water etc).

UNIT	DESCRIPTION (equipment / supplies)	ESTIMATED $JA Value

If necessary list on an additional sheet of paper any other equipment /supplies and attach to Claim Form.

(3) My fishing equipment was affected ___

Tick the type of fishing equipment affected

Fish traps ___ Lobster traps ___ Nets ___ Long lines ___ Vessel ___

Diving Equipment ___ Other ___

If other, please specify

Tick below how equipment was affected

Partial damage ___ Lost ___ Destroyed ___ Other ___

If other, please

specify____

____

____

____

Date/ time incident occurred _______________________________ OR

Date/ time incident was observed

____

If the incident was not directly observed please specify the date and time you last saw your equipment in good working order _______________________

As best as possible give the location or last known location of the fishing equipment

____

____

____

____

____

____

From Block chart provided list the block(s) within which equipment was being used when affected. (the focal point representative will provide the block chart and assist claimant in answering this question) _______________________

Itemize details of your claim in table below

UNIT	DESCRIPTION	ESTIMATED $JA Value

AC

Comments

____
____
____
____
____
____

Please use the GSI – Jamaica Hydrographic Survey Compensation Agreement Claims Report Form
Supplemental sheets provided to record any additional information in support of this claim and attach to the claims form.

I ____________________________ the undersigned hereby declare that to the best of my knowledge

(Name of claimant)

And believe that all the information given in support of this claim is true and realize that any false information given can result in the disqualification of this claim and that criminal charges may be brought against me.

Signature ___________________________ **Date ________________**

Certified Copy of Claimant's Fishing License and Vessel License must be submitted along with Claim Form.(in addition to the normal notary public a fisheries instructor or authorized officer at the focal points can certify licenses by attaching the words "original seen" and dating and affixing their signature)

SCHEDULE 4.4

GSI - Jamaica Hydrographic Survey
Compensation Agreement

Deed of Release & Indemnity

1. The Undersigned (whose name and address is set out in Schedule I below) hereby acknowledges receipt of the sum of [J$ ***] from Geophysical Service Incorporated ("GSI") in full and final settlement of all damages, claims, costs and expenses arising out of the incident brief details of which are set out in Schedule II below ("the Claim Incident"). In consequence of such payment the Undersigned hereby irrevocably and unconditionally discharges and releases GSI, Rainville Energy Limited, Petroleum Corporation of Jamaica, The Government of Jamaica and their respective directors, employees, and agents (herein "the Released Parties") from all actions, proceedings, claims or demands whatsoever which the Undersigned or any person claiming by or through him may have against any of the Released Parties arising out of, or in connection with, the Incident (whether or not such incident arising there from was known or unknown as at the date hereof.)

2. The Undersigned represents and warrants that he is the only person lawfully entitled to make and sustain a claim in respect of the Incident and hereby covenants to indemnify and keep each of the Released Parties fully indemnified against any action, proceeding, claim or demand which may be made by any other party against any of them in respect of the Incident.

3. The Undersigned shall upon request cooperative to give relevant information that may be at any time requested by GSI or their Insurers.

4. In this Release and Indemnity (i) references to the singular includes the plural and vice versa and (ii) references to the one gender includes all other genders.

5. This Release and Indemnity shall be governed by and construed in accordance with Jamaican law.

Schedule I

Name of Releasor:
Address of Releasor:

Telephone No:

Schedule II

Incident

Describe incident in brief:

Specify Items lost or damaged.

[Execution by Individual]

SIGNED, SEALED and DELIVERED by)
)
In the presence of:) Name:

Witness
Address:
Telephone no:

[Execution by Company]

EXECUTED under the Common Seal of) Director
LIMITED in accordance with its Articles of)
Association by)
a Director and)
a Director/Secretary in the presence of:) Director/Secretary

SCHEDULE 5

GSI - Jamaica Hydrographic Survey
Compensation Agreement

Table 5.1: Replacement cost and daily earnings of the more common types of equipment employed within the Jamaican Fisheries Sector.

Description of Equipment	REPLACEMENT COST $JA	DAILY EARNINGS $JA
Fish Trap	7000.00	$735.00
Lobster Trap	5600.00	$46,200.00***
Set Net (complete net per lb)	3900.00	$350 per lb
Long Line		
Fiberglass Canoe 28'	320,000.00	*
Fiberglass Canoe 30'	380,000.00	*
Fiberglass Canoe 33'	480,000.00	*
Fiberglass Canoe 35-45	700,000.00 – 1,000,000.00	*
Out Board Engines 40 – 50 Hp.	220,000.00 – 280,000.00	*
Outboard Engine 55 – 75 Hp.	350,000.00	*
GPS	15,000.00	
Compass	5,000.00	
Life Jacket	3,000.00	
Flares	2,000.00	
Anchor	5,000.00	
Ropes	7,000.00	
Radio	12,000.00	
Conch Fishing**		
Hookah Rig		
Dory		

* Depends on the Type of Fishing activity and the number/amount of gear that is not able to be worked

** It was considered rather unlikely that Conch fishing equipment would be damaged. However should the Seismic survey activity in an area result in the shut down of conch fishing operations then the daily loss of earnings would = . This figure is arrived at by dividing the TOTAL Quota by the number of Days in the Conch Fishing Season.

*** Data for a string of 25 Lobster traps/24 Hr. soak period.

SCHEDULE 6

GSI - Jamaica Hydrographic Survey
Compensation Agreement

Appeals Form

To: The Appeals Tribunal

Re: Claimant: ____________________

Date of Reported Incident: ____________________

1. Reference is made to claim, Reference No. (s) of Claim ____________________ made pursuant to clause 5.3 of the Rules and Procedures for the Protection of Fishing Interest in the Conduct of Off-Shore Hydrographic Operations.

1.1 I/We   pursuant to clause 8.1 hereby appeal against the decision of the Claims Verification Committee made on the   day of 200[ ][1]

Grounds of Appeal

2. The ground(s) of appeal are as follow(s):

Submission on Appeal

3. I/We will [*tick the appropriate box below*] :

- ☐ make a written submission to the Appeals Tribunal which will be submitted within working (10) days;
- ☐ make an oral submission to the Appeals Tribunal
- ☐ be represented by an attorney at law

4. My/our address/telephone number(s) are as follows:

Address:[2]
Telephone No.:
Cell. No.

Name: Signed by:

For Official Use Only
CVC Case Report Reference No. ____________________

---

[2] If a party is appearing through an attorney, he should insert the attorney's address and contact numbers.

SCHEDULE 7.1

GSI - Jamaica Hydrographic Survey Compensation Agreement

Principles for Assessing Claims

(A) **Lost, damaged or destroyed fish/lobster traps**

This item of claim shall be assessed based on the agreed replacement value assigned thereto according to Schedule 5

(B) **Lost, damaged or destroyed fishing equipment (other than traps)**

1. In the event of a total loss of boats and engines, this item of claim shall be assessed based on the agreed replacement value assigned thereto according to Schedule 5 less (i) "a new for old" allowance of 10% to 50% depending on the remaining useful life of the fishing boat and engine (ii) an allowance for recoverable salvage (where applicable) based on the available parts which have been recovered and are reusable.

2. In the event of reparable damage, the claim shall be assessed on the estimated cost of repairs.

(C) **Loss of Use fish/lobster traps and other fishing equipment**

- (i) Loss of use for each type of fishing equipment shall be calculated by using the respective value of Daily Earnings as set out in Schedule 5 and taking into account current catch rates
- (ii) In respect of fishing equipment not listed in Schedule 5 the loss of use will be determined by the Claims Verification Committee.

SCHEDULE 7.2

GSI Jamaica Hydrographic Survey
Compensation Agreement

Terms of Reference for Claims Verification Committee (CVC)

1.0 **Membership of CVC**

1.1 The members of the Claims Verification Committee shall be:

a) The Jamaica Fishermen's Cooperative Union (JFCU) Limited;

b) The Fisheries Division of the Ministry of Agriculture (FD);

c) Geophysical Services Incorporated (GSI).

Neither the Chairman of the JFCU Limited nor the Director of the Fisheries Division is eligible to be appointed as a regular or alternate member of the Claims Verification Committee.

1.2 There shall be a quorum of the three organizations represented on the Claims Verification Committee.

1.3 Each organization shall designate two representatives to serve on the Committee, one regular member to serve at each meeting and an alternate member who will serve in circumstances where the regular member cannot sit by virtue of conflict of interest, illness, unavailability or any other reasons. An alternate member shall have all the powers and duties of the substantive member in whose place he sits.

1.4 If the designated alternate member cannot serve on the Committee then another alternate member from the organization of the regular member in question shall be appointed to serve on the Committee for the duration of the consideration of the claim in question.

1.5 Each organization shall be represented by one person at any sitting of the Claims Verification Committee.

1.6 The Fisheries Division's representative shall act as the chairperson of the Committee. Each member of the Committee is entitled to one vote only. The Chairperson shall not have a casting vote.

2.0 **Meetings**

2.1 Meetings of the Claims Verification Committee shall be held only after:

a) All the relevant documents i.e. a verified copy of the claimant's fishing license, a verified copy of fishing vessel license, Claims Report Form(s), Daily Report Form(s), Vessel Incident Report Form where applicable, and any other relevant documents deemed necessary have been submitted in accordance with clauses 7.4 and 7.5 of this Agreement;

b) All relevant documents have been copied to and perused by all the Committee members.

2.2 Meeting of the Claims Verification Committee in respect of a given claim shall be held within five (5) working days of receipt of all the relevant documents by the Committee members. Any member of the Committee may request the convening of a meeting of the Committee.

2.3 The proceedings of the Claims Verification Committee meetings with regard to each claim shall be conducted in a standardized manner as determined by the Committee.

2.4 The Claims Verification Committee may seek expert advice to assist in its deliberations.

3.0 **Claims Processing**

3.1 The Claims Verification Committee shall be authorized to settle individual claims of up to a limit of $ 250,000 Jamaica dollars

3.2 If the recommended settlement of any claim by the Claims Verification Committee is in excess of $ 250,000 Jamaica dollars then the said claim shall be referred to GSI for consideration for settlement.

3.3 If the claimant is not a registered and licensed fisher folk or at the time of the incident or was fishing in contravention of that individuals license or any provisions under the Fishing Industry Act (1975) and Regulations, then the claim will be rejected.

3.4 Completed Claims Report Forms along with a photocopy of the claimant's fishing license must be sent to the Fisheries Division which shall verify whether:

a) the claimant is a registered and licensed fishers;

b) the claimant is licensed to carry out, in the area in which he was fishing, the particular type of fishing operation in which he was engaged at the time of the incident.

3.5 The following are the items of claim which may be made against GSI under these Rules and Procedures:

a) displacement, loss or damage to fishing equipment;

b) loss of use of fishing equipment;

c) disruption of fishing activity

3.5.1 Types of claims to be heard will exclude death, personal injury/dismemberment claims or any other claims normally addressed under the International Maritime Organization or under Insurance procedures. All claims related to personal injury should be reported to the Jamaica Constabulary Force, the Maritime Authority of Jamaica and the Fisheries Division before submitting such claims to GSI.

3.5.2 All personal injury claims may be submitted directly to GSI through their Fisheries Liaison Officers.

4.0 **Rulings**

4.1 In relation to each item of claim, the amount payable shall be quantified in accordance with the principles set out in Schedule 7.1. The Committee may, if deemed necessary, defer settlement of any claim pending further investigation pertaining to said claim.

4.2 Claims Verification Committee shall evaluate each claim and shall among other things, determine whether:

(a) the claim should be honored, and if so the amount to be offered in settlement;

(b) the claim should be rejected in whole or in part and if so the reason(s) for such rejection.

(c) the amount claimed is reasonable having regard to all the circumstances including, in particular (i) the type of fishing operation disrupted (ii) the fishing equipment allegedly damaged, destroyed, displaced or lost; (iii) the likely remaining useful life of the fishing equipment; (iii) and if recovered, the likelihood of any salvage value;

(d) there are other circumstances which are likely to affect or otherwise impact on the validity or *bona fides* of the claim.

4.2.1 Notwithstanding, the Claims Verification Committee may give due consideration to all the circumstances surrounding a claim and determine if such a claim may be considered.

4.3 In respect of each claim the committee shall produce a Claims Verification Committee Case Report (Schedule 7.3) that details *inter alia* the proceeding, conclusions and recommendations of the Committee.

4.4 Each member of the Committee shall sign the Claims Verification Committee Case report in respect of all Claims.

SCHEDULE 7.3
GSI - Jamaica Hydrographic Survey
Compensation Agreement

Claims Verification Committee (CVC) Report Form

CLAIMS VERIFICATION COMMITTEE (CVC)

CASE REPORT

Reference No ____________

Date: ________________________

Time: ______________________ **Location of Hearing:** ________________

Date of Preliminary Report: _______________ **Date of Final Claim Report:**
____

Documents presented: **Verified Copy of Claimant's License** ___
Claims Report Form ___
Vessel Incident Report Form ___
Vessel Daily Report ___
Observer Daily Report Form ___
Observer Incident Report Form ____
Other supporting Document (Specify)

____
____
____
____

Claimant's General Information

Claimant's Name: _______________________

Reference No. on Claim Report Form: _______________

Home Address:
____

Telephone No.(s): ______________________

Fishing Licence No.: ______________ **Expiry Date:** ______________

Name of affiliated Fisheries Cooperative: ______________________

Claimant: present ☐ absent ☐

Name of person accompanying/ representing Claimant: ______________

Relation to Claimant: ______________________

Details of Claim

Incident witnessed by Claimant

Type of activity Claimant was engaged in?

____

____

____

Table showing position details of Incident

Incident	Hydrographic Vessel	Scout Vessel	Claimant
Date			
Time			
Location			

Activity			

Comments

____

____

____

____

____

____

____

Incident not witnessed by Claimant

Deployment of Equipment

Date ______________ **Time** ______________

Location_______________________________________

____

____

Date and time problem was observed:

____

Table showing position details of Seismic Vessel and Scout Vessels

Date:

Incident	**Hydrographic Vessel**	**Scout Vessel**	**Claimant**
Date			
Time			
Location			
Activity			

Fill out supplementary tables for any additional dates required.

Was the Claimant Fishing in Contravention of their Fishing License? Yes ___ No___

Explain

____

Summary of Incident:

____

Type of equipment:

____

Amount of equipment:

____

How was the equipment affected:

____

Is there a claim for loss of use: Yes ___ No ____

If yes explain

____

____

____

____

____

CVC Ruling

Valid ☐ **Invalid** ☐ **Investigate** ☐ New hearing date: __________

Reason for Ruling

____

____

____

____

____

____

____

____

____

____

____

Compensation Details

Item	Description	$JA Value

Comments and any other Details

____
____
____
____
____
____
____
____
____

Name CVC Member's Present	Organization	Signature

Appendix 4

Sediment Dispersion Modeling Report

Sediment Dispersion Assessment
(Burrow Area and Shoreline Discharge)

of the

Palisadoes Beach Restoration

Prepared For:
The National Works Agency

Prepared By:

May 24, 2007

Table of Contents

1 Introduction

The National Works Agency would like to begin a rehabilitation project of the most critical sector Palisadoes Dune with urgent character. The road along the Palisadoes peninsula serves as the only access road to Port Royal, Norman Manley International Airport, the Quarantine Complex of the Ministry of Agriculture in Plumb Point, Caribbean Maritime Institute, Royal Jamaica Yacht Club, Buccaneer Beach and Gun Boat beach. The Palisadoes peninsula also serves as a very important natural breakwater to the Kingston Harbour which is one of the largest in the world.

1.1 Background of Beach Nourishment for Rehabilitation

Gamma SA conducted various oceanographic and coastal process modeling exercises between December 2006 and March 2007. The recommendations of their study include rehabilitation of the Palisadoes Beach berms through extensive renourishment. It was felt this approach would not prejudice other options for further protection of the Palisadoes. See figure 1.1 for a typical cross section of the proposed dune. In addition to the foregone, the most critical sector would also be reinforced with a revetment.

It is the beach dune rehabilitation and renourishment which is the subject of this study. Overall it is estimated that the project will utilize 1,100,000 cubic metres of sand from the burrow area.

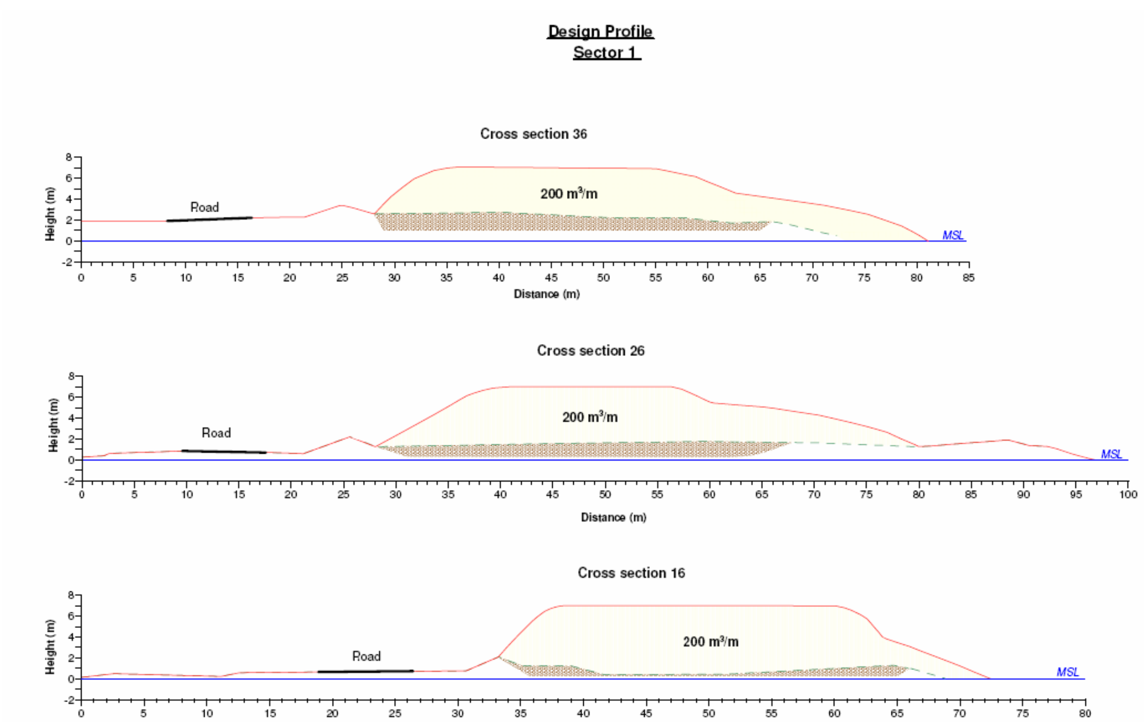


Figure 1.1 Typical berm cross section

1.2 Objectives

The objectives of this study were as follows:

1. To determine the potential extent of sediment plume discharges at the extremity of the burrow area.
2. To determine the potential extent of sediment plume discharges on the shoreline.

1.3 Acceptable Sediment Plume Concentration

It was important to establish the acceptable sediment plume concentration for use in this study. The National Environment and Planning Agency (NEPA) have guidelines on this matter and recommend a maximum of 10 mg/l[1].

1.4 Description of Beach Nourishment Exercise and Initial Plume Concentrations

Gamma described the use of the hydraulic dredge in their report (Chapter 8) in order to win the 1.1 Million cubic metres of sand. Notwithstanding the description of the activities proposed in their study the process can be described as follows:

1. Dredge positions and sucks sand water mixture from burrow area into hopper of dredge. Sand and other coarse particles settle in the hopper, whilst silt and finer material are allowed to overflow in order to fill the hopper with sand
2. Dredge sails to offshore pipeline that is connected to sector being nourished.
3. Sand is pumped to bermed renourishment areas on the shoreline and the settled material is leveled by bulldozers.
4. Dredge sails back to burrow area.

It was anticipated that the dredging or nourishment exercise could generate a plume that could affect the biophysical resources in and adjoining the project area. It was necessary to estimate the discharge rate and sediment concentration of the:

- hopper discharge and
- any incidental shoreline discharge

in order to estimate the potential impact of the dredging exercise. See table 1.1. In summary, an initial concentration of 9.5 gram per litre is expected at the burrow area discharge and 1.9 gram per litre for the shoreline discharge.

[1] NRCA (1997) Coral Reef Protection and Preservation Policy and Regulations

Table 1.1 – Estimation of sediment plume concentration for burrow area hopper discharge and shoreline discharge

	Scenario		
Dredge Programme Specifications	**Burrow Area**	**Shoreline**	
Size of Productivity	10,000	10,000	m3/day
Sediment	fine sand	fine sand	
Sediment Size	0.1	0.1	mm
Power	550	550	HP
Length of pipeline	800	800	m
Size of pipeline	750	750	mm
Flow	1.1	1.1	m3/sec
Percentage silt	5%	1%	
Analysis			
Area	0.44	0.44	m2
Velocity	2.49	2.49	m/sec
Headloss-Frictional	10.4	10.4	m
Headloss-Fittings	15	15	m
Pressure at end of pipe	5	5	m
Head - total	30.4	30.4	m
Actual Power	595.8	595.8	HP
Percentage sediment	11%	11%	
Concentration in overflow-silt	**9.5**	**1.9**	**g/l**

1.5 Methodology

The following methodology was adopted in order to achieve the objectives:

1. Acquire and hindcast were necessary, tides and wind for the period of the Cuban teams oceanographic study
2. Develop a hydrodynamic model of the project area from east of Hope River to Portland Point (St. Catherine)
3. Calibrate a 3-dimensional hydrodynamic model for the oceanographic data available.
4. Investigate the following sediment dispersion scenarios for the discharge of dredged sediments at the burrow area:
   a. Rising and falling tides
   b. Slow to fast metrological conditions
   c. Sediments in the project area

2 Relevant Oceanographic Data

2.1 Bathymetric Data

Detailed bathymetric data for the project area was essential for formulating the hydrodynamic model (Finite Element Model, FEM). There are two existing bathymetric charts that cover the general area. These are:

- BA 255 (British Admirality)
- DA 454 (Defense Agency)

In addition to the existing bathymetric chart, a bathymetric survey was executed by the Cuban team of Dr. Juanes and Dr. Rafael Peres. From Cane river to Plumb Point, 37 survey lines were executed perpendicular to the shoreline ranging in depth between 5m and 30m. The main goal of this survey was to find an appropriate basin to be used as the borrow area. The equipment used to conduct this survey is Acoustic System DT-5000, BIOSONICS Co. GPS Garmin 76 with WASS antenna guaranteeing a precision of 3m. See figure 2.1.

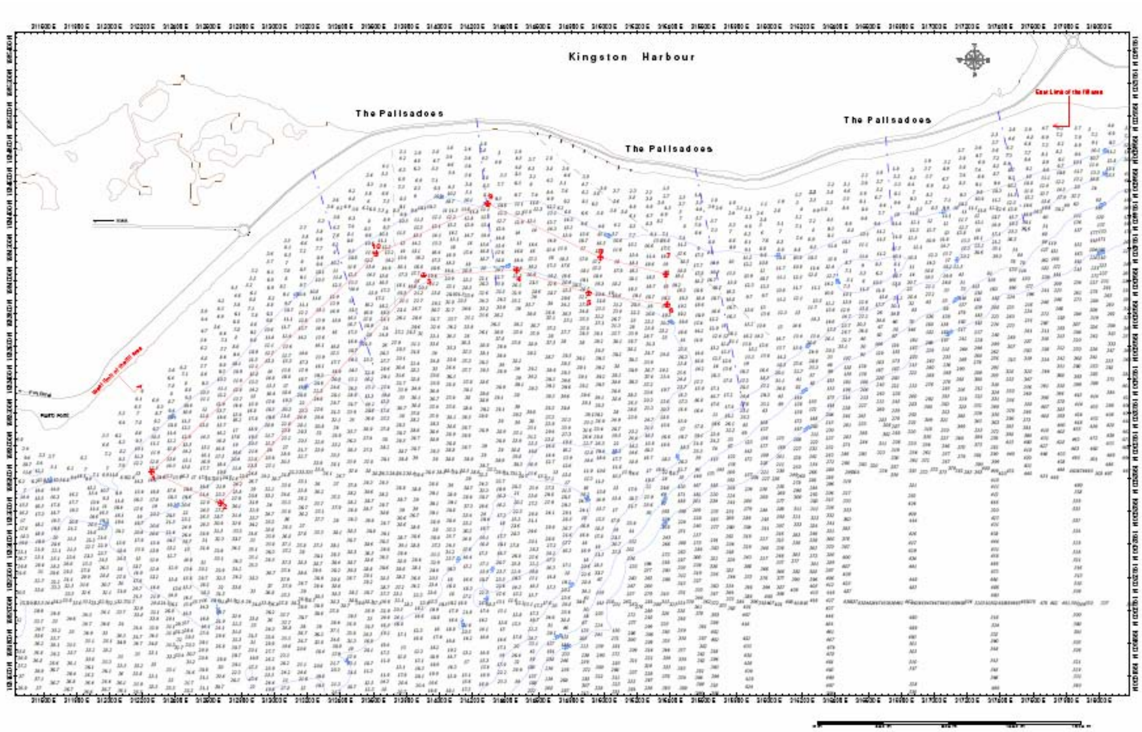


Figure 2.1 – Bathymetric survey by Gamma SA

Figure 2.2 – Bathymetric Map of Area showing nodes (RED DONUTS) for sedimentation plume modeling

2.2 Currents

In order to facilitate the development of the hydrodynamic model for the area and to fully understand the relationship amongst tides, winds and currents, current speed and direction information was required. This information was acquired from historical drogue tracking missions and from recent current meter surveys.

2.2.1 Recent Current Surveys

Gamma SA deployed a moored propeller type meter in the project area for a two week period **2 metres off the sea floor in water depths of 5 to 16 metres**. See figure 2.6 for the location of the current meters. Unfortunately, it was not possible to acquire the current meter records to allow for detailed inspection of the data with the corresponding wind data. Not withstanding this it was possible to inspect data for magnitudes, directions and occurrences.

2.2.1.1 Nearshore Current Meter Data

Nearshore currents appear to be approximately parallel to the shoreline with current speeds of 0 to 10 cm per second. The deeper current meter reflected faster sub-surface currents at station 1. This signature is consistent with tides.

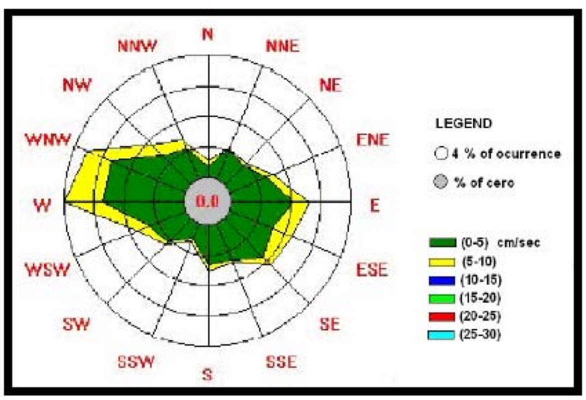


Figure 2.3– Station 1 Current meter rose from Gamma SA study, December, 2006

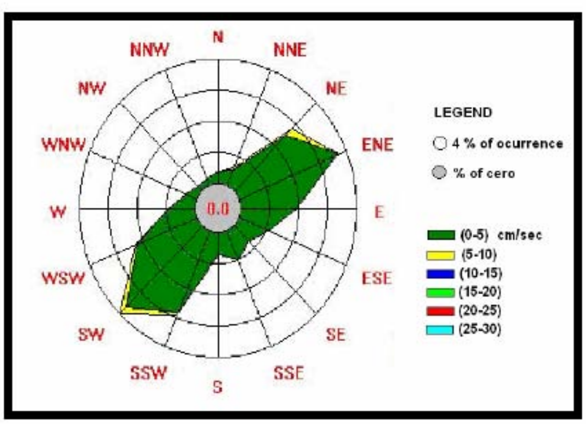


Figure 2.4– Station 2 Current meter rose from Gamma SA study, December, 2006

2.2.1.2 Offshore/Burrow Area

The information from the current meter rose from station 3 revealed a persistent westerly or southerly current for the locations of the current meters, with current speeds typically less than 5 cm/sec. This signature is also consistent with tides.

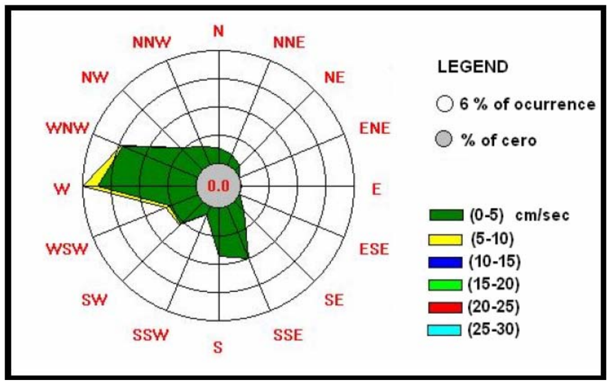


Figure 2.5 – Station 3 Current meter rose from Gamma SA study, December, 2006

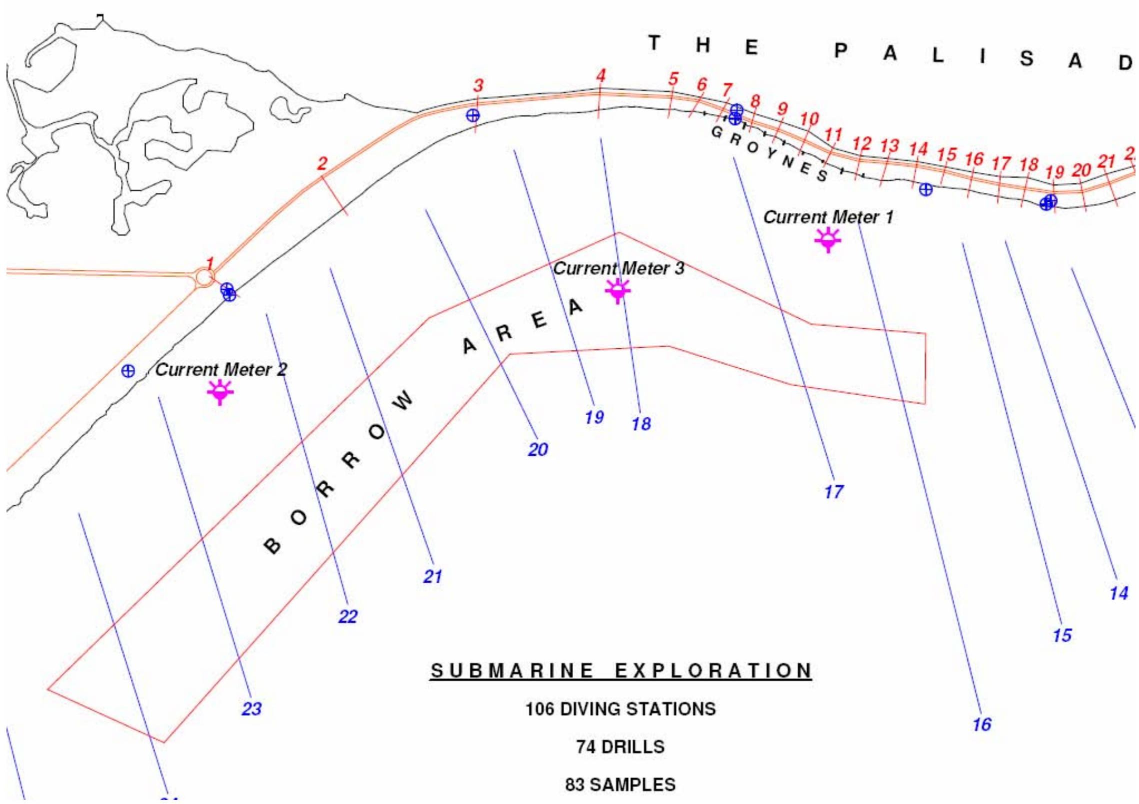


Figure 2.6 – Location of Gamma SA current meters

2.2.2 Southeast (SE) Shelf Drogue Tracking Missions (2005)

Current speed and direction data was obtained for a wider area than the project area along the south east Kingston Harbour shelf. Such current information was essential for the development of the hydrodynamic model. These missions took place on February 8 and 10, 2005. See figures 2.7 and 2.8 for plots from these missions

2.2.2.1 Rising Tide Currents

The drogue tracking data for February 10, 2005 indicate that for rising tides, both surface and subsurface (2 metres) currents, located approximately 3 to 4 kilometres off the Hellshire coastline reach speeds of up to 18.5 cm/s and move almost parallel to the shoreline in a south southwesterly direction (see figure 2.5). The S moving surface currents just east of Sandhills Bay's two main reefs are indicative of these south southwesterly moving currents observed in the western section of the Shelf.

Similarly, mid shelf currents appear to move in a south southwesterly to southerly direction, but have slower speeds of 2.4 and 3.5 cm/s. Just south of the Palisadoes strip, currents move in a northeasterly to southeasterly direction with speeds of 6.6 to 8.5 cm/s. As seen in figure 2.5, the directions of these currents are dramatically different from those observed two days earlier on February 8, 2005 during rising tide, when the currents moved in a northwesterly to southwesterly direction. These currents however had similar speeds as those observed on February 10, 2005, of between 4.3 and 6.3 cm/s.

2.2.2.2 Falling Tide Currents

Falling tide surface and subsurface currents on February 8, 2005 move mainly in a southwesterly direction with a speed of 10.7 cm/s, parallel to the coastline (see figure 2.4). This general direction varies on February 10, 2005; all current directions within the entire southeast shelf are north, north northwesterly with speeds ranging from 2.0 to 14.5 cm/s. These north moving currents are also seen east of Sandhills Bay.

Tide and wind data were not available for these drogue tracking missions. If such data was available, a more detailed analysis of the results would have been possible, and the observed trends may have been substantiated with either tidal and/ or wind data.

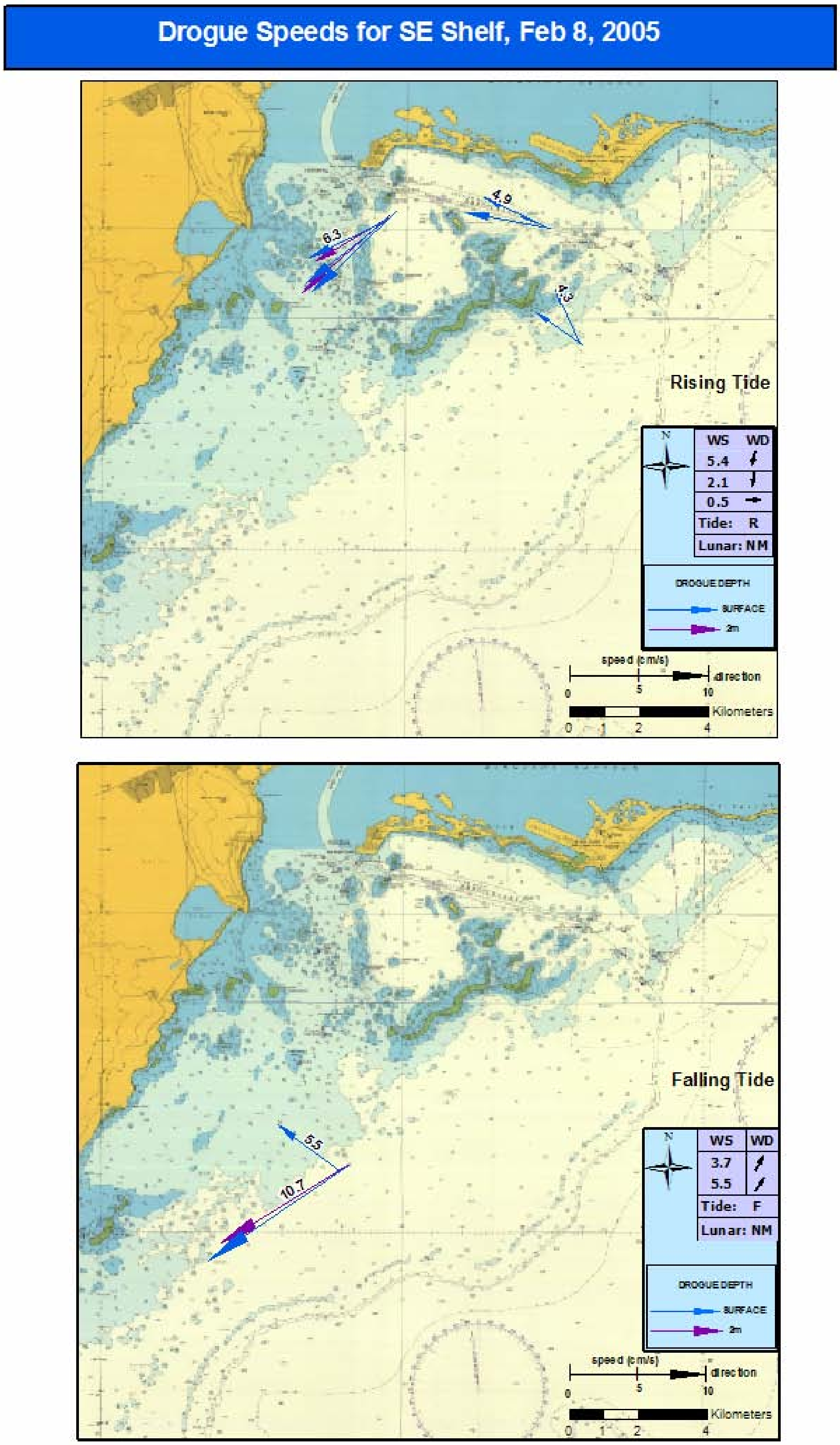


Figure 2.7 – February 8, 2005 drogue tracking mission for SE shelf

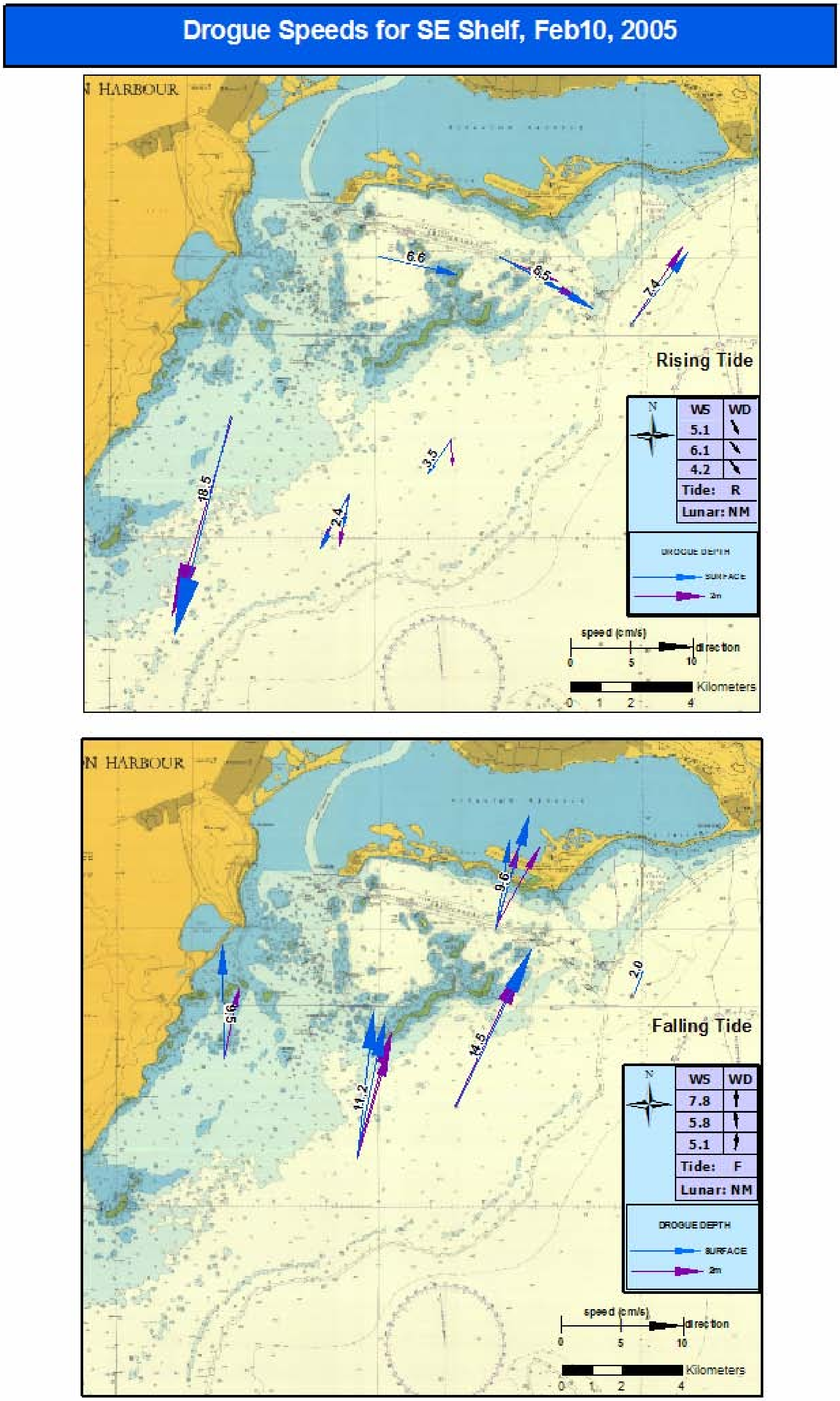


Figure 2.8 – February 8, 2005 drogue tracking mission for SE shelf

2.3 Wind Data

Wind data for the duration of the field data collection period (December, 2006) was obtained from the Norman Manley International Airport, through the Meteorological Service.

It was also necessary to utilize a long term wind data set as a primary source of driving forces for the wave and current models, described later. As such, wind information was collected from the Norman Manley International Airport for the period 1999 to 2004.

The wind data was analyzed in terms of directional and percentage occurrence in order to characterize the wind climate for the project area for all directions. The seasonality of the wind climate was then investigated on a monthly basis, and secondly for four time intervals of the day.

Inspection of the wind rose for the period 1999 to 2004, revealed that the dominant direction is from a east north easterly to south easterly direction (with a direction of east south easterly on average), with wind speeds of 5 to 8 m/s. The rose also clearly indicates that wind has been observed to come from all directions.

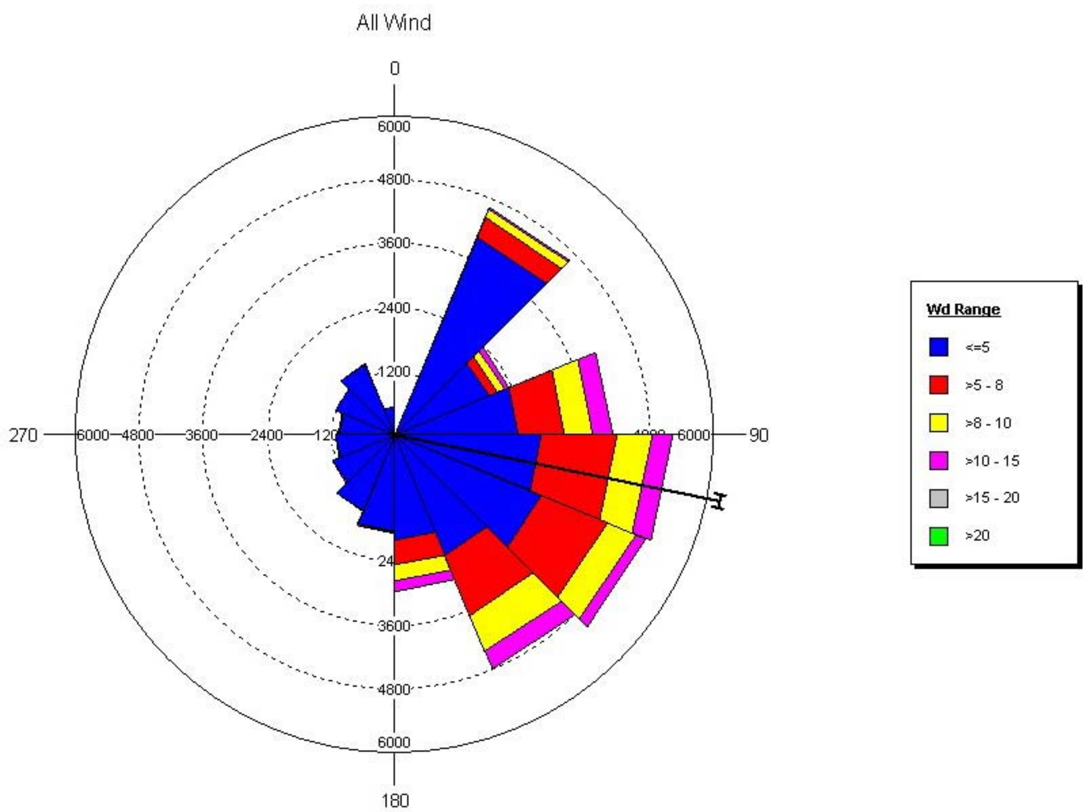


Figure 2.9 – Norman Manley International Airport wind data for 1999 to 2004, Meteorological Service

The wind data was analyzed to determine the average wind direction, which was determined to be from the east-south-east. A worst case direction of north-easterly winds was also examined in order to investigate the potential impacts of the sediment plume on the south east cays. The wind data for these relevant directions for the slow (<5% occurrence), average and fast (<95% occurrence) is summarized in table 2.1

Table 2.1 – Summary of wind speeds utilized for hydrodynamic modeling

	Slow (knots)	Mean (knots)	Fast (knots)	Direction (degrees)
East	2.3	8.8	19.1	114
North east	1.9	4.9	18.8	46

2.4 Burrow Area Sediments

It was important to inspect the information on the sediments that were likely to be encountered in the burrow area. Gamma SA in conjunction with the University of the West Indies sampled and analyzed 58 locations in the burrow area (Appendix 2 of the Design Report.

The information from the analysis of the burrow area sand samples revealed that all sediments could be characterized as coarse sand in most instances and fine sand in fewer instances, with a 0.1 mm to 0.59 mm Median grain size. This is a very important observation as sandy sediments can be expected to settle relatively quickly and thus have minimal environmental impacts.

In summary, no sediment sample was described as silt and thus the sediment can be expected (by definition) to have less than 5% silt.

3 Hydrodynamic and Sediment Dispersion Modeling

3.1 Hydrodynamic Model Software

The sediment plume models were generated using RMA11. RMA11 is a finite element water quality model for simulation of three-dimensional estuaries, bays, lakes and rivers. It is also capable of simulating one and two dimensional approximations to systems either separately or in combined form. It is designed to accept input of velocities and depths, either from an ASCII data file or from binary results files produced by the two-dimensional hydrodynamic model, RMA2, or the three-dimensional stratified flow model, RMA10. Results in the form of velocities and depth from the hydrodynamic models are used in the solution of the advection diffusion constituent transport equations

3.1.1 Description of RMA- 10 Model

RMA-10 is a three-dimensional finite element model for stratified flow by King (1993). The primary features of RMA-10 are:

- The solution of the Navier-Stokes equations in three-dimensions
- The use of the shallow-water and hydrostatic assumptions
- Coupling of advection and diffusion of temperature, salinity and sediment to the hydrodynamics
- The inclusion of turbulence in Reynolds stress form
- Horizontal components of the non-linear terms are included
- A capacity to include one-dimensional, depth-averaged, laterally-averaged and three-dimensional elements within a single mesh as appropriate
- No-, partial- and full-slip conditions can be applied at both lateral boundaries
- Partial or no-slip conditions can be applied at the bed
- Depth-averaged elements can be made wet and dry during a simulation and
- Vertical turbulence quantities are estimated by either a quadratic parameterisation of turbulent exchange or a Mellor-Yamada Level 2 turbulence sub-model

3.1.2 RMA 11 Model

The RMA 11 sediment transport model by King (1995) is a three dimensional finite element model that can also function as a two dimensional depth averaged model. The sediment transport component of RMA 11 is based on process representations from the STUDH sediment transport model.

The primary features of RMA11 are as follows.

- RMA11 shares many of the same capabilities of the RMA2/RMA10 hydrodynamics models including irregular boundary configurations, variable element size, one-dimensional elements, and the wetting and drying of shallow portions of the modeled region.
- RMA11 may be executed in steady-state or dynamic mode. The velocities supplied may be constant or interpolated from an input file (This may be RMA2 or RMA10 output).
- Source pollutants loads may be input to the system either at discrete points, over elements, or as fixed boundary values.
- In formulating the element equations, the element coordinate system is realigned with the local flow direction. This permits the longitudinal and transverse diffusion terms to be separated, with the net effect being to limit excessive constituent dispersion in the direction transverse to flow.
- For increased computational efficiency, up to fifteen constituents may be modeled at one time, each with separately defined loading, decay and initial conditions.
- The model may be use to simulate temperature with a full heat exchange with the atmosphere, nitrogen and phosphorous nutrient cycles, BOD-DO, algae, cohesive or non-cohesive suspended sediments and other non conservative constituents.
- A multi-layer bed model for the cohesive sediment transport constituent keeps track of thickness and consolidation of each layer.

3.2 Model Development and Calibration

3.2.1 Mesh

Current speed and direction data and bathymetric data collected were used to develop a detailed three-dimensional hydrodynamic model (RMA-11) of the area. The area modeled included the southeasterly shelf, Kingston Harbour and the seaward shoreline of the Palisadoes Peninsula as well as the adjacent Borrow area in detail

The Finite Element mesh consisted of 421 elements and 1281 nodes in the surface level. Three vertical nodes were used at the corner of each element to allow for some vertical resolution of the currents as per the Terms of Reference.

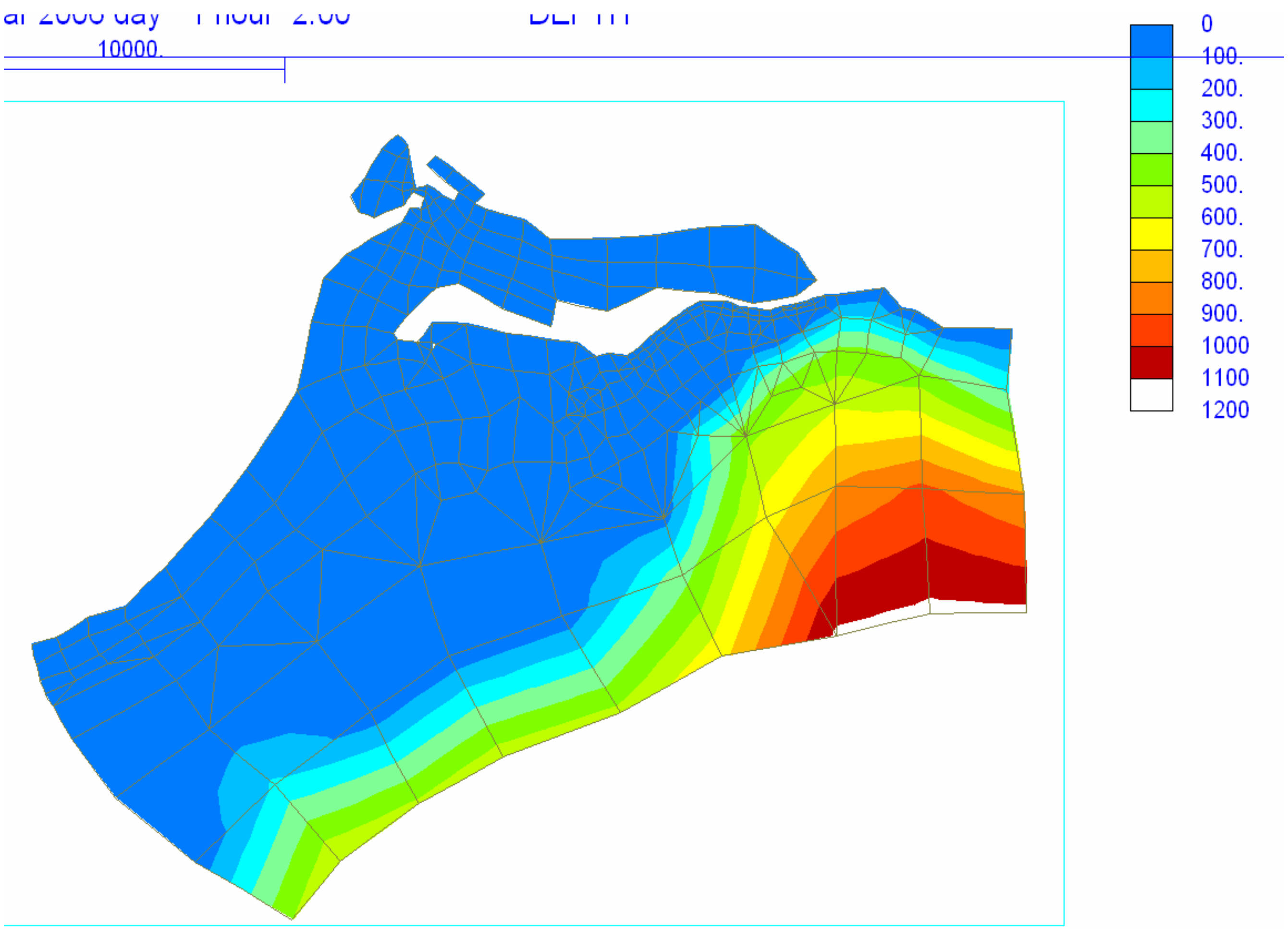


Figure 3.1 – Finite Element Mesh and bathymetry for study

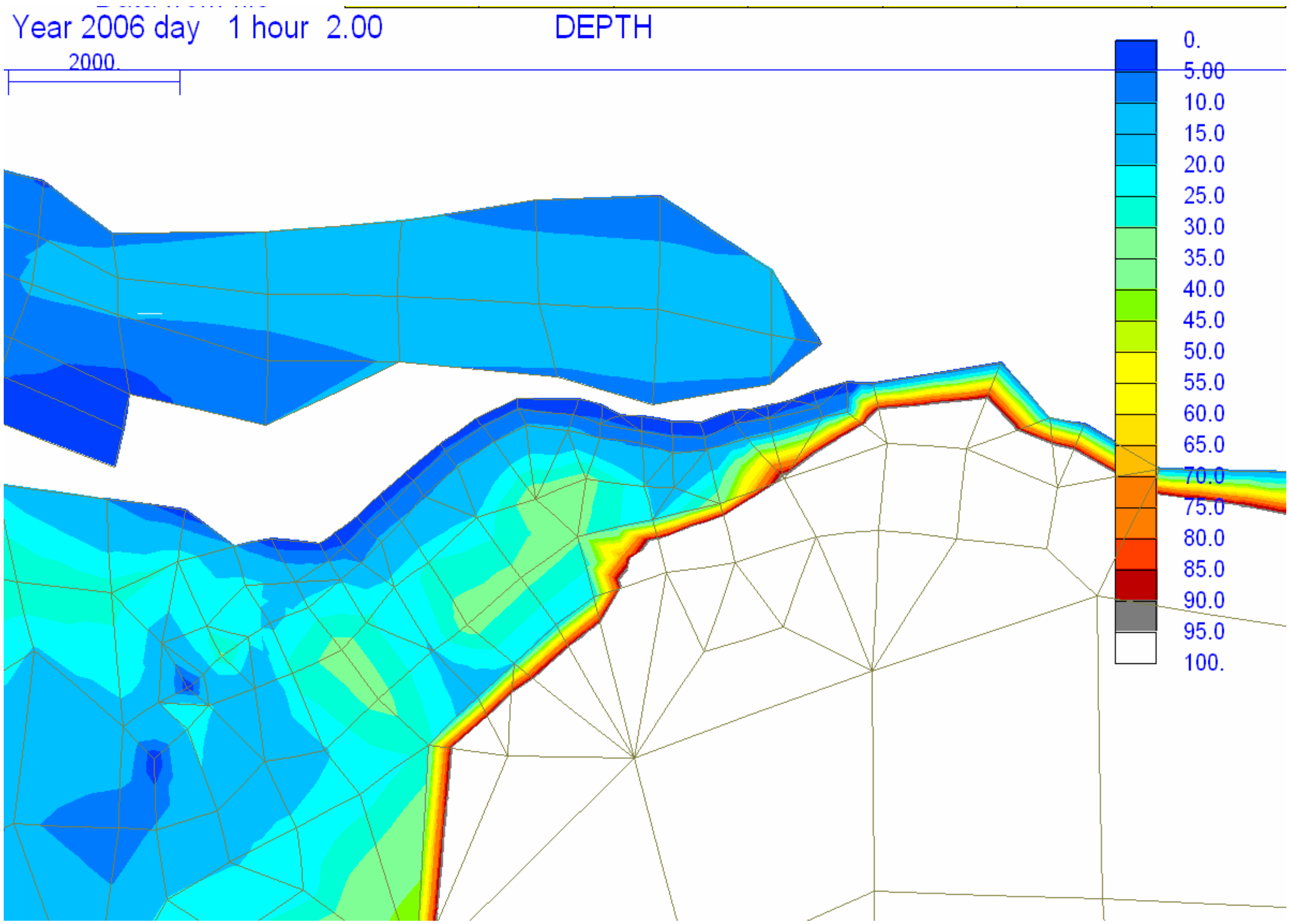


Figure 3.2 – Finite Element Mesh and bathymetry for study (zoom of Palisadoes strip)

3.2.2 Calibration

The model was calibrated by adjusting the tide elevation signal on the model boundaries, turbulence and viscosity parameters, until there was reasonable agreement between the observed currents and model predictions.

Surface current speed and directions for both falling and rising tides all coincide within 60 to 70% of measured values. Predictions had a tendency to be faster than measurements, thus the results could be expected to be exaggerated and plume predictions would be longer than could be expected in reality.

Sub-surface predictions range between 3 to 5 cm/sec for the project area. This coincides with the measurements of the current meter at the difference locations.

Overall, there was relatively good correlation between observations and model predictions as is summarized in table 3.1. Both current speeds and directions were accurately predicted and the model development was concluded at this stage.

Table 3.1 – Observed and predicted current speeds and directions.

Location	Rising Tide				Falling Tide			
	Observations		Model Predictions		Observations		Model Predictions	
	Speed (cm/sec)	Direction	Speed	Direction	Speed	Direction	Speed	Direction
Opening to Sandhills	5 to 10	E	8	E	10 to 45	E	12	NE
Hellshire	5	S	6 to 8	S	6 to 10	N	8 to 12	N
SE Cays	3.5	SW	5	WSW	14.5	NE	10	E
Palisadoes					2.0	NE	5.0	E

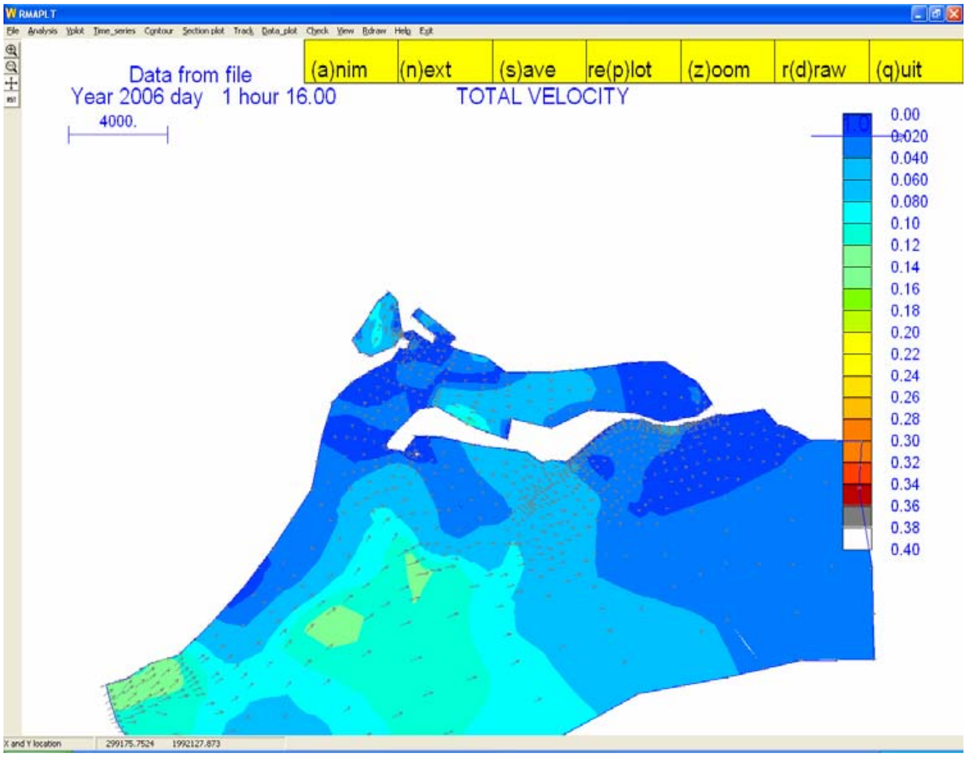


Figure 3.3 - Falling tide surface current predictions for the FEM model

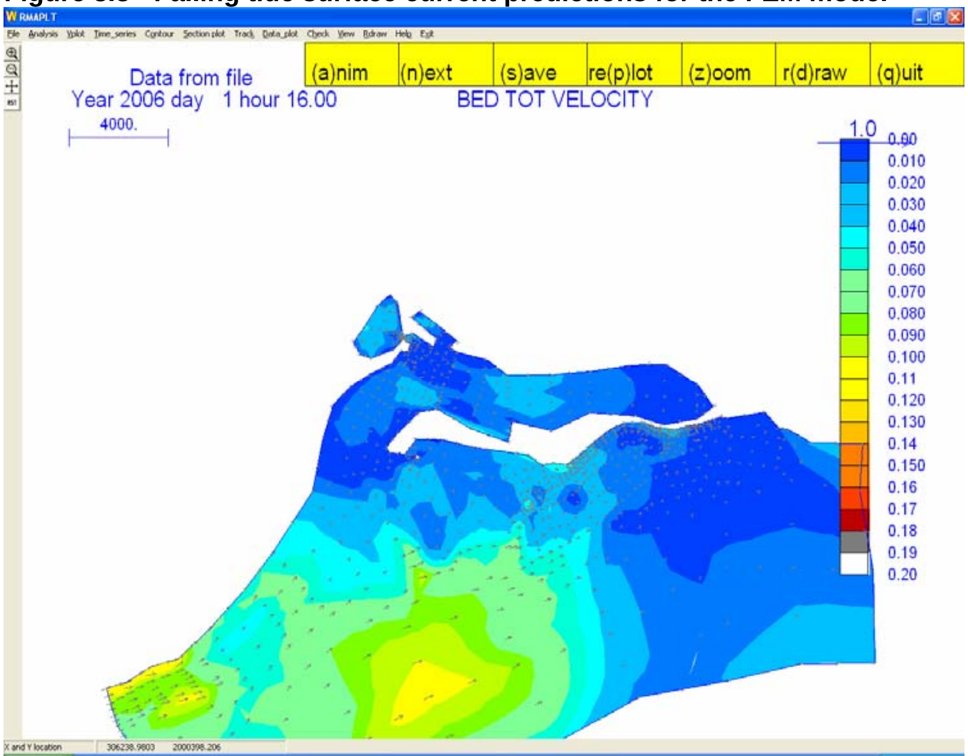


Figure 3.4 - Falling tide sub-surface current predictions for the FEM model

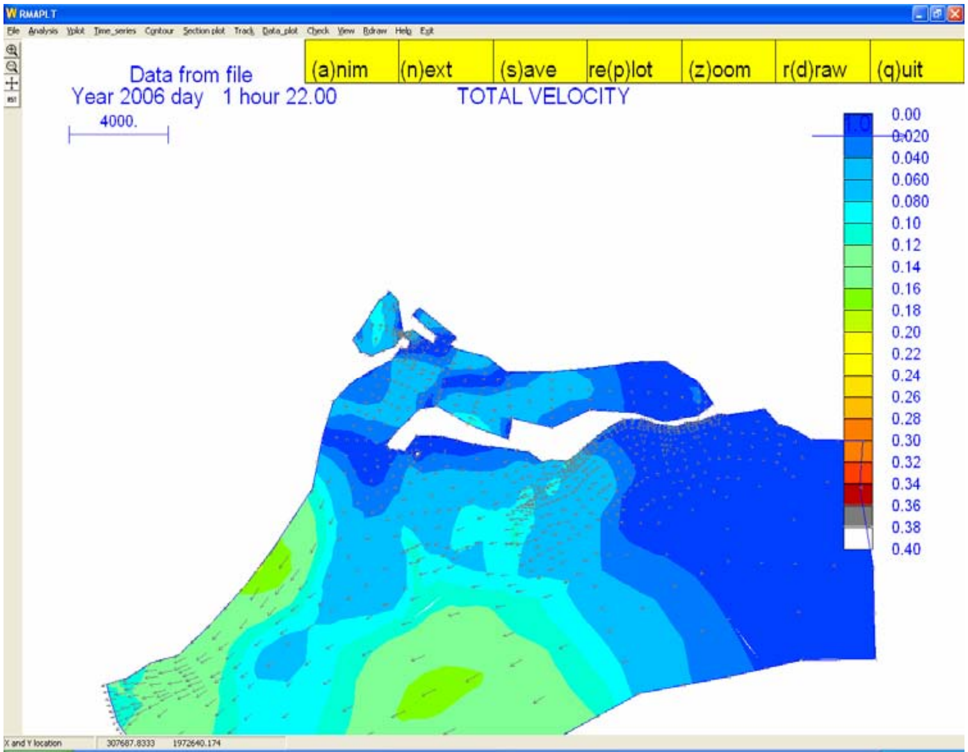


Figure 3.5 - Falling tide surface current predictions for the FEM model

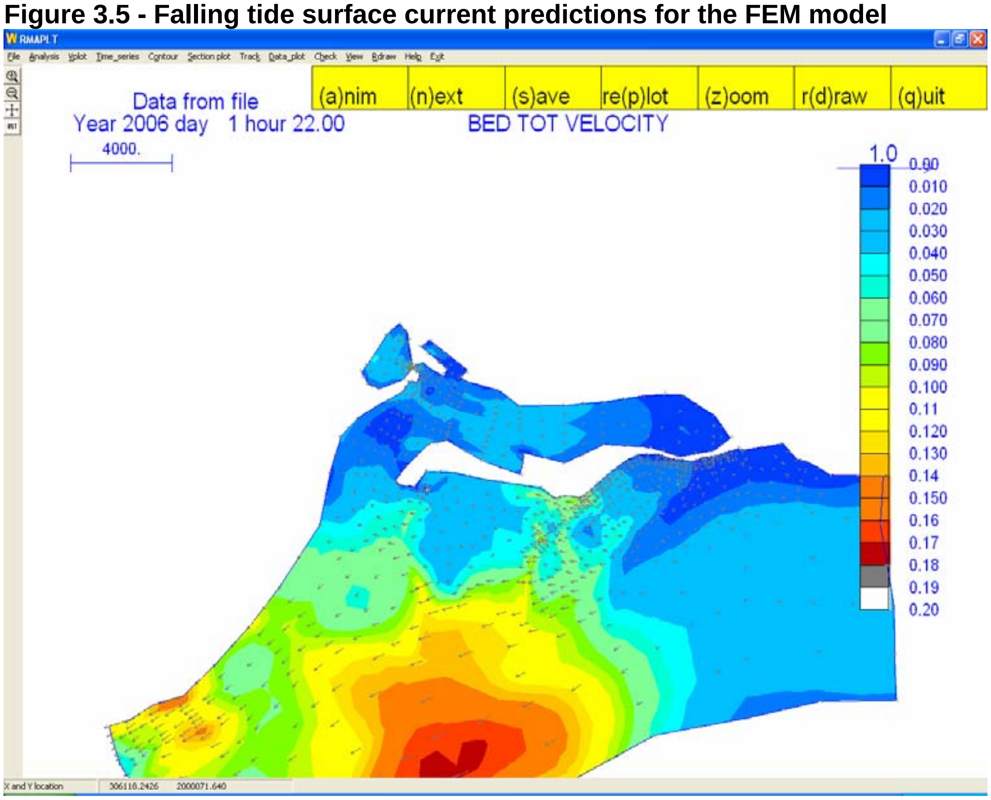


Figure 3.6 - Falling tide sub-surface current predictions for the FEM model

3.3 Sediment Plume Modeling

The results of the sediment dispersion modeling exercise were discussed in relation to the 10 mg/l concentration band of the plume. This concentration was determined to be the allowable concentration of sediment concentration to which corals could be exposed without resulting in mortality.

3.3.1 <u>Burrow Area Sediment Plumes</u>

Sediment plume off Plumb Point was predicted to have a nominal size of 300 to 400 metres. A plume generated in this area is predicted to stay offshore for the operational conditions considered for both the NE and E wind direction considered. See table

Plumes generated off Harbour View or most easterly end of the burrow area was determined to be more elongated than those at Plumb Point. These plumes can be expected to have a nominal length of 600 to 700 metres with a width of 400 to 500 metres. These plumes can be expected to come within 300 to 400 metres of the shoreline.

Overall, these plumes are expected to stay within the band between the offshore and nearshore reef systems.

3.3.2 <u>Shoreline Discharges of Sediments</u>

Accidental discharges of plumes on the shoreline at Plumb Point will result in plumes with nominal total lengths of 2,000 to 2,500 metres by 400 metres offshore. The current speeds appear similar for most likely variations of winds and tides and thus plume lengths are approximately the same for most oceanographic and meteorological conditions considered.

Groin Field sediment plume discharges can be expected to be longer than the Plumb Point discharges. A plume length of 3,000 metres along the shoreline by 500 metres offshore during slow to average wind speeds and 3,500 metres for fast wind speeds can be expected to occur.

Sediment Plumes at Harbour View will be considerable shorter with a total length of 1,500 to 1,800 metres and extend some 300 to 400 metres offshore.

Overall, these plumes pose a threat to the nearshore reef if they are not controlled by turbidity barriers and appropriate construction techniques.

3.4 Summary

Offshore burrow area sediment plumes are in general much smaller (being 300 to 500 metres in diameters) than nearshore plumes (1,500 to 3,500 metres). These plumes can also be expected to stay within the band between the nearshore reef fringes and offshore reefs.

Shoreline plume discharges can be expected to be extensive and need to be controlled by turbidity barriers and berming of shoreline discharges into sedimentation basins.

Fortuitously, the dredging and beach nourishment operations are not expected to have any detrimental impacts on South East Cays and other important reef system on the Kingston Harbour shelf.

Table 3.2 – Plumb Point burrow area discharge

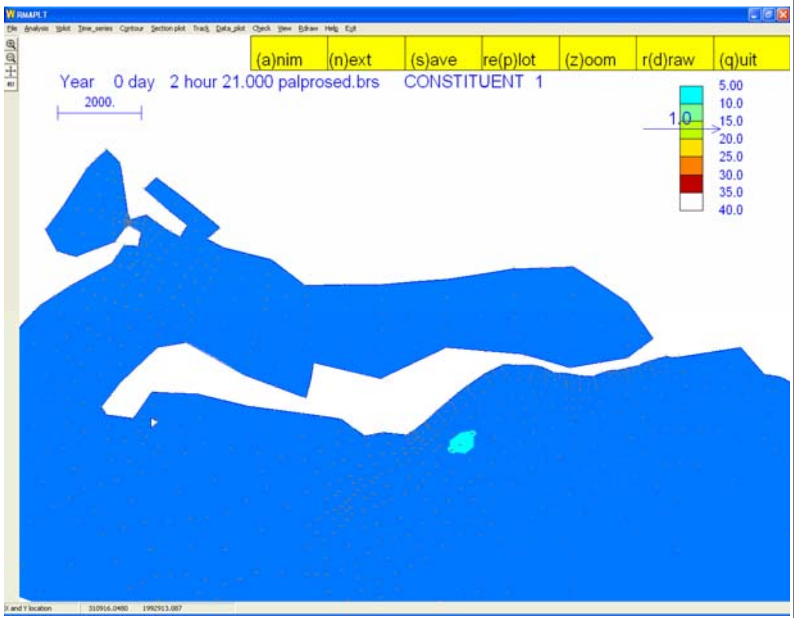
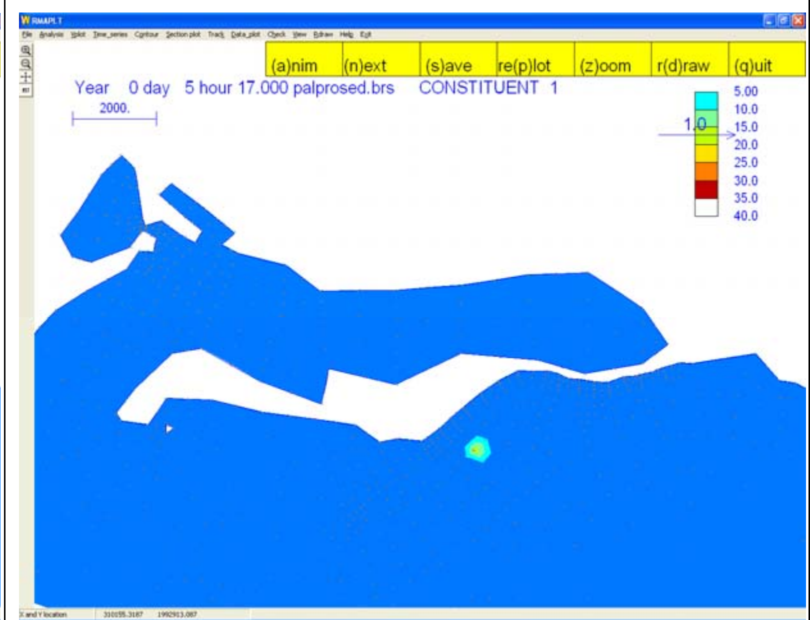
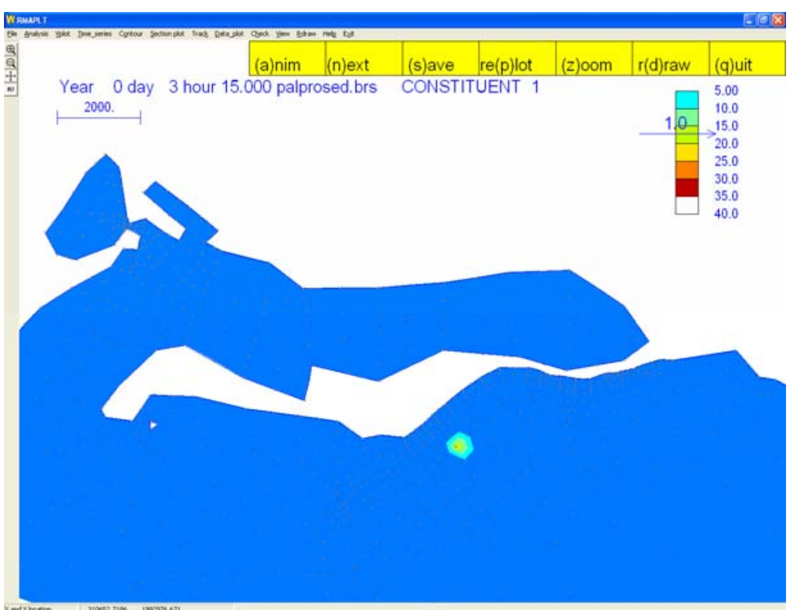
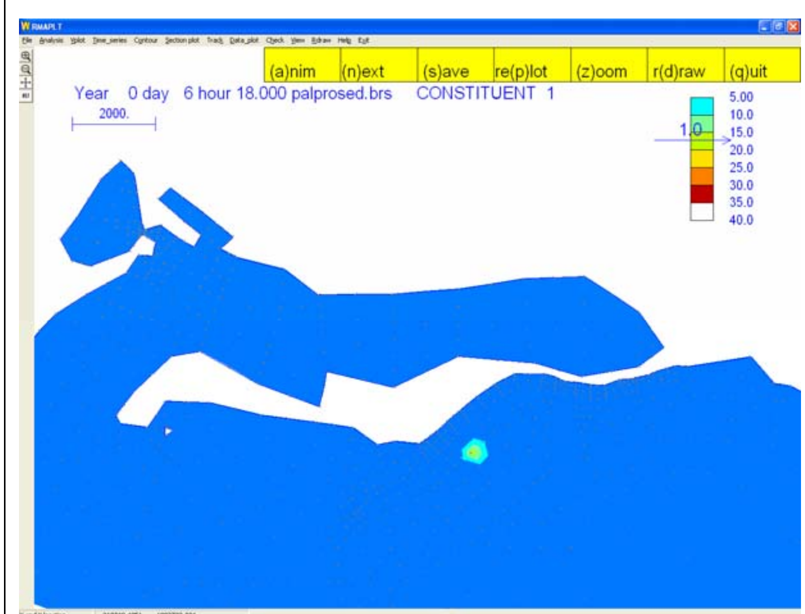
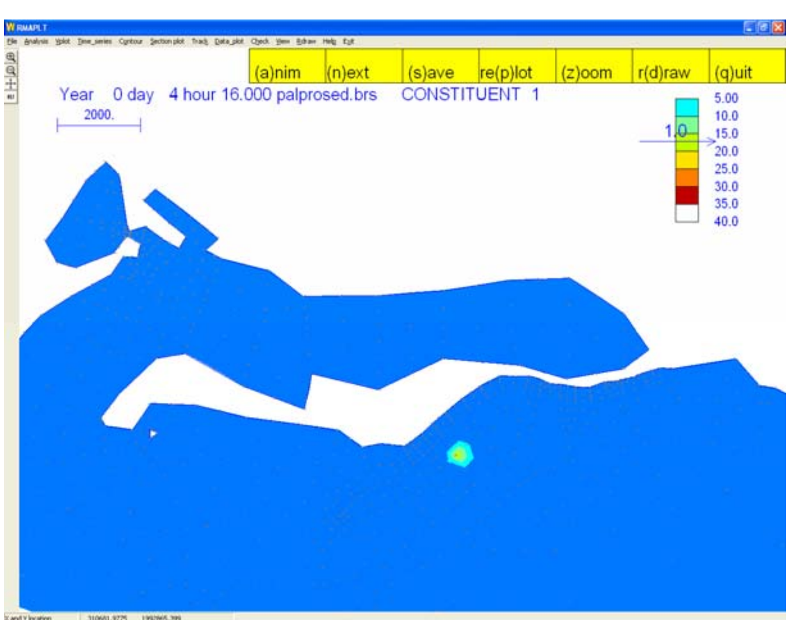
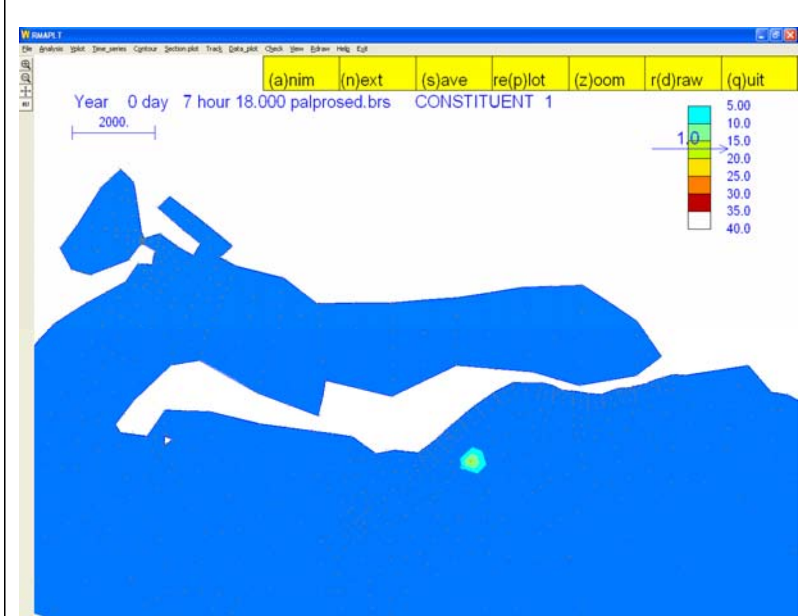
	Easterly Wind Direction	North Easterly Wind Direction
Slow wind speeds		
Average wind speeds		
Fast wind speeds		

Table 3.3 – Harbour View burrow area discharge

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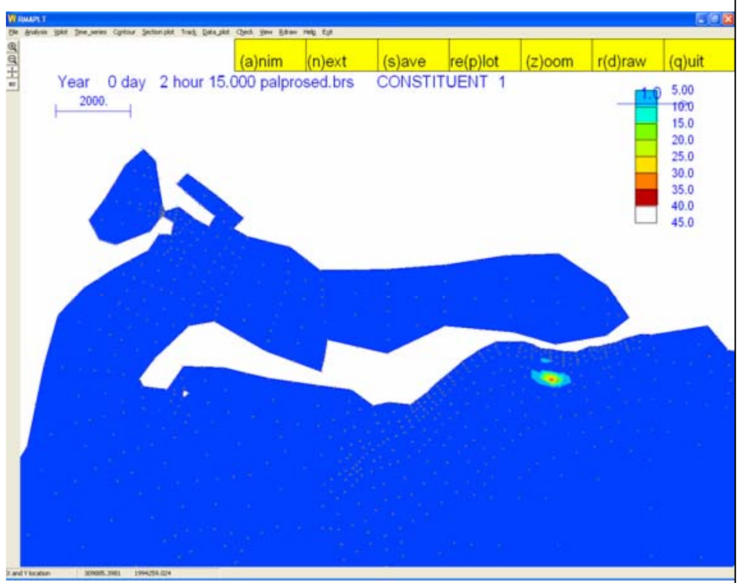
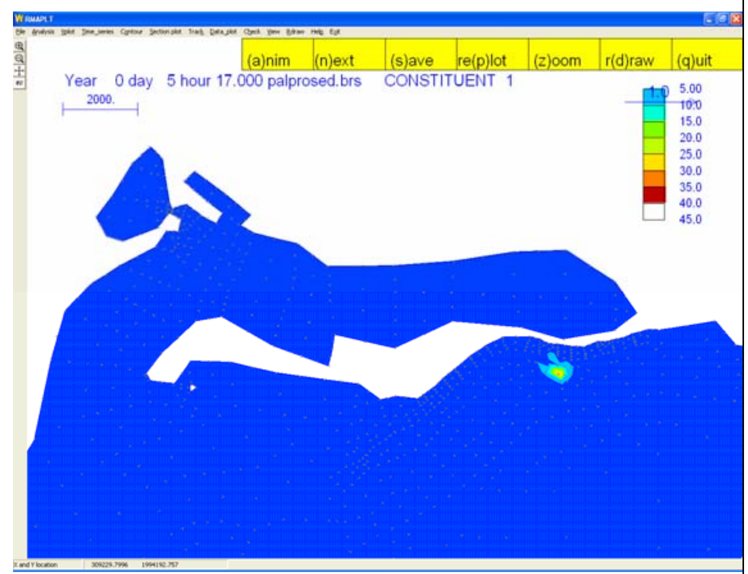
<tr><th></th><th>Easterly Wind Direction</th><th>North Easterly Wind Direction</th></tr>
<tr><td>Slow wind speeds</td><td>
</td><td>
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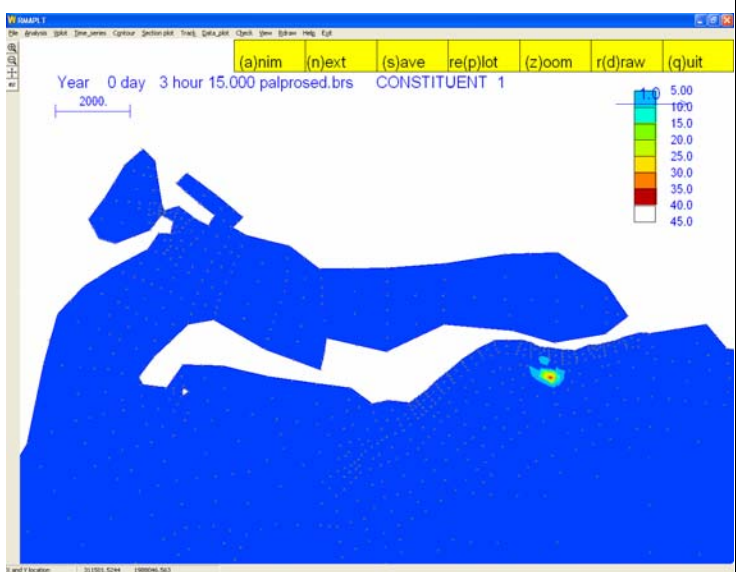
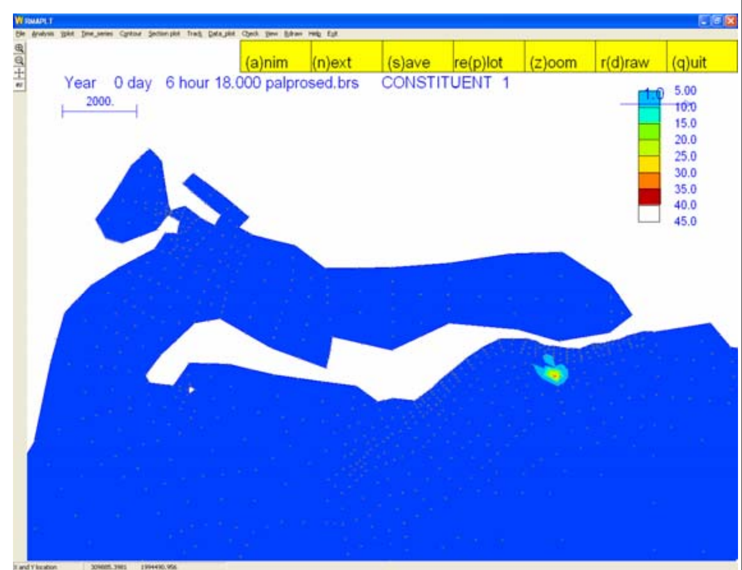
<tr><td>Average wind speeds</td><td>
</td><td>
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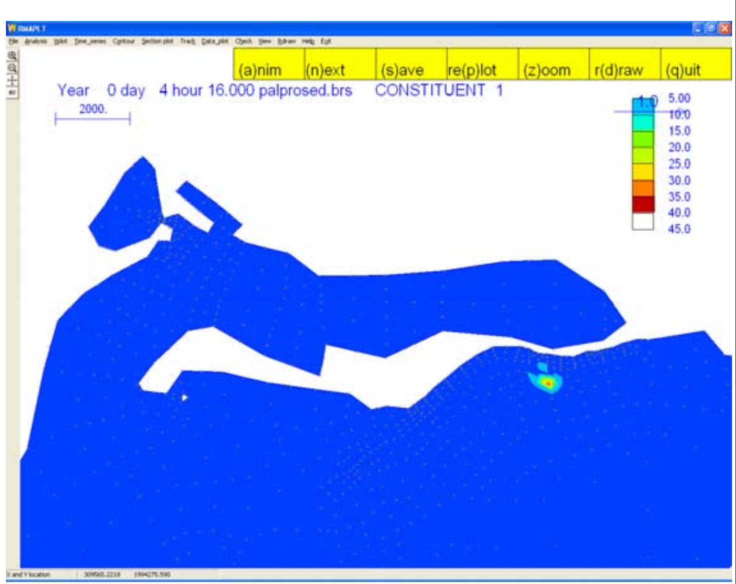
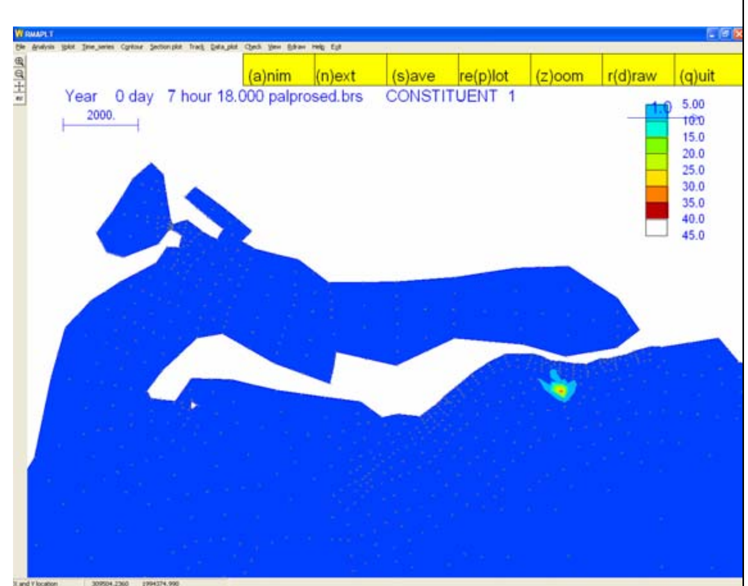
<tr><td>Fast wind speeds</td><td>
</td><td>
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Table 3.4 – Plumb Point shoreline discharge

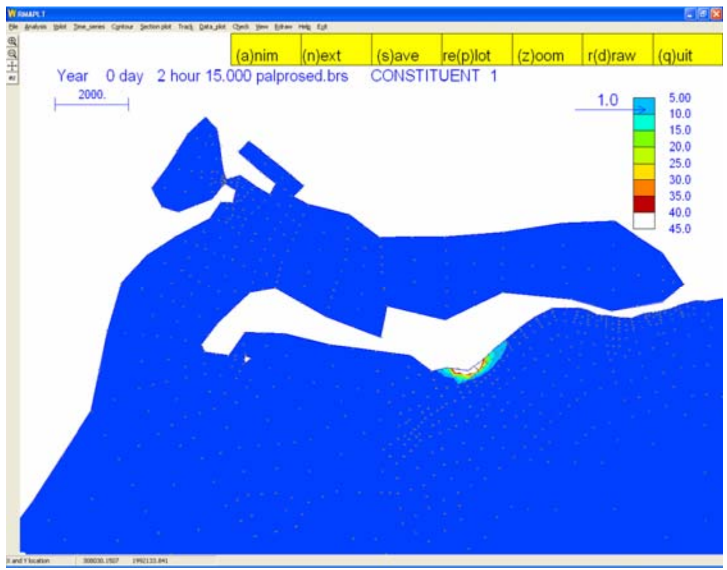
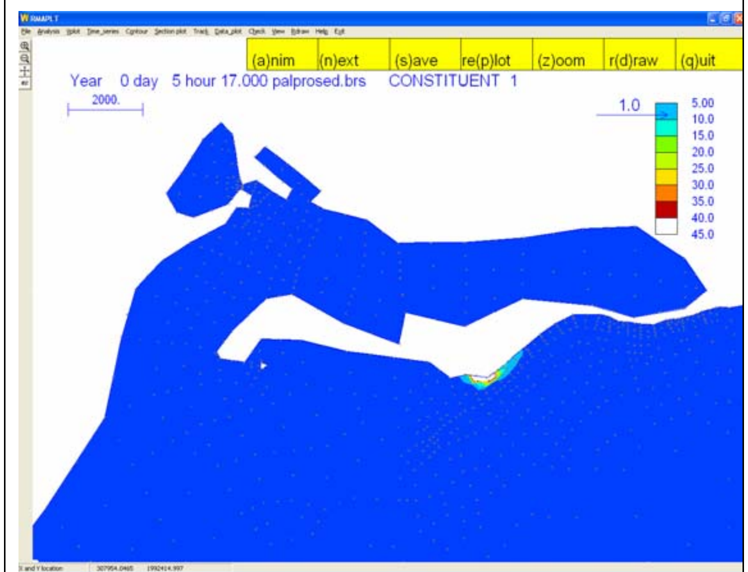
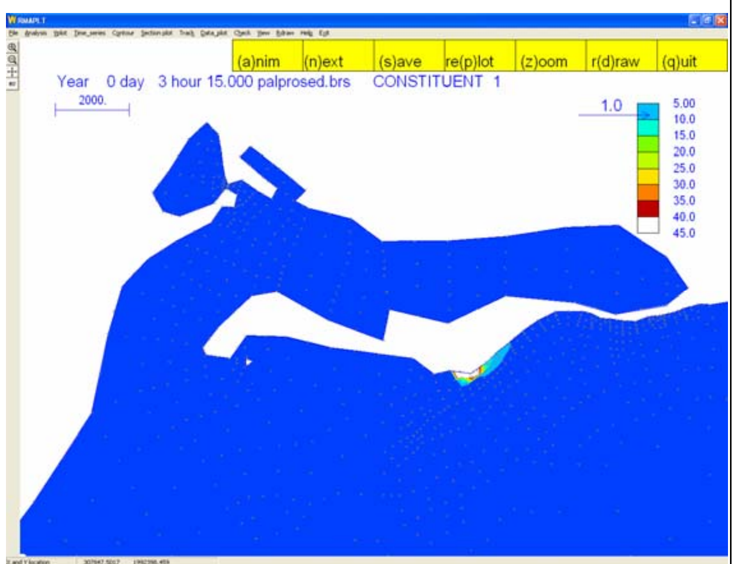
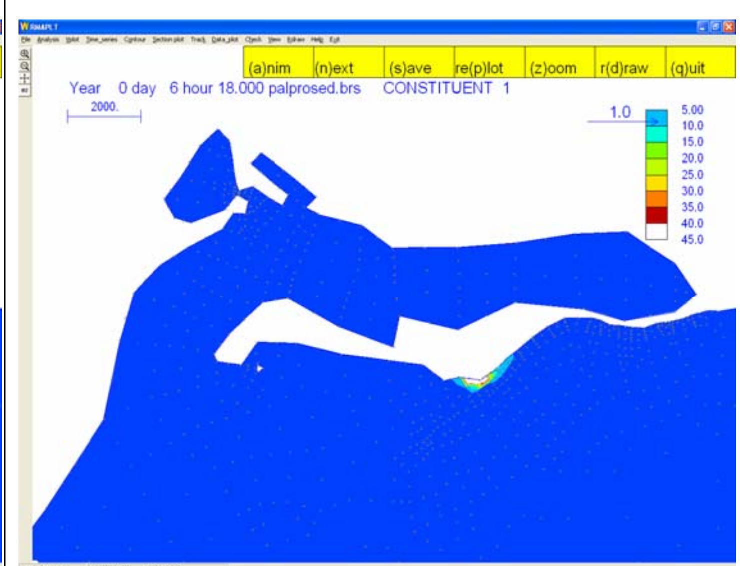
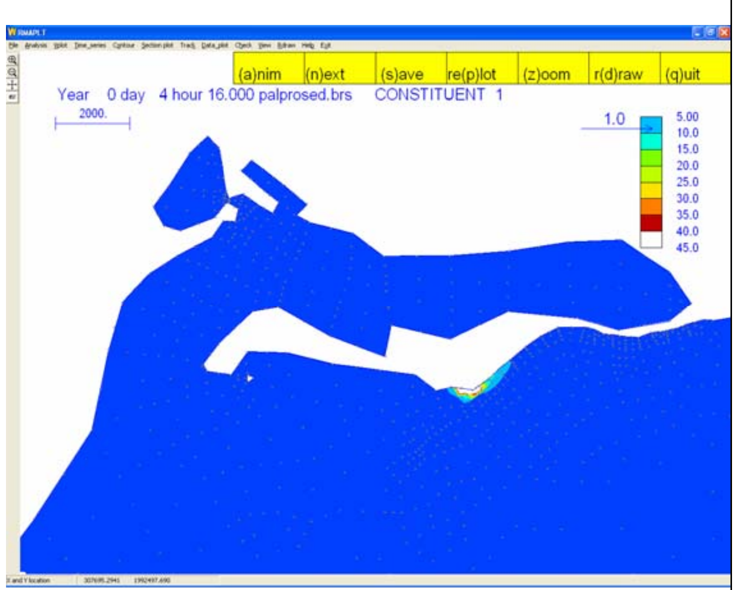
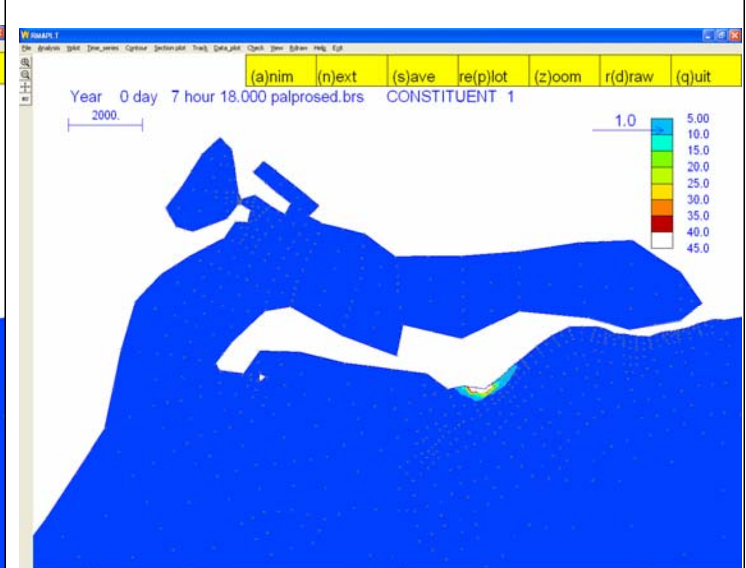
	Easterly Wind Direction	North Easterly Wind Direction
Slow wind speeds		
Average wind speeds		
Fast wind speeds		

Table 3.5 – Groin field shoreline discharge

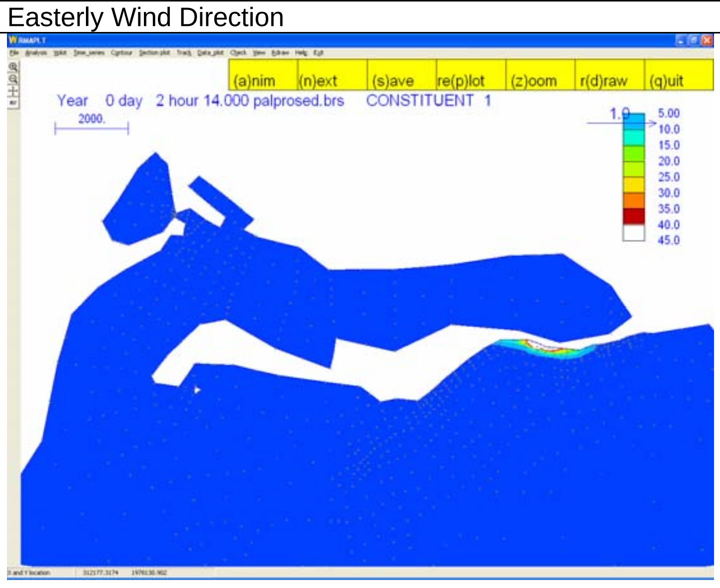
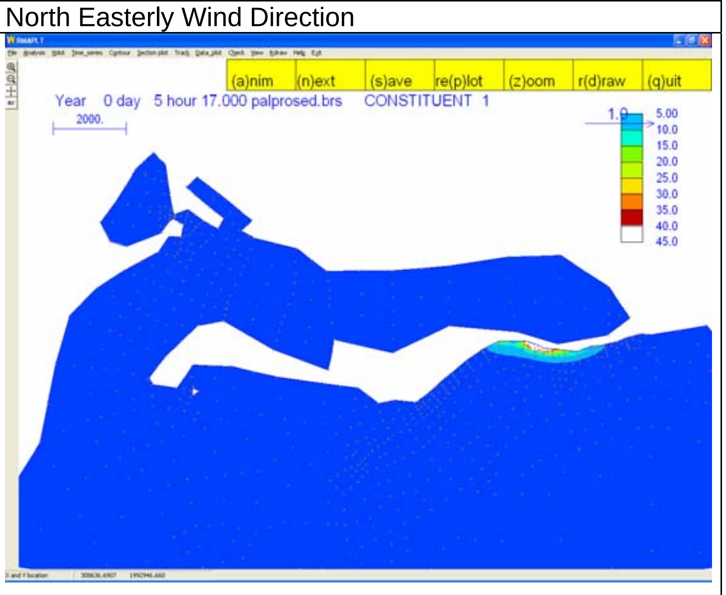
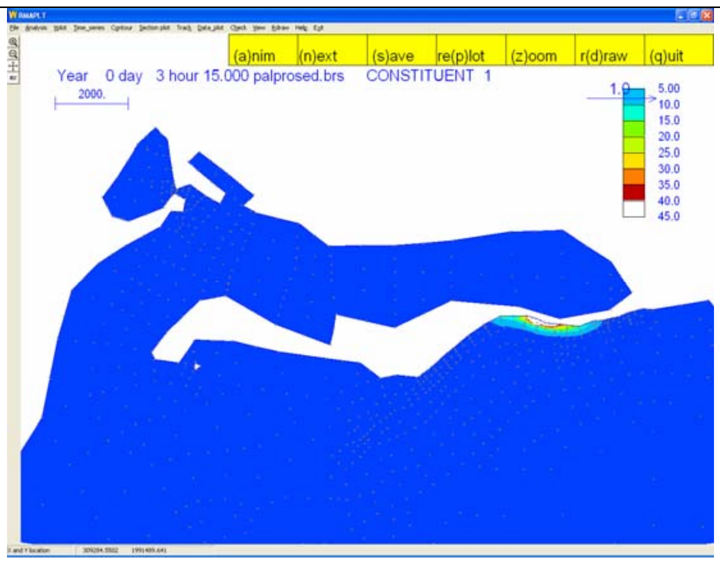
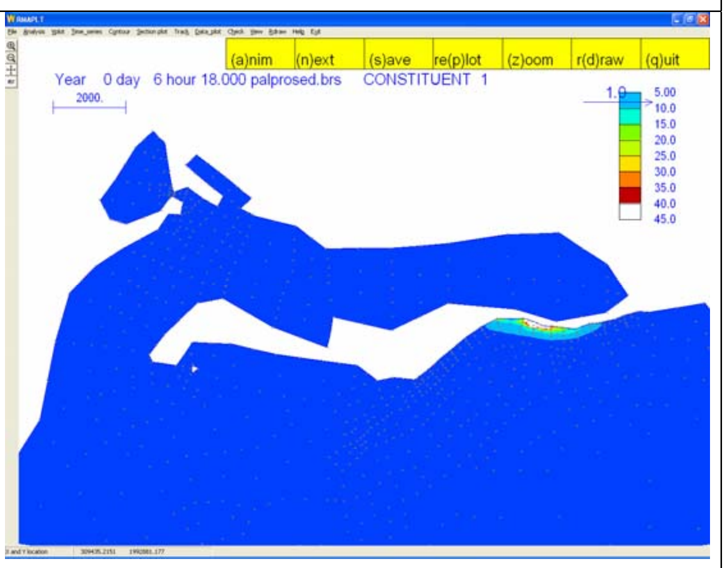
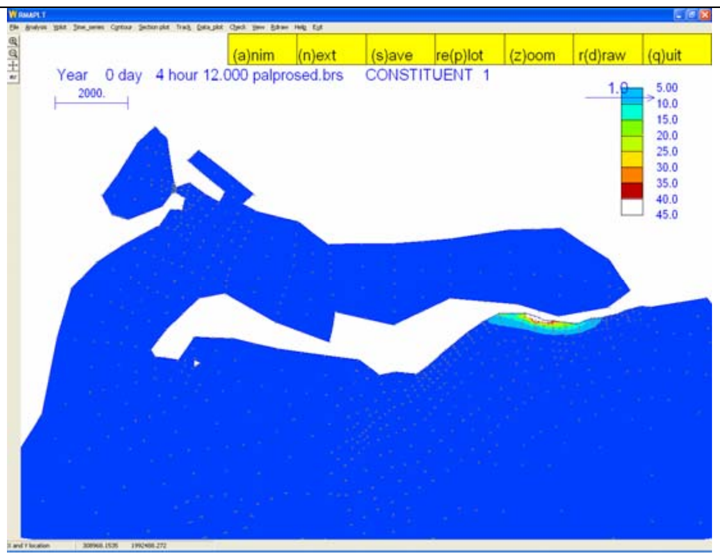
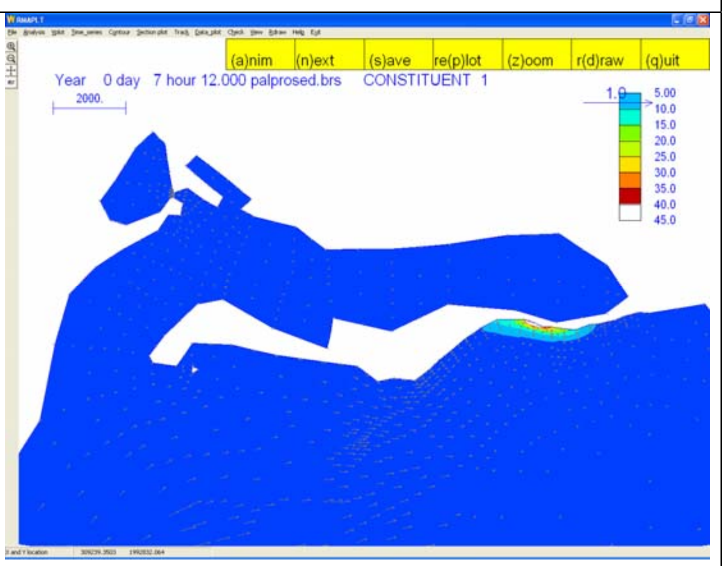
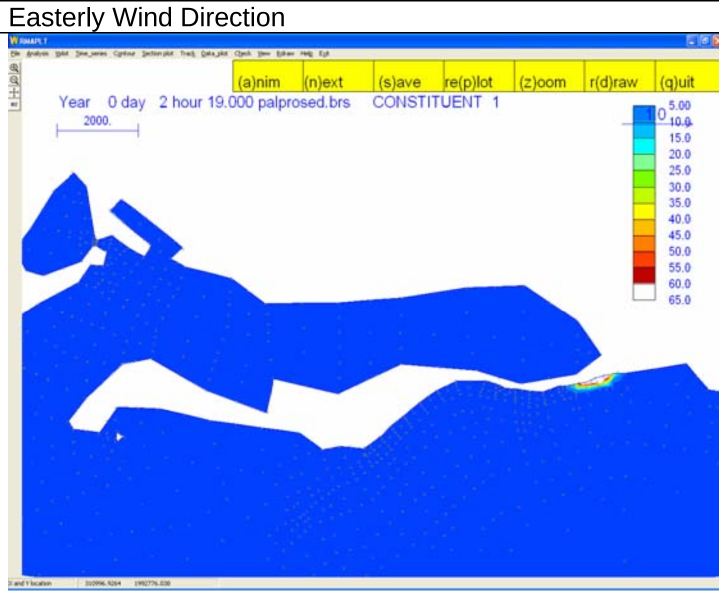
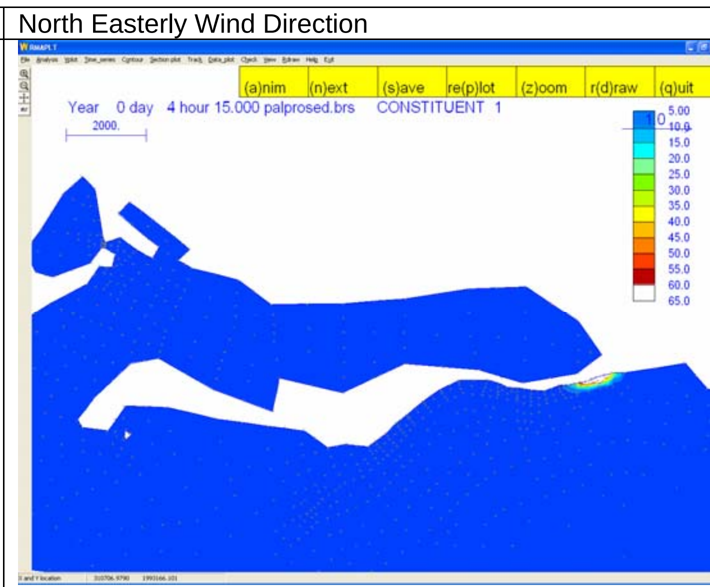
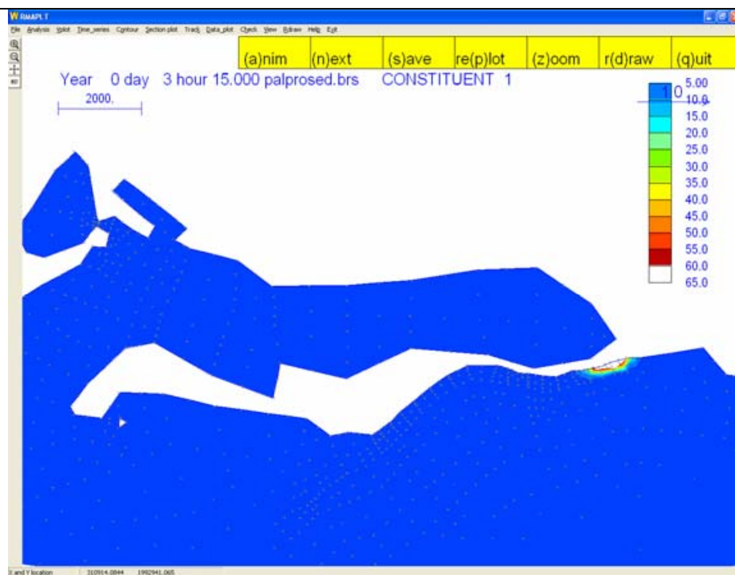
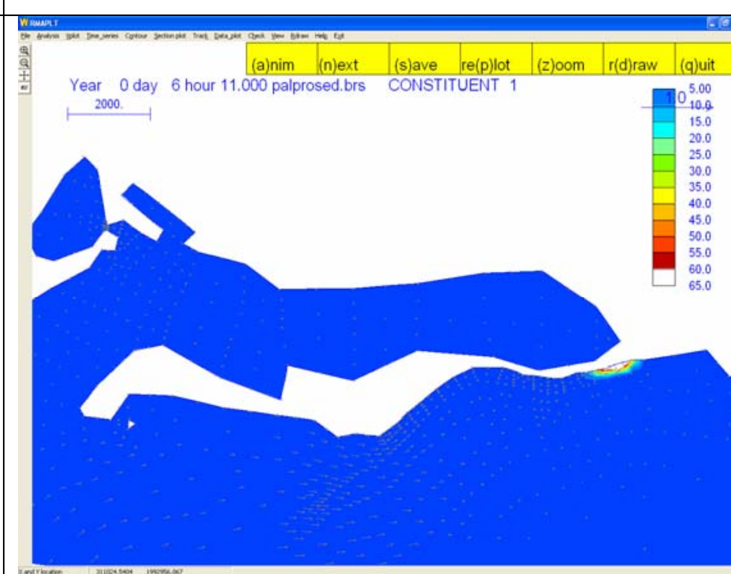
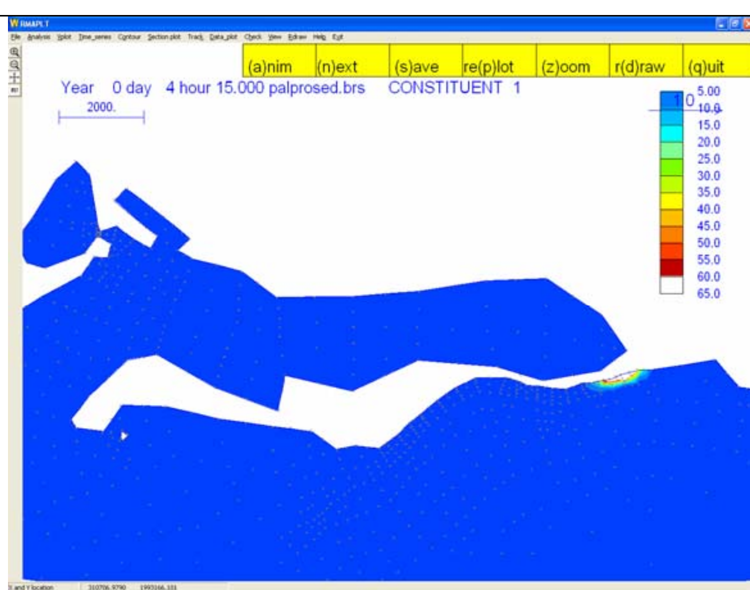
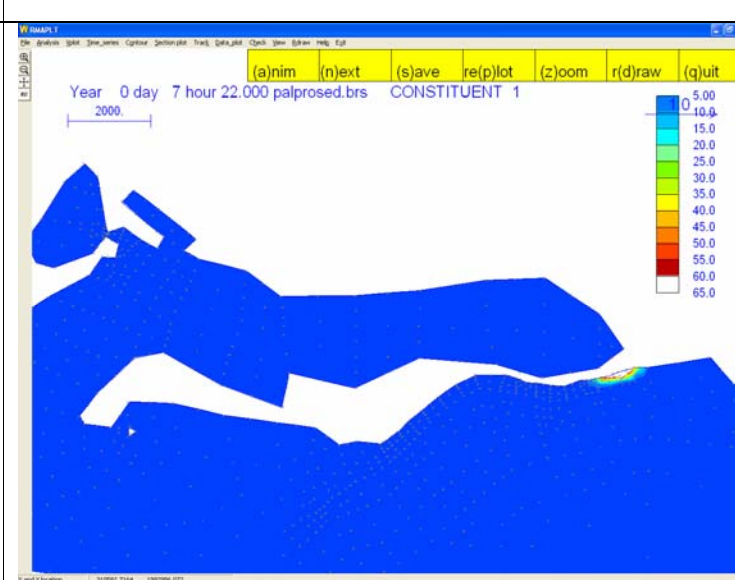
	Easterly Wind Direction	North Easterly Wind Direction
Slow wind speeds		
Average wind speeds		
Fast wind speeds		

Table 3.6 – Harbour View shoreline discharge

	Easterly Wind Direction	North Easterly Wind Direction
Slow wind speeds		
Average wind speeds		
Fast wind speeds		

4 Conclusions and Recommendations

4.1 Conclusions

The following could be concluded from our analysis:

1. Existing current meter data revealed that sub-surface and surface currents can be expected to move in both easterly as well as westerly shore parallel directions with a tidal signature. The resulting plumes can therefore be expected to extend to either sides of a discharge, depending on the stage of the tide and wind conditions.

2. Burrow area sediment plumes are not expected to have trajectories or concentrations that would result in any adverse ecological conditions to either offshore or nearshore reefs. These plumes are only expected to be some 300 to 500 metres in nominal dimension

3. Accidental shoreline discharges of sediment plumes can extend 1,500 to 3,500 metres in longitudinal dimensions. These plumes could impact on ecologically important nearshore reefs. It is therefore very important to pay particular attention to the environmental considerations (such as turbidity barriers and sedimentation basins/berms) during the construction of the beach dunes when the sand is being pumped onto the shoreline.

4. Important Kingston Harbour shelf reefs including South East Cay and others are not expected to be adversely impacted by the dredging operation.

4.2 Recommendations

The following are our recommendations based upon the data reviewed and analysis conducted to date:

1. Sediment plumes due to shoreline discharges should be controlled by turbidity barriers and berms to form sedimentation basins at the discharge point.

2. An extensive current and wave monitoring programme should be initiated at least one month in advance of the dredging programme. Currents and waves should be monitored for the duration of the dredging programme at two locations in the project area. The preferred technology would be Acoustic Doppler Current Profilers (ADCP). ADCP allow for:

    a. Measurement of currents at and below the water surface

    b. Wave measurements

    Wave measurements are going to be essential for contract administration and determination of allowable standing time (if any).

3. A water quality monitoring programme should be conducted before and during the construction, in and around the project area to;

    a. Establish a comprehensive baseline

    b. Ensure contractor compliance with the Environmental Permit

    c. Determine compliance with acceptable standards for suspended sediment for coral reefs.

Appendix 5

a. Verbatim of First Public Consultation

b. Verbatim of Second Public Consultation

c. Questionnaire on Public Awareness

Appendix 5

a. Verbatim of First Public Consultation

VERBATIM NOTES

OF

THE

NATIONAL WORKS AGENCY

PALISADOES PROTECTION

&

REHABILITATION PROJECT

Held at the Medallion Hall
On the 3rd of May, 2007, commencing
at approximately 10.00 a.m.

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NATIONAL WORKS AGENCY

PALISADOES PROTECTION

&

REHABILITATION PROJECT

MAY 3, 2007

PRESENT WERE:-

Earl Patterson, Chairman	-	National Works Agency
Lynval Ramdial	-	National Works Agency
Maureen Hendricks	-	National Works Agency
Calvin Thompson	-	National Land Agency
Peter Wilson-Kelly	-	Fisheries Division
Ian Jones	-	Fisheries Division
Cowell Lyn	-	Airport Authority of Jamaica
David Smith	-	Smith Warner International
Graham Jervis	-	Smith Warner International
Garth Jackson	-	National Water Commission
Anthony Morgan	-	Participant

CHAIRMAN: Good morning and welcome. The meeting is called to order. I am Errol Patterson and I am from the National Works Agency. We have invited you here this morning to share the work we have done to date on the Palisadoes Protection and Rehabilitation Project. The Project involved quite an exhaustive technical study that was commenced December 1, 2006, and a report was submitted to Government on February 15, 2007.

The study came out of an event on the Palisadoes in Hurricane Ivan where extensive damage was done to the Peninsula. The Government subsequently entered into technical agreement between ourselves and the Government of Cuba and out of that agreement with the technical people in Cuba, and I leave the name to someone else to recite, a team led by Dr. Juanes came into Jamaica with a number of specialists, if I recall, Ram, twelve all-told?

MR. RAMDIAL: Twelve.

CHAIRMAN: I think it is twelve specialists from Cuba came, led the intensive project that led to the submission of the report as to what can be done and ought to be done to renourish and protect the peninsula from the round-about at Harbour View to just in the area of the runway at Norman Manley but also extending eastward to Caribbean Terrace, somewhere between 12 and 14 km, 12 km from the round-about to the airport and also back ways.

Now the study, while being undertaken by Dr. Juanes and his team, had the benefit of being supervised and, you know, for the purpose of oversight and participation by only key interested participants in the field in Jamaica.

Today, you know, we are very, very pleased to have Cowell Lyn in the audience because he happened to be one of these specialists in this particular area of marine work and participated exhaustively in reviewing and providing other tangible inputs into the study as it was being undertaken by the Cuban study group. But we also have a number of other people here, and I don't have all their names in front of me and at my age I sometimes can't remember them all, but I see Calvin from NLA – Calvin, your section deals with mapping and...?

MR. THOMPSON: Surveys and mapping.

CHAIRMAN

......Surveys and Mapping Department within the NLA., Mr. McKenzie from NEPA; over there I see Errol Mortley from the Works Agency, he is an Environmental Engineer, he participated fully as well; I see Mr. Ramdial, he is the Project Manager for the execution of the project and I am looking around at the study group, the Steering Committee at the time, who worked on the Steering Committee. Anyone else who was working on the Steering Committee at the time? Okay, Peter Wilson-Kelly over there who has also got vast experience in marine-related matters and everyone else, welcome.

As I said, my job is to introduce which I have largely done, there are people here more qualified and it is not our intention to get into all the details of the study because the purpose of the meeting was to essentially do a fairly quick recap. I think the first presentation is going to be done by Errol Mortley and, in fact, Peter Wilson-Kelly will touch on the background as well as elaborate on the environmental impact of executing the work.

The study is done, the recommendations have been made, and what we are now doing in moving forward is to ensure that in implementing the project on the ground, we are cognisant of whatever impact, adverse or positive, may result as a result of this implementation. But before I invite Errol up, let me just summarize the findings because there is a short term and a medium to longer term recommendation coming out of the study.

The short term recommendation is that that most impacted or affected area along the Palisadoes Peninsula, in that low lying area adjacent to the groyne field that was damaged in the hurricane, that area where we have lost some of the existing or the original dune protected works, the recommendation is that it should be addressed with urgency and the area that we are referring to measures in length just on or about 310 metres, so if one drives along there and looks over one would have seen the destroyed groyne fields and that is what we are contemplating to commence work in the shortest possible time.

The recommendation from -- the report from Gamma, the Cuban technical study group, is that that area be repaired using a system of rock revetment so that is in essence what is being proposed and what is being pursued and the Government also gave an undertaking to undertake remedial work to ensure that during the hurricane season, you know, that particular area is protected, that most exposed area.

So we have initiated discussions in sourcing the required rocks as Courtney designed for undertaking the works and as I said, we are anticipating in the shortest possible time to be able to excavate and repair the area in close proximity to the groyne field being 310 metres in length or just about a 1000 feet long, if you are accustomed to feet more than metres, it is going to be more than just about 15metres wide. So it is going to be excavated pretty close to sea and then into the area - we just happen to have a number of drawings, all those drawings that are scrolled up on the table, if anyone happens to have a particular interest in what the details would look like as it relates to the finished product, could look at the drawings and discussions subsequent on the presentation or during the presentation itself - but we think that certainly that would be a positive outcome implementing that first phase of the project.

The second phase of the project and far more expensive phase, just to put it on table, involves dredging just offshore just about 500m - 500m Ram?

MR. RAMDIAL: Yes.

CHAIRMAN: ..... or 600m offshore from the high water mark and recovering in the order of 1.1 million cubic metres of sand. That recovery of sand will allow for us to establish a dune 6.5km in length, and when I refer to just behind the back of the runway, the area is better known as Plumb Point. So on the mapping the affected area for re-mediation work or the re-nourishment work will, in fact, be from Plumb Point just behind the runway at Norman Manley back to the round-about and will extend around to include Caribbean Terrace - Caribbean Terrace, I am referring to the seventeen homes that were affected during that hurricane event as well, the bulk of which have subsequently been acquired by Government, you know, as part of the re-mediation work and protective work for the shoreline in that particular area.

Now I come back, as I said, to the second phase which talks about the dune and the design of the dune is such that we intend, should we have a repeat of an event like Hurricane Ivan, we would be far more protected in the future than we were in the past and I won’t get into the details necessary as to the geometry of the dune but suffice to say it would be much taller than me and I am just about -- I am 5 foot 10 -- it would be about three times my height but I won’t get into the details because it is going to be 6.5 km in length, it is going to be - Ram, remind me - over 50m wide? That is pretty wide on top and what it would allow for, it would allow for all the environmental outcomes that we would desire because once this is established in the long term or the medium to long term, I should say, then the basis of an -- amusement is not the right word because -- Ram, what’s the word I am looking for?

MR. RAMDIAL: Recreational.

CHAIRMAN: .....recreational amenities, right, establishing recreational amenities as part of treating with the solution in Palisadoes, that is a integral part of whatever solution is to be implemented in the long term so I trust that gives you a feel as to what it is. I know Powell will speak much more eloquently than I can on the matter because he has been on the radio, in fact, doing a particularly good job on a number of occasions. So we have gotten into the business and there are many and varied solutions, there are many and varied solutions that could, in fact, be put forward in implementing coming out of all the investigations and the studies.

What has, in fact, been proposed and accepted is to put in, for want of a better word, a soft renewable solution because when you build this massive dune, it will provide wall protection required but it is also exposed so that if you did, in fact, have a major and sustained significant event, then in every likelihood you would be losing some of the sand that you would have dredged and the break-through would, in fact, be picked up back in the event, much of it would be washed over back into the harbour because, in fact, that is also one of the outcomes of the last hurricane that much of the sand also came over and has ended up on the harbour side, that we refer to it here as ‘big sea’ and ‘little sea’ so to speak.

So with that, we invite Errol Mortley -- and I also recognize Steven Shaw. Steven Shaw is your man on the radio and he is credited in many instances with making things look as good as it is or better so Steven is our Manager for Communications and Customer Service, welcome, sir.

So Errol, yourself and Peter, I am not sure quite what the order is but I hand over and we will go through some of the details. Particularly this is one project that we are expecting will have a positive impact on the environment. What we really want to be acquainted with is during the implementation certainly what may be the short term impacts, what-have-you but when it is all finished I think the overarching benefits will be positive, no two ways about it. We are establishing that corridor to be able to use some of the amenities for, you know, entertainment, for recreation during those periods and also at the same time to be able to protect the road which is the main artery to the airport which is, of course, very essential to Jamaica's economy. Okay, Errol.

MR. MORTLEY: Thank you, Mr. Patterson. Good morning, I hope that -- I only see one, two persons who have not been integrally exposed to the project, and the ladies. So most of the information that I will be presenting is relatively familiar to quite a few persons here. Just to explain that I may have one little — I am trying to summerize the Project prepared by the Gamma group and I will try to present it as best as possible. It would have been better if Dr. Juanes was here, he would have been the best person to go through the project and his work but I will try to do the best I can.

The other thing is that having heard Mr. Patterson’s comments, my job is much easier. I will go through quicker and I will allow more time for Peter Kelly to make some presentations to present his baseline data.

Just a brief overview, that the Government of Jamaica through the Ministry of Works and also the Ministry of Local Government had this project to implement, so it was a work in progress between the two Ministries and it entailed initially, basically -

* a study of the coastal regime of the Peninsula from Caribbean Terrace to Port Royal;

  engineering designs and construction drawings for the 5km sector that is planned to be rehabilitated plus there is a 1.5 km section of the road that is critical to all of this.

So that basically is it.

SLIDE

You will see more of these pictures by Mr. Wilson-Kelly but this is the area we are talking about essentially and for those of us who are familiar with Hurricane Ivan and the other subsequent weather incidents, you would have known the problems with this area. Most of us know the area, so I will not go through the details. If we had other visitors here then I would to go through all the details, so we can go to the next slide. But I just want to mention also that the Palisadoes was declared a protected area. I think the Report had 1977.

MRWILSON-KELLY: Which is not correct.

MR. MORTLEY: So the entire area is actually a planned environmental management zone and there are some issues which have to be looked at or to be highlighted while work is being done in that area and that is :

* Entrance Development Zone

* Mangrove Restoration Zone along the

northshore;

Public Recreation Zone to guide recreational access and use of the dunes and south shoreline;

* Closed or No-Entry Zone for public safety to allow for natural vegetation and stability of shorelines and dunes.

So the concerns raised when the area was declared are still to be considered for any development along that stretch but subsequent to all of that Hurricane Ivan and the other events have reeked havoc on the area to make it – put it in a worst position and Peter Kelly's thing will show how the dunes have been impacted significantly since the area was actually declared. So although we were looking at the human impact, the natural impact made a greater dent in the area than we thought.

After Hurricane Ivan in September 2004, the peninsula basically showed us, based on what happened there, it showed us how vulnerable the Peninsula is or the tombolo to both storm surges and other activities. So there was major dislocation in terms of access to the area from the hurricane.

During the hurricane, the waves destroyed the remains of the beach rock, which Peter will show you in his presentation, and most elements of the groyne field were damaged, washed away sand dunes which normally protect the road and then eroded the edge of the road when water flowed across the road during Hurricane Ivan and, I think, subsequently in 2005 and sometime last year also.

So it is estimated that the waves rose at that time about 3.0m over certain parts of the road and at some parts along the road the shoreline is only 6.5 - 8.0m from the edge of the road, whilst in other areas it is over 40m away. So it is a very vulnerable important strip of roadway to the country.

Mr. Patterson went into some of the issues that relate to the project background but I think one thing pivotal in all of this is that the airport is the significant gateway to the island and this puts the project very high on the agenda of Government because of the location of the airport and during those events several persons were stranded at the airport and various significant problems uneconomic to the country arose but I won’t go into all that detail so you can move on to the next slide.

SLIDE

So the damages were clear and as indicated before:

extensive shoreline disruption; destruction of most of the beach berms and the dunes;

extensive damage to the groyne field;

destruction of the rock revetment and artificially heightened beach berm east of Plumb Point;

huge volumes of sand going across the road on to the harbour side, and

the destruction of seawall and beachfront houses at Caribbean Terrace.

So given the association with the Cuban team, the study was commissioned last year with a few outputs.

The Consultant will review the information that was available on the Palisadoes and carry out a comprehensive visual inspection and detailed study to protect the area from storm surges and not only that strip but also Caribbean Terrace was included in there and to come up with priorities in terms of investment over the short term period. So they provided within their scope of work all the necessary calculations for the programme to be undertaken.

S L I D E

So the Gamma team developed a detailed plan for disposal areas in terms of location, site preparation, material management and compaction procedures. These are standard information in the plan but at the end of the day it was subsequently presented to us as a feasible, useful plan that could be used, not only for the construction, but it would be scrutinized by persons who are impacted by the project and also to provide clarity on the issues because we hear of things in the media, you hear things in the newspapers but a lot of the information is not necessarily factual.

So this study actually gives us a fairly good understanding of the processes taking place out there. I think the closest we came was when we had the Harbour Study in the ‘90's in terms of a lot of information and then your information from the University of West Indies but not in a direct way, so we are now given the opportunity to get direct information which can be used to actually make decisions.

A number of field work activities were actually carried out and I will just go through them quickly because in Peter's description he will list them. So we did — well, not we – the team did the bathymetrical survey. From Cane River to Plumb Point, they carried out 37 survey lines to the shore and these were executed between 5m to 30m deep and the main goal of this survey was to characterize the submarine slope to find a sandy basin useful as borrow area. Now the next slide will show you exactly what I am talking about.

SLIDE

So these things that you can't see on the screen are basically the numbers which reflect the –

MR.WILSON-KELLY: Spot depths.

MR. MORTLEY: Yes, for that survey so you can come up with the contours and all that information. The main objective is actually to figure out where that sand source is and it is actually the major base map for most of the other maps which have been actually produced. So this bathymetrical survey, in fact, I think when we started discussion about Palisadoes in 2004 after Hurricane Ivan, this was one of the major hurdles in terms of carrying out this actual survey. So this was done.

The other one was they did some submarine exploration to look at the sand thickness in terms of what was available and how it could be exploited and by what method it would be exploited. So what they did, they looked at the borrow area, 74 drills were executed using a manual driller to determine the availability of sand and the depth of sand.

S L I D E

Following that, the team conducted a sediment survey where samples were taken from that site, 97 samples were taken, 82 of which correspond to the submarine exploration located within the borrow area itself so within the samples they took, a fair portion was taken from the borrow area. It was critical for the study and Peter will allude to it because one of the concerns we had is whether or not the sand that is available there was suitable to create the dunes because you don't want to be creating a dune that long and have to import sand from a different location, whether from there or far away and it was critical to do the survey. In the study there is a fairly good description of the sediments and why these sample sites were actually selected and the suitability of the type of sand for the dune that was proposed.

S L I D E

So from that this borrow area was determined. This is very critical, not only for the dune creation, but also for the environmental review and impact and in our application to NEPA for the licences - in fact, I should mention that we applied for about three licences –

one licence to dredge sand,

one licence to place dredged sand, and

another licence to create, to do rehabilitation.

So this area was critical to – in fact, given the location of this area to the coastline, I think Peter will mention there was some revision to make some shifts in terms of where material is dredged from so that you don’t create any impact to the area closest to the shoreline. So having done this, it was actually critical.

SLIDE

Then the other major one was to look at the current measurements because -- also one I think Peter will mention more of -- because it will guide us, guide the implementors in terms of the time, work and how to actually apply the method of placing the sand on the shore, to give us an idea of the greatest impact area. So two stations were established to measure the near shore currents and another to measure the currents in the borrow area. The equipment recorded during 11 days with 15 minute intervals. I know Peter will go some more into that.

SLIDE

So these, I don’t know if you can see them, but one site is here, the metre is placed here and one is –

MR.WILSON-KELLY: And one in the bottom and up top. Top section of the borrow area. Top right, come down inside the borrow area. Right there.

MR. MORTLEY: So one is here. I think one, two, and three, right.

SLIDE

Then the other major activity was the topographical survey which looked at the study area and they looked at 49 cross-sections of the peninsula and this was done by the National Land Agency and their team with all the required modern methodology to come up with favourable cross-sections because you want to have your baseline data so when you hear Mr. Patterson mention about it being three times his height, it is something that will work and 50m wide.

So the base work was done and I think we moved from a point of making assumptions from what we thought or what we heard or the little data we had to actually use the field data, and also hydrological survey. Basically, I think, one of the issues which came up was the impact of the Hope River and the Chalky River?

MR.WILSON-KELLY: Not Chalky River. Hope and Cane River.

MR. MORTLEY: Yes, Hope and Cane River

MR.WILSON-KELLY: And Cane River is just to the east of that. It is past it, you are not going to be able to see it.

MR. MORTLEY: Right, but this one is critical too. So two routes around the Hope River mouth and Caribbean Terrace were executed to verify the morphologic and sedimentary characteristics of the littoral near that area because the issue over here was the impact of the discharge from these rivers onto the Palisadoes including, it went as far as to Yallahs so this was critical to determine how important these rivers were to the sand supply or sediment characteristics of the area.

SLIDE

So following that data gathering, the team came up with a strategy to deal with the problem at the Palisadoes and the issue here is that the erosive process that was undergoing at the Palisadoes and the high vulnerability of the road and other impacts as seen in Hurricane Ivan, it was evident that the Palisadoes required the application of management and protection measures that respond, not only to a vision for its development, but also to the urgent need to avoid the formation of breaches and breakage of the road.

SLIDE

I will mention it later on, but I think we had a two-hour high wind last year and sediment collected and sand was on the road. I think it was mentioned in the Report that that puts it in a vulnerable position, so one of the short term methods which came out was the construction of a new road as a proposal and that would actually look at increasing the level of it about 2m and incorporating a drainage system that allows water to pass toward the inner part of the harbour at times of severe sea penetrations. So that is one of the proposals looked at and it says -

> 'With the new road Palisadoes would have a first defence level constituted by the beach and dune and a second level at the height of the current road, thus guaranteeing the functioning of the new access road to Port Royal and the airport even under the effect of a significant increase in sea level.'

This is one of the proposals on the table.

Having looked at that and the discussion from the oversight team, what was put on the table also was the fact that there are urgent measures needed at the Palisadoes even now and it was to ensure the protection of the 5km of coast before the occurrence of another event similar to that of Hurricane Ivan. In the Report there is a fairly good description of how – well, the team placed the vulnerability of the Palisadoes Tombolo, given a lot of scenarios and the basic outlines, in fairly good detail why it is vulnerable. We won't get into that detail today but you will see from the Report the fact that Hurricane Ivan showed the vulnerability and that it needs to be taken into consideration.

So according to the Classification of Coastal Engineering Problems, it was considered to be one that required protection and the next slide will show you, based on the Classification, what they recommended. They recommended shoreline stabilization from that classification and backshore protection. I think Dr. Juanes went through in fairly good detail the discussion on this. I am not an expert in this area but he outlined why – based on the vulnerability, what would be necessary for Port Royal's protection.

SLIDE We spent some time looking on the urgent measures and the fact that the 5km of the coast needs to be protected and the most advisable option was a dune reconstruction.

> 'The possibility of having sand deposits very near Palisadoes critical sector reduces sand transportation costs by using a trailing suction hopper dredger, thus minimizing collateral damages to traffic and viability caused by the transportation of large sand volumes and reducing the execution time of work.'

So if we are going take sand from any other source outside of that immediate area, it will take much longer and a lot of dislocation. As we will see in the transportation of the boulders from Paul Mountain to Palisadoes, I think it is what, 6 weeks?

MR.WILSON-KELLY: 45 days.

MR. MORTLEY: 45 days, several trucks per day hauling stones in traffic.

SLIDE

The study went through the advantages of applying sand nourishment, I won’t get into that, Peter will mention some things relating to that so I won’t go through all that detail. I will just skip to the next couple of slides. I am sorry, this heading jumped out of it.

SLIDE

After having looked at the evaluation of the work to be done on the 5km stretch, the things were rated such as seawall, breakhead, revetment and groin, all of them presented three fundamental inconveniences. In other words, the team looked at some of these issues and why they were not feasible for what was required or what was needed and some of the inconveniences were:

> They were not alternatives of immediate application because of the time required for the process of decision-making, projection and execution to protect the 5 km stretch; and
>
> they are basically hard solutions which for the stretch of coastline are not advisable, the

particular coastline.

I think, however, that these came out of the discussion prior to the decision to use geotubes. I think this supported the need to use geotubes as against what we – just thinking back now the next slide will show that the team had initially proposed the use of geotubes as a solution, and that would have informed those alternatives. I think after we sort through those discussions and looked at the problems with the anchoring of those geotubes on the sub-straight, we probably went back to the hard solution with a soft cover?

MR.WILSON-KELLY: That is correct.

MR. MORTLEY: Yes, the hard solution with a soft cover.

MR. PATTERSON: That sounds correct. (Laughter)

MR. MORTLEY: Yes, that's correct. Okay, so then, few more slides.

SLIDE

Once the dune reconstruction is executed, it will be necessary to reconstruct at least the groyne located in the most western position of the groyne field and this will sort of stabilize the most critical sector of the coastline.

So we end up by saying that in the shortest term the critical issue was to look at that 310m of coastline which Peter will mention and show on his thing.

SLIDE

Mr. Patterson didn't go through all this thing, I don't have to.

SLIDE

Peter will also discuss this in some detail but this is the design for that revetment for that critical section. I know Peter has that in his presentation.

MR.WILSON-KELLY: I do.

MR. MORTLEY: So I can skip that and run to the next one.

MR. PATTERSON: Could you just back up and look at the cross-section?

MR. MORTLEY: It will come again.

MR.WILSON-KELLY: And it will come in my presentation too.

MR. MORTLEY: He will discuss the details as well. I think I want to go through as quickly as possible.

SLIDE

This basically relates to the design of the dune and the borrow area. The borrow area has been selected as a marine sand deposit located very near the fill area as can be observed on the map. It is suitable for the work to be done, so this is basically a description of the borrow area and Peter will go into it.

One of the difficulties I had was to use the translated version of the Report - Spanish to English - to fully understand the context of the Consultant's words because as you know, we had translated it from Spanish to English and we had not re-worded it because it is their words, so that makes it a little difficult to understand.

SLIDE

So that slide supported this slide that this borrow area, the minimum depth is 11.8m with a maximum of 24m and a mean of 16.8m resulting in a regular surface without irregularities – I think Peter went and did some photographs within the borrow area?

MR.WILSON-KELLY: Not within the borrow area, peripheral to the borrow area.

MR. MORTLEY: So he had some photographs of the benthic works or the benthic structures that you probably can see within this area.

MR.WILSON-KELLY: I didn't take any of the borrow area, it is basically sand.

MR. MORTLEY: Okay. So there is nothing much to see.

MR.WILSON-KELLY: Nothing much to see.

MR. MORTLEY: In the photograph where you had the ....

MR.WILSON-KELLY: That pretty much summarizes it.

MR. MORTLEY: So basically that is what it looks like. Mr. Patterson went into the issue of the sand volume so we don't have to go into that again.

The other issue was the issue of the design for the revetment because what was important in the Report is that they didn't come up with a design for the revetment and this advised the strategy for the work to be done. So the strategy for the area was the construction of a revetment in the most critical sector conceived as an urgent measure, and it is proposed, taking into account the high vulnerability of the site to storm wave attacks at present due to destruction of the groynes and the almost disappearance of the sand which is what we find out there and we see it when we often travel by.

SLIDE

This is the point that was made that the road is less than 25m away from the coastline and sea water reaches the road with the occurrence of only strong sea breeze at noon which is what happened last year.

SLIDE

Now this, I want to emphasize this slide because I think, having discussed it with one person who reviewed the paper, it was thought that this was the final solution but what came out in the end was that at first it was conceived to build a structure using geotubes like those shown in these two photographs but taking into account the low availability of filling material and the unsuitability as to quality as well as the depth of over 1m at the site where the structure should be located, it was decided not to design the revetment using quarrystone, so these will not be used as the favoured solution. I think the slide I mentioned earlier supported the use of this but following that subsequent discussion, this is what the consultants came up with.

SLIDE

My last slide is that the works will be executed using a...

MR.WILSON-KELLY: Trailing suction

MR. MORTLEY: Right, and they have gone to explain how much material will be used and how long it will take and I think they came up with 125 days failing no bad weather just for the dredging works. There are other things to be done like the placement of sand, the shaping of the dune and other things to be done but, of course, there are other works to be done before the sand can be placed to reconstruct the dune and Peter will present some more details.

It was hoped that Chris Burgess would have presented a critical element of the study of the project which is the sediment transport model which we – well, I think most persons here are familiar with the discussion. I don't know if my friend from Fisheries or the other person there but that data will be available by the end of the month. So NEPA will be given all of the required information for their deliberation.

I hope that I was able to present this as best as I could. I struggled with Dr. Juanes' information. Okay, thanks for holding out during my presentation. The questions relating to technical issues, Mr. Lyn will assist in answering those technical questions.

MR. LYN: As far as I may be able to do.

CHAIRMAN: Peter?

MR.WILSON-KELLY: Yes, sir. I am up.

MR. PATTERSON: It's your turn.

MR.WILSON-KELLY: Thank you very much, Mr. Mortley. Ladies and Gentlemen, Mr. Mortley assumed that I will be doing a lot of explaining. I do intend to explain but probably not at the level of details that he suggested.

Errol spoke to the design of the work in question but as he also alluded, the Palisadoes area has been noted for its ecological and economic importance. He outlined that it was declared as a protected area in 1998 by the National Restoration Conservation Authority. In 2005, the National Environment and Planning Agency made representations to the

RAMSAR Commission to have the area declared a RAMSAR site. Now RAMSAR governs the declaration of important wetland areas so the Palisadoes area had been deemed to be important for more than one reason and additionally, as Mr. Jones here will allude to, it also has importance as a fishing area, so both myself and Richard Kelly of PIOJ and Fisheries Fame were asked to have a look at what was being proposed in the context of the environmental setting, and what I am going to be presenting to you this morning is a brief synopsis of what exists environmentally in that area and then I will at the end of it suggest some of the possible areas of impact that will occur.

The slides that you will see here are figures which are attached to an environmental impact assessment which we are currently preparing and once that document is finished and presented, you will be recognizing some of these slides.

I know I am not a philosophical person and I am not that much into literature but I just found this particular case very interesting. Back in 1951, the Government of Jamaica was faced with a very similar situation, the same location after the passage of Hurricane Charlie. The then Public Works Department was grappling with the task of restoring the very same critical 310m of the shoreline on the Palisadoes area which had been affected by Hurricane Charlie.

SLIDE

They enlisted the services of a gentleman by the name of Sidney Makepeace Wood to design a stabilization method for this critical 300m which, in effect, spans all of this area here and these projections heading out into the sea were the Makepeace Wood Groynes that were designed to stabilize this area. This picture was taken back in 2002. Fast forward over 50 years, we had another hurricane pass by in the form of Hurricane Ivan which did more damage to the area.

SLIDE

It not only damaged this critical area here but it was determined through the Gamma Team that all of this area here which is approximately 5,000m, 5km worth of shoreline was severely affected by the passage of Hurricane Ivan with a critical area of 1.5km being identified and inside of that 1.5km was your 310m of very critically damaged area here which is where the groyne fields are.

SLIDE

So Errol outlined the proposal, the restorative proposal. This slide will be familiar. This is the borrow area and what we attempted – sorry, I lost my train of thought awhile ago.

SLIDE

The idea was to dredge from that borrow area and to pump to shore using not this vessel but the one that Errol had shown but I wanted to show you the principle behind it. This is a trailing suction hopper dredger and how it operates is that it lowers this boom to the sea floor and basically acts like a vacuum cleaner, sucks up the material from the bottom which is then stored in the vessel, the vessel then takes it to a floating pipe that would be rigged at the shoreline and it will then pump the material that it has dredged on to shore.

The next set of diagrams will outline to some extent the proposed boom works that Errol had mentioned.

Imagine this area here being the Harbour View round-about here, Jamaica Gypsum Pier is here and this is the roadway heading towards the airport and this is a cross-section of this area which is outlined here. This is your roadway; over here would be towards the Kingston Harbour area, over here would be towards what we commonly refer to as the 'big sea' section of the Palisadoes area. This line represents the current alignment of the dunes that are at the location as measured by the National Land Agency and this material here is what would be placed on top of that to recreate the dune.

SLIDE

We spoke of the critical area. These represent the current location of the Makepeace Wood groynes that are at the location and this area here represents the boulder revetment which will be built and as Errol nicely put it, it would be a 'hard solution with a soft cover'. So the road will be protected by the revetment and the revetment itself would be protected and camouflaged by the dune which would be created.

SLIDE

These three images here basically outline the process involved in the creation of the dune. Firstly, a retention pit or pond will be created with the use of bulldozers, then the dredged material will be pumped by way of a floating pipeline into the retention area and then from that it would then be shaped by bulldozers to create the dune in question.

SLIDE

Errol had spoken to this, I will just mention it very quickly. The reason for selecting this method was as outlined in points 1 through 4. The point that I was particularly pleased about and interested in is point 2, it represents a solution which recreates nature. It is not the hard solution that was done back in 1952. There is a certain level of aesthetic appeal to actually using this sort of a method and more importantly, Item No. 4 it represents a design which does not mitigate against the imposition of other designs.

SLIDE

So after determining what was to be done, what we elected to do was to try to determine the environmental features that existed in close proximity to where the proposed works were going to be done. So what was done was that we devised a study area which basically used the start point and end part as the northern reference. This line here represents roughly where the island's drop-off is. From this point you go into very deep water. This line is roughly at 30m depth and the entire study area basically encapsulated this area and also included the boundaries of the borrow area.

SLIDE

But we made an observation on the very same image that we have here, I don't know if you can see it but there is a bit of obscured water right here which suggests sediments moving in the water column. Now we have assumed that that might have come from a discharge of some of the rivers here. Having seen this and having recognized that a part of the work will involve the disturbance of sediments on the sea floor, we surmised that we may need to look outside of the immediate geography of the study area because we also surmised that currents may take sediments generated from this area towards a westerly direction, and I will speak to the direction afterward, but what we then elected to do was to include in the evaluation of the study area another area which would, in theory, be down-current from the work area.

The area that we chose was Southeast Cay and the reason for that is that NEPA has had over four years' worth of monitoring experience in this particular area under their Caribbean Planning for Adaptation Climate Change Project. So what we elected to do was to use the information that would have resided in NEPA on this location here as a baseline for the evaluation of impact that could come from this area. So in summary, the study area includes this area and this area.

SLIDE

Most of the information was derived by using aerial photos such as this and we were gracious enough to get a number of aerial photos from the Survey Department and after doing our initial aerial photo assessments, we did some ground shooting work at these sites here. These two sites represent shallow sites. They were basically in the order of 7m deep while this one which is the windward edge is up to about 20m deep.

We have had a number of years worth of diving experience along these shallow areas here so we were able to conclude that looking at these two areas would be pretty much representative of what is actually at the location. We haven't quite completed the work as yet. These sites numbered 1 through 12 represent the locations of water quality sampling sites. What we intend to do is take samples of water for nutrients - nitrates and phosphates - turbidity and total...(inaudible)... and what we will do with this - and hopefully we can integrate this into the work, CAC Solutions could be able to do it, Chris Burgess - is to try to generate a model of how disturbed sediments and other pollutants that might reside within the bottom substrates might move during the course of dredging and also during the course of deposition of those sand deposits on the beach. So this is work to come.

SLIDE

Alright, some results. This slide represents a spacial rendition of the types of substrates that exist on the sea floor within the boundaries of the study area.

Item 1 here which is in this area here, this is the

Tombolo; this brown shaded area here was determined to be beach rock. Now what this beach rock is, it is the remnants of the sand deposits that were on shore which have become cemented together by calcium deposits over many years which became all hardened together and it formed a solid platform on the sea floor at this location here.

Seaward of that, the line here for the beach rock and this line here, were shallow coral reefs. So inside this area here, following the trace of the laser, is a shallow coral reef which fringes the Tombolo. Between this shallow coral reef area and this area here, which is a layer of deeper coral, anywhere between 15 to 20m deep is a very large sediment plain and the borrow area is established right in the middle of that. So you have:

beach rock

shallow coral reef

sediment plain

deep coral

SLIDE

What I hope to do with the next slides coming up is to try to show you some visual renditions of what these features are. This is one here I hope will outline the beach rock that exists. You can see these little striations here and I was pretty intrigued by this because beach rock basically forms right at the water's edge so what this suggested to me and Professor Robinson from the Geology Department, UWI, was able to concur with this, this suggests a gradual retreat in the shoreline of the Tombolo over thousands of years to where it currently is. So it is fair to assume that the Tombolo's shoreline used to be somewhere here and over the years it migrated inland to this location here.

SLIDE

This location '**A**' is right at this location here.

SLIDE

This was a lidar image that I was able to get from my good friend Calvin here. It also shows these striations here. All of this area bounded by the laser represents where beach rock is. These spots here are shallow reefs which immediately adjoin that beach rock.

SLIDE

And these three images here now go on to illustrate the nature of the coral reefs that adjoin the area. Images 1 and 2 - 1, these features here and 2, these features here are coral pinnacles, basically aggregations of corals about the size of this room or smaller surrounded by sand channels whereas further off towards this location here - and I don't know if this is very clear but the next slide will show it - is a reef feature which has the characteristics of spur a nd groove features which are illustrated here.

SLIDE

Now this is not the reef that is adjoining the Palisadoes area, this is actually adjoining the Southeast Cay, Port Royal Cay really but the spur and groove, the darker areas are your coral reefs, the lighter areas are sand channels. It is amazing how brainless animals like corals can come up with a hydrodynamic formation which helps it to dissipate the waves as it comes along and that is exactly what the spur and grooves do.

SLIDE

Now we did some dives out there at the sites that I have shown you - and forgive me for these, one of my counterparts had interfered with the auto focus button on the camera, you are going to have to trust me that what I say here is, indeed, what is there - but these represent the types of corals that were found at both the shallow reefs and deep reefs areas and they were basically 1-2-3- 4-5-6 types. Note they are of the boulder variety meaning that they look like boulders. We didn’t find any branching type of corals out there and I am not surprised. The area is pretty well affected by high sea conditions under normal circumstances and your branching corals would not necessarily survive under those conditions, whereas your boulder corals which have a lower surface area and a lower frontage to the waves would have much more resilience in this regard.

So this blurry image here is supposed to be a Smooth Starlet Coral; this one here is a Boulder Brain Coral; this one here is a Mustard Hill Coral. These were taken in the shallow areas.

SLIDE

These are slides which were actually taken in the deeper coral areas at 20m depth but they were also represented in the shallow areas - Symmetrical Brain Coral, Cavernous Star Coral and your Massive Starlet Coral, so all in all seven types of corals were observed at the location in question.

So after getting a feel for the types of corals that were there, we tried to estimate the percentage cover of corals in relation to algae and it is important to look at. Back in the ‘70's the Discovery Bay Marine Lab had pioneers trying to determine what the ratios were of corals to algae and it always is a competition battle between the two. Corals like to grow on smooth clear substrates, algae also love that; algae grow much faster than corals and will always infringe on their space. So if you have a ratio of algae to corals where the algae proportion is larger than that of the corals, then that is the cue as to the health of the corals. Back in the ‘70's, the Marine Lab was able to determine that northcoast reefs had a ratio of 54 % of coral cover to 4 % algae cover. At the location that we looked at we were seeing 93% algae cover to 7% coral cover for shallow reef areas and a bit more improved for the deeper areas 85% algae cover and 15

% coral cover and at the Southeast Cay area, the NEPA information showed 98% and 2%.

In summary, you have a reef that is under stress and it is understandable. You have the Hope River, Cane River, Chalky River, Yallahs River, all emptying into that area, you have the old Harbour View Sewage Plant which also empties upstream of this area and I can understand why it is that these sorts of results would have been shown. But having said that, the mere fact that you can find these features still existing there is testimony to the fact that there is a resource still existing and trying hard to survive.

SLIDE

So we move from the corals to the fish. Mr. Jones will be interested in this particular point. We did some surveys at the locations and what we were able to find at the deep edge, these were the types of fish that we observed. These are not the actual images of the fish we took on site, we took them off the 'net but I put them here for illustration. These guys here and here are your prized type. How you classify your fish in terms of importance?

MR. JONES: Quality fish and trash fish.

MR.WILSON-KELLY: You have quality fish and trash fish.

MR. JONES: Right.

MR.WILSON-KELLY: The Snappers would be your quality fish, less so with your Grunts, alright, whereas in the shallower locations these were what you will find and these were the sites that we had looked at. I have highlighted two particular types in red - the Mutton Snapper and the Lane Snapper. In the slides to come, you will see that the fish types most frequently targeted by the fishers in the Palisadoes area are those two types here. We were quite pleased to see the numbers of juvenile Lane Snappers that we saw at this particular site, hundreds of them, which led us to believe that the structures themselves were providing some sort of nursery function for them.

So we did some stats using a method, the Atlantic Gulf Rapid Reef Assessment technique, we were able to look at certain categories of fish.

SLIDE These types here - your Groupers, your Snappers, and Grunts - are your quality fish; these types here - your Parrotfish and Sergeant fish - are those types that like to eat the algae that is on the reef. So you have those that are environmentally important and those that are commercially important and what we did was that we compared the information we got from the three sites that we examined with work that had been done by the University of the West Indies back in 2000. What we were finding, in summary, is that the numbers of fish are far reduced, the sizes of the fish are also far reduced which suggest issues with respect to either habitat loss coupled with over-fishing.

SLIDE

But having said that at the -- for your Snappers, this figure here relates to the Lane Snappers that we found at the westernmost of the shallow sites and that was very encouraging to see.

Alright, moving on to fishing, the Fisheries Division defined several fishing areas within the study area - correct me if I am wrong, Jonesy - 'Shipwreck' relates, not to the tail of the Caribic Air, but to a very old wreck, you can only see the remnants of the engine block which is off here; 'Lighthouse' which is here and the 'Windward Edge' which represents the drop-off between shallow water and deep water here.

SLIDE

We got this information out of the Fisheries Division and, in summary, there are a total number of 140 fishers who make their livelihood in and around the vicinity of the study area and these numbers here give a breakdown as to the numbers which come from the respective beaches that adjoin - basically Bull Bay, Greenwich Town, Port Royal, Rae Town and Rockfort - most of them reside within the Kingston Harbour.

SLIDE

MR. JONES: One second, you said 140 fishermen?

MR.WILSON-KELLY: 140 fishermen reside in that area.

MR. JONES: Very small.

MR.WILSON-KELLY: Very small. Catch statistics generated by the Fisheries Division and we outline again -

Estimated number of fishers using the area - 140,

Estimated average catch per fisherman per day -

1 kg.

MR. JONES: Two pounds.

MR.WILSON-KELLY:*2 lbs.

Estimated average value of catch per day $300.

MR. MORTLEY: Less than the petrol.

MR.WILSON-KELLY:* Estimated average number of fishing days per year 180;

Total value of catch per 180 fishing days $7.5m.

What I have not gotten out of the Fisheries Division but I will extrapolate from this, is the total weight of catch per year. Now if you are catching 1 per day and if it is 140 fishers per day, that is 140kg per day times 180 which I kinda think it is a little bit on the high side but I will yield to your opinion on that. The point is the area is frequented by fishers, we have an understanding of how many persons are out there and it is unlikely that you have this number of persons on a daily basis at any one time. My observations have shown anywhere from 4 to 8 boats during the mornings and more than that at nights and like I said before, the prize catch for these persons are Mutton

Snapper which they fish in the day and Lane Snapper which they fish using light at night.

MR. JONES: (Inaudible) .....it is representative of the last 20 years or is there a decline in the number of fishers now?

Q: So you think that replaces the sea fishing

MR.WILSON-KELLY: It is difficult to say the extent far beyond 20 years what has been the trend. We have to look more closely at the statistics. But you mentioned the rise of agriculture?

MR. JONES: Right. Agriculture is somewhat alien to a lot of fishermen and you will never get them to accept that, so it is difficult to make a comparison between agriculture and them showing an interest. For many of them it is their only livelihood, they are full-time fishers in what they do and what I am kind of concerned about are the numbers that actually fish at nights because I have actually come into the Harbour at nights sometimes and there are so many of them out there.

MR. MORTLEY: Lots of them out there.

MR. JONES: It is very dangerous for them so the statistics might not even include these people who actually possibly just started fishing at nights so it is something we have to look at in-house and see the exact figures.

MR.WILSON-KELLY: Well, certainly it is going to be a concern. I haven't looked at it in the context of this particular presentation but it is something that will come up in EIA itself, the number of night fishers that are out there with the dredger operating in the area, in and between the areas that they would be, that is a matter that would have to be looked at it very carefully.

SLIDE

Alright, winding down, I found this particularly interesting. The past few slides had spoken about marine resources and what I would hope to allude to with this particular slide are the resources that exist on land. The EIA document will go into details on the types of dune vegetation which exist out there but for now I can summarize by saying that you basically have three types and types are highly dependent on where they are in relation to the sea. There is a type that is far more adapted to being inundated with water, and as you move further inland, you get those types that are more adapted to drier conditions.

SLIDE

But the important thing about the dune vegetation is that it is a key component for the anchorage of the sand which exists here and what we had done here was that we had used a geographical information system software to define the areas of dune vegetation that existed on three sets of images - 1961 image, the 2003 – was that 2003?

MR. JONES: Pre-Ivan.

MR.WILSON-KELLY: Yes, pre-Ivan and 2005. This was a Google earth image that we had used and I am pretty certain it was 2005 because I was able to identify some revetments that the National Works Agency had put out on the Palisadoes area on them.

So pre-Ivan, 10 years post-Charlie and 1 year post-Ivan. Notice the patterns of dune vegetation in the critical area. For the overall 5km of shoreline, 10 years post - Charlie you had 6.97 hectares of dune vegetation there which, understandably, increased as time goes by to 7.9 hectares and then dropped significantly down to 4.18 hectares immediately after

Hurricane Ivan. So this just goes to re-enforce for me the correctness of the proposal that was being looked at.

Now, certainly, when dredged sand is placed on this, you will have even a further reduction but my recommendation would be that as part of the overall works, you would also want to actively encourage the regrowth of this and certainly for aesthetic purposes and for the recreational purposes that are being contemplated, it would also help to enhance that.

SLIDE

But in summary, over the years an increase and a decrease and this, I hope, will illustrate some of that change. This image you will remember from the very opening slide, this was taken in 2002, these areas here represent where your dune vegetation is and this one I took in 2007, notice the absence, and any restorative work is going to have to factor into the equation of restoration of that dune vegetation.

SLIDE

Alright, the last thing that I will discuss is an appreciation of how the currents move within the study area. This current role was taken from the Cuban Technical Report and basically what it outlines is that during the course of a day, you have two dominant current directions. One is generally to the west and one is generally towards the south east and those two currents sets are driven primarily by the direction of your daytime and nighttime winds. In the daytime, you have winds generated anywhere between 15 and 20 knots from the southeast and basically they would be heading in that direction; at night 55 knots from the north west heading in that direction. So this component would govern this component of your current movement while your pervading daytime winds piling the waves up on shore and deflecting it towards the west would then reflect this current movement here.

This represents work in progress because we need to now look at this information in relation to your water quality to determine how those factors would move as generated by dredging. So we await some modelling work that is being done by CAC Solutions Limited now and along with the water quality information we would then have a better understanding of the areas that would be at greatest impact or least impact during the work in question.

SLIDE

And the final slide that I will point to here lists, and I am being presumptuous here because we haven't got all the information yet, but in the context of possible impact I have listed them as:

> Impacts to your marine benthic and free-swimming resources adjoining the Tombolo and the area from which sediments are to be accessed due to turbidity and sedimentation.
>
> Impacts to the same resources between that sediment supply area and locations to seaward due turbidity and sedimentation.
>
> Impacts to biological components on the shoreline, this would be your dune vegetation.
>
> Impacts related to those features that may be within the borrow area itself.
>
> Impacts on the livelihoods of fishers that might ply the area.
>
> Finally, the recreational impact, a temporary displacement of access to the area by those

persons who may have enjoyed that access for fishing, recreational fishing, exercising and sightseeing.

I would like to conclude at this point here and turn it over to you, Chair. I don't know if there are any questions that persons may want to ask.

CHAIRMAN: Well, I would just add one impact, you know, remember we have to support the positive, not the negative and while these....(inaudible)... they think positive is recreation and general enhancement

MR. MORTLEY: And re-establishment of the sand dune.

CHAIRMAN: Thank you. Okay, Peter has done an excellent job, I am sure, Powell, as you sit over there you will probably be saying to yourself if Dr. Juanes was here, he would be quite proud listening to the work as if presented by himself.

(Laughter)

If he was physically sitting in the audience and listening to Errol and Peter making the presentation, he probably would have said, 'Well done, I think they have grasped the study very well'. And as I sat there also I said to myself what a tragedy because one of the things Dr. Juanes made very clear in the beginning when he met the team was that he thought all the competency was residing right here in Jamaica. What he really needed was the opportunity to share and to actually expand on the thought process and when you actually sit in the audience and look at the work presented back, we said to ourselves, 'Well, we can't keep this to ourselves' . I had said in the very beginning to the members of the Steering Committee when the work is done, we should do everything possible to make it, not just work, but make it academic and I think, certainly. as the work is put together, it is something that certainly the Jamaica Institution of Engineers and others in the learning environment, somehow we have got to be able to get the reports put in forms and formats that it can be presented to technical groups and be used for education and not just limited to the object, which is fixing the Palisadoes Peninsula. There is so much more to offer in terms of informing the scientific and the engineering public so to speak.

So, you know, somehow we are clearly going to meet again as a steering committee because I think again whenever the Environmental Report is completed, we need to make sure that the steering committee collectively has the benefit of sharing in what that final product is.

No doubt we are going to make sure that Dr. Juanes and his team also get the report, and so on and so forth. I am not sure, Cowell, maybe I may charge you with the responsibility to make contact with the JIE because as I said, at their next forum each year that they put on and they call for papers and whatever it is, certainly it would be a missed opportunity if having invested - and I wouldn't use the word 'freely' but 'willingly' because I can't over-emphasize the willingness of the various government departments and agencies who have given up their time and their intellect in supporting and informing the outcomes of the study. You know, Juanes and his team did an excellent job in planning the area and continue to reiterate the point that he couldn't have done it and he certainly couldn't have done it with such efficiency had it not been for the informed input of the local government departments and agencies, so to speak. Calvin?

MR. THOMPSON: I don't know to what extent you are aware of the existence of a group called the National Council on Coastal Zone Management out of the Ministry of Foreign Affairs but I think it would be a very good idea to have this presentation or a condensed version of this presentation delivered to that group because as the name suggests, they consist of several interest groups who consider matters like this and make recommendations to Cabinet on environmental as well as coastal management matters. To date I don't think a formal report or a formal delivery of the information relating to Palisadoes Protection and Rehabilitation Project was sent to that Committee so I will suggest that you consider it.

CHAIRMAN: (Inaudible).

MR. THOMPSON: Yes, we have indicated to the Council that the operation is going on but I think a formal presentation has not been made and I think it would be an excellent idea if a condensed version of this very presentation be made to this Council.

CHAIRMAN: Okay, what you can do then, Calvin, is provide all the detailed information to Ram.

MR. THOMPSON: But I will provide the information.

CHAIRMAN: Yes. As I sat here I also thought, you know, invariably speaking to the Minister and/or from both the Ministry of Local Government and Environment as well as the Ministry of Housing, Transport and Works, the important thing is that I spoke about the impact on the economy, the corridor to the Airport and beyond and I think those, among many other reasons, are why certain decision makers need to have the benefit of understanding and appreciating......

MR. THOMPSON: I am sure you will get a lot of support from that Council if presented with something like this.

CHAIRMAN: But I did also make mention that the work or the solution as presented, I won't go into discussing the budget necessarily, but it runs into significant millions of dollars for the initial phases and it means having a broad consensus and support and I am always going to make sure that Cabinet gives it the added support that it actually deserves.

But, you know, when I came up here first I didn't actually have the Report but I certainly would want to put on the record because I read Dr. Juanes' Report and it speaks as follows from the beginning:

> ‘The Palisadoes Protection and Rehabilitation Project has received permanent supervision by the Steering Committee through weekly meetings that were fundamental to the successful development of the project.
>
> The Cuban Team through Juanes would like to express deepest appreciation to the members of this Committee and particularly to CalvinThompson from the National Land Agency,
>
> Survey Department, JEF, School of Met Services, Cowell Lyn, who is here with us from the Airport Authority of Jamaica; David Smith, from Smith Warner International - he was here but he had to leave; Chris Burgess, of whom mention was made that he is doing some modelling work to further inform the determination of the discussions and Chris Burgess is from EIA; Sean Green and Capleton Paul, both from NEPA as well as Anthony McKenzie, who is here with us; Professor Ted Robinson , who certainly brought very much to

bear with his vast knowledge to the table, and Shakeera Kerr, both of them from the Marine Geology Unit as well as Dr. Hamas(?) - did I get that right - at the University, and Peter Wilson-Kelly - Peter both sat on the Steering Committee and in the end we commissioned the EIA through Peter and there is another Kelly as well.

MR. MORTLEY: Richard Kelly.

CHAIRMAN: Richard Kelly.

He made mention further that in addition to all of these whom we would refer to as outside of the immediate Task Force group, so to speak, because the immediate Task Force group in the beginning comprised the Ministry of Transport and Works through the National Works Agency and the Ministry of Local Government and Environment. So when the initial project was formed and we got brought on board, the first thing that we did was to say let us basically invite the interested public and the response was just out of this word.

But the CEO of the Works Agency, Milton Huggins, I mentioned Lynval Ramdial, the

Project Manager, Maureen - Maureen has learnt Spanish as a result of this - Maureen Hendricks; Mr. Philbert Brown who from the very beginning was the lead person from the Ministry Local Government and Environment, he is unfortunately absent today; Joe Shake also from Ministry of Local Government and Environment and Mr. Franklyn McDonald from UNET and, of course, myself.

Certainly I wanted to make sure that is reflected in the notes what the Steering Committee did and continues because I think David Smith's last comment before he actually had to leave this morning was to make sure that we have another meeting with the Steering Committee before we actually start the excavation with NEPA so we can do a final sign-off that this is going to work, that is going to yield the short-term solutions in accordance with the recommendations, so to speak.

At this point in time, we are open to questions. I think, Errol, you made the point that were one familiar after essentially studying this thing from December and now on, many people in the room are pretty familiar with the nature and scope of the problem and have become more so familiar with the proposed recommendations and solutions.

I think, Peter, you made mention that the EIA Study is well advanced and that we need to close that pretty quickly because in doing all the right things, we want to also ensure that we are doing it with all the best information available as we prepare to actually start the first critical phase of this thing, we are looking forward to getting into the accelerated form, the act of completing that report just to ensure that there are no surprises. At this point in time no surprises appear to be on the surface. We want to make sure we present the study to NEPA and have it reviewed and as I say continue the public exposure of the work and not just for this particular area.

Cowell, you made mention that the prospect certainly of repeating this in many other areas around the periphery of the island, this would serve the purpose of setting up a framework for undertaking simular types of works and I think certainly that is why we need to be sure that it is well documented and presented and shared in terms of what we have learnt having undertaken this exercise.

With that, as I say unless there are questions, points of clarification, this will bring our meeting to a close.

PARTICIPANT: I would like to ask something, Mr. Chairman. How could a member of the public get hold of this Report?

CHAIRMAN: Which one, the EIA Report?

PARTICIPANT: Everything.

CHAIRMAN: They normally will be posted on NEPA's website.

PARTICIPANT: No, not only the EIA Report, everything.

CHAIRMAN: The Report and sections of it will be available. The Report has been shared with the Steering Committee until it is promulgated but it is my intention that the Report is not intended to be locked away, it would serve no meaningful purpose so the Report can be available. I don't want to comment but the public at large, how can we get this copy to them? Mr. Morgan, as you leave, remember my copy, I am trying make sure.....(laughter)

PARTICIPANT: I just happen to hear about this thing early in the week and I just happen to be here but both Peter and Cowell, they know why I would have an interest because I was one of the proposers wanting to do offshore mining at

Yallahs about five years ago when the environmental community descended on us like a ton of bricks and we have not stopped running and what, I tell you something, what I personally - and, of course, everybody knows I am a businessman - what I personally would be interested in is to see what are the environmental conditions that would allow, that would make it possible to do that sediment borrow that is outlined on the map.

I am asking this because I have a business interest in it but also there are some recent developments where one of the new hotels, it was alleged, removed beach sand from another point on the island in order to make their beach and over the next five years or so, there are a lot of major hotels that are coming on stream and they are going to need sand. It is something that I investigated. Initially, I thought that I probably would be able to manufacture beach sand using grinding equipment but most of the manufacturers I talk to say it is very difficult, not only because of the rounded edge of the sand, but because beach sand is narrow band of (inaudible) and it is very difficult to grind them. What they are saying to me is the best way of getting beach sand is to get it from offshore. This is something that is going to be in great demand in Jamaica over the next five years and if some group like the Steering Committee - I am not saying you must do it - if some group that has that sort of technical know-how don't get together and try to solve this problem, what we are going to have is people coming here, building hotels and then go and steal the sand from other areas. We are going to have some serious problems.

CHAIRMAN: The point is taken, Tony, but I did make mention earlier in the discussion......

MR. MORGAN: I am sorry that I came so late. That is why I would like a copy of the Report.

CHAIRMAN: ......in the discussions earlier that this is useful academically, the discussion we are having is not beach erosion, it is something that has been impacting the coastline areas around whatever, so it is the methodology that lends itself to becoming a template.

One would assume that certainly whenever one is to do re-nourishment and reclamation or dredging, it is not something that you would say now that we have done a study, and it would have to be studied, whether having gone through this exercise, then the method is simply a template.

Certainly, the point I made about sharing the outcomes from the Report with the public, the interested public, the technical specialized public that clearly is our intention but in the first instance, it is intended to inform the decision makers as it relates to Palisadoes.

MR. MORGAN: The question that I had asked as someone that is interested in offshore mining, the question that I had asked is that I would like to see the Report because I would like to start getting an idea of the environmental conditions that would sort of lend itself to offshore mining. In other words, if I want to do offshore mining, I can start off by using some of the information in this Report to identify areas of interest? That is what I am saying.

CHAIRMAN: Alright.

MR. MORGAN: I don’t know if I had missed it but was there a proposed starting time and date?

CHAIRMAN: You might have just missed it.

(Laughter)

Would you like me to go it over once more?

MR. MORGAN: Yes.

CHAIRMAN: For the benefit of all of us, the very near term aspect of this speaks about replacing the 310 foot hard work rock revetment. It is the remainder of it which is essentially recovering the over 1 million millimetres of sand that is the medium to long term and associated with that would be the issue of replacing in the most westerly groyne, whatever it is, for longshore berms and that is part and parcel of that medium to long term. There are little rocks down there which as Ram puts it, 'hard solution covered over by a soft solution'; that 11,200 cubic metre of rocks, we would want to see it in place before the end of June.

As we speak, the Government has put the funding in place for it and on Monday, we are hoping that we would have met all the necessary approvals. So we are putting it together and we are submitting it through NCCU or whatever it is to get all the approvals so that aspect of it is well advanced.

We have identified the rocks, we have put the arrangements in place, we have made recommendations but we await essentially the sign-off from the Contracts Committee and also from Cabinet to proceed with the works but it is the Government's intention that come the end of June, because Ram was asked how long this hard solution would take to be implemented, we had a schedule of 51 days from the time we say go to the time we actually put up that - how high is it, Ram?

MR. RAMDIAL: 4 meters.

CHAIRMAN: So that is the project schedule that we have agreed that it would take 51 days to put that in. And, Peter, you had made mention that when the dredge gets on board to do the recovery work, that is what? 120-something days?

MR. MORTLEY: 125 days.

CHAIRMAN: 125 days, right, because you know what they say about ships, ships and dredge, they don't make money while they are hanging around, you know, so they would want most certainly to be a high efficiency machine to finish off this job and I could almost take the word out of Cowell's mouth, once they arrive, all of these other re-mediation works, you know, may very well be over quickly because to get a dredge into the country is an expensive cost, the mobilization cost to get it here.

So again we have been sharing the information with various government agencies and departments and there is quite a bit of work to be done and once you get the dredge, that should start operations and other interested agencies would also want to capitalize on that. Okay, again thank you very much. Cowell?

MR. LYN: You mentioned that you were hoping that I will take some of the outputs of this work and present it to the JIE. I would just mention that also present with us here is a past President, Mr. Garth Jackson, and I will ask Garth to collaborate with me on one special aspect that really has not come up here this morning and that is the determination of the design parameters that have been adopted in fulfilling this work. It is very important that the engineering community be aware of the work that has been done to postulate wave heights, wave periods, such critical design parameters so that when work like this is being done elsewhere, the methodology and the results will be available to the engineer ing community and might even be incorporated in the new Code that is about to be promulgated. Garth, you and I have that job to do to bring this work to the attention of the JIE and ensure that it is recognised.

CHAIRMAN: That, certainly, would be appreciated. It would be a travesty to not just spend money but I suspect probably get back far more value than the money we have spent. The money is almost insignificant to the returns we have had coming out of this study and I think that gives us the obligation to make sure it is widely circulated within the academic community and add value to the future. So again thanks very much for coming.

ADJOURNMENT 12:23 P.M.

Appendix 5

b. Verbatim of Second Public Consultation

VERBATIM NOTES

OF

THE

NATIONAL WORKS AGENCY

PALISADOES PROTECTION

&

REHABILITATION PROJECT

Held at the CEO Conference Room
National Works Agency
On the 16th of January, 2008, commencing
at approximately 10.00 a.m.

****

PRESENT WERE

Mr. Lynval Ramdial	-	Chairman
Mr. George Knight	-	NWA
Mr. Anthony Jarrett	-	Project Manager
Mr. Chris Burgess	-	CEAC Solutions Co. Ltd.
Ms. Ruth-Ann Lacey	-	NEPA
Mr. Mark Richards	-	Engineer, NWA
Mr. Anthony Drysdale	-	Development Officer, JFC
Mr. Gladston Whyte	-	Chairman, HBFC
Mr. Owen Malcolm	-	Secretary HBFC
Mr. Peter Wilson-Kelly	-	Peter Wilson-Kelly & Associates
Mr. Michael Mason	-	Chairman, PRFC
Mr. Vincent Gordon	-	Chairman, RTFC
Mr. Noel Maylor	-	Secretary
Ms. Yvonne Cox	-	Member, HBFC

16.01.08

COMMENCED AT 11:06 a.m.

MR. RAMDIAL: Good morning ladies and gentlemen. Thank you for coming to the National Works Agency although it a very short notice.

One of our projects this year is the rehabilitation and protection of the Palisadoes strip and we are involving you because we need - as outlined in the letter - we need to get the permit from National Environmental Planning Agency and one of the requirements is that we consult with the fisher folks in the vicinity to get their feedback and comments.

Some of you may be aware that in 2006 the Government of Jamaica and the Government of Cuba had some dialogue and they had retained some Cuban technocrats to come and do a study of the Palisadoes area. That report was completed in February 2007 and it is that study that we are going to be presenting to you now and you will get the findings and the recommendations of the Cubans handouts.

So without much further ado, I will go down the line and ask if there are any apologies for absence. I got a call from Mr. Mason, he said he is on his way.

MR. RICHARDS: And Mr. Kelly is on his way.

MR. RAMDIAL: Mr. Kelly is on his way?

MR. RICHARDS: Morris from NEPA and also Jarrett from TPDCO.

MR. RAMDIAL: Okay. And Mr. Patterson is at another meeting; Earl Patterson who should be chairing the meeting.

Before we start off I would like to introduce the presenters and the NWA Personnel. We have Mr. George Knight who is directly responsible for the execution of the project. My name is Lynval Ramdial, Mr. Knight is taking over from me. Mr. Mark Richards is our Environmental Engineer, he will be making a presentation of the project overview; Mr. Christopher Burgess who is from CEAC who is making a presentation; and Mr. Peter Wilson Kelly who is on his way; and Mr. Jarrett from TPDCO. So I don't know if you want to introduce yourselves as we are here. Mr.

Gordon, you would like to introduce yourself and your team.

(INTRODUCTIONS MADE)

MR. RAMDIAL: So we will ask Mr. Richards if he will make the first presentation which is an overview of the subject.

MR. RICHARDS: Morning everyone.

PARTICIPANTS: Morning.

MR. RICHARDS: Thank you for coming at such short notice. I will be giving an overview of the project, the Palisadoes Protection Rehabilitation Project. Now the first thing we need to find out is what's the Palisadoes, where does it lie and of what importance it is; why are we planning to protect it by spending so much money.

So if you look at the first slide you will see that Palisadoes is this area from about – this is Caribbean Terrace, Harbour View – about 12 – 14 kilometres out from Port Royal. That is what we are concerned with. It has a number of important features such as the Airport, the Quarantine, the Animal Quarantine area, Port Royal;

which is a historical town; swamps - a lot of environmental significance.

Now, the relevance of the Palisadoes as I have said, it houses the Airport, the Quarantine Complex of the Ministry of Agriculture; at some point, the Caribbean Maritime Institute, the Royal Jamaican Yacht Club, a couple of beaches which are used by a lot of the public; it also houses the historical town of Port Royal. It is also an indispensable defence, natural defence for Kingston Harbour and I figure that is where it gets the name Palisadoes, because the palisade is something that is a fence that helps to protect, right. So maybe that is one of the main reasons why it is called the Palisadoes. And also it has a number of wetlands out there which might be filled with ingenious species that need to be protected.

Some more important facts is that the Palisadoes and Port Royal were declared as protected areas in 1998 and an extensive plan was developed to maintain and manage the resources and the institutions out there. So first they had an Entrance Development Zone where parking, manned information kiosk, signs – that would be at the start of the Palisadoes. Mangrove restoration on the north shore is also in the plan. Public recreation area, zone to guide recreational access and to use dunes on the south on the shorelines; so they are planning, big plans are being made for out there. There is a closed area where there is supposed to be natural regeneration of shoreline and vegetation and also there is supposed to be some available area where you can go and jog and hike and nature walks and things like that. So these are very big plans for out there and as I said the institutions out there need – are very important to us, also.

However, this is the cause for concern because all the plans and institutions are subject to the availability of access to the area. And one of the main concerns is that there is only one access road out there, right. So this has prompted us now to say we need to protect this road. This need for protection is evident when we look at the impact of hurricanes, right. Hurricane Ivan in 2004 exposed the vulnerability of the Palisadoes Tombolo and the Palisadoes is called a tombolo since it was in essence a small group of islands that sediment has gathered in between and caused the filling out and that's why we get the land out there. So storm surges during hurricanes could completely separate sections of the tombola. These are some of the vulnerabilities that were seen during Ivan and also the area could suffer major dislocation in terms of access arising from future natural disasters such as earthquake and major floods, right.

So in Ivan the pounding of waves destroyed the remainder of beach rocks and most elements of groyne field that was put out there to help protect the Palisadoes back in the 50's; washed away sand dunes which normally protect the roads and then eroded the edge of the roads when waters flowed across the road; these were some events which we saw, and huge volumes of sand stone were brought across the road into the harbour and also left on the road.

Ivan was the basis for starting this project but Dean has come along and shown us that it is even more urgent because these events should not have occurred so close together. So we are seeing where we have events of forty/fifty-year return period occurring twice in less than a decade so we need to get this thing looked at.

Now, this is after Dean and we saw these sand dunes over here, over here were all cleared from the road. So we didn't have access to the airport, didn't have access to anything; people stranded at the airport, stranded out in Port Royal and a lot of resources had to be expended to clear the road and get it back to working condition.

The impact of earthquake on Port Royal is very familiar to us. There have been a number of earthquakes. The 1692 earthquake actually removed parts of Port Royal so it is not far fetched to see that maybe we could get something like this here. So in developing and protecting we need to consider these impacts on the Palisadoes.

Now the other thing is storms at sea. You remember the other day we had a storm way out at sea but we felt the effect by the road being inundated out at the airport and this wasn't the first time it was noticed. This was noticed in 1994 when these surveys were being done when a slight wind during midday could have caused water to gush across the road. So this road needs a lot of work and protection. So the Government seeing this decided to work through the Ministry, the then Ministry of Transport and Works and Water, and the former Ministry of Local Government and Environment. I am not sure if that is still the name. That is still the name?

CHAIRMAN: No. Ministry of Local Government no longer exists.

MR. RICHARDS: These guys along with the NWA decided, you know, sat down and thought that we need to protect the Palisadoes. So the work that they envisioned entailed: a study of the costal regime of the Palisadoes Peninsula Caribbean Terrace to Port Royal and they wanted engineering designs and detailed construction drawings to afford us the protection that we need. Okay.

From preliminary investigations – a lot of people have studied the Palisadoes before. So from I think the Palisadoes Conservation Plan done by Powell and Sherice Simpson they had suggested that there are points on the Palisadoes that needed urgent protection. So based on that and on some preliminary consultation with Cubans and people involved in the project they thought they would concentrate on section of 5 km of the tombolo which needs priority attention and there was also special areas in this 5 km that needed urgent attention, and they needed to protect this to ensure that the Norman Manley Airport was accessible and all the amenities out there were accessible. So based on the preliminary studies they decided that the most important area was from Plumb Point to Caribbean Terrace. So they started with seeking to protect in there since it was the most vulnerable section. And there were sections in here that were more vulnerable than others so those would need added or reinforced protection.

So the in-depth study was carried out by some Cubans and they did this in four stages and they started in 2006, November. So the first stage involved the study of the marine climate to define the design parameters for coastal protection. So they would study wind speed, wind direction, rainfall, temperature, all of that.

Then they would go on to stage two which involves field work which would be characterise – the physical characterisation of the study area and evaluate engineering alternatives to protect the area.

And then the third stage would still be processing the information and gathering information, but they will go more in-depth into designing and modelling and all of that information and they would be taking into account in their deliberation at this stage the environmental impacts, the engineering necessities and stuff like that.

And then the fourth stage was just translating everything to English so we could read it and I could present it to you in an understandable format today.

So the study output – these are some of the Terms of Reference. The consultant will review the available information relative to condition of the Palisadoes Peninsula and carry out a comprehensive visual inspection. The consultant will provide description of the works, their scope, method, results, calculations together with justification for large investments that they are proposing. The consultant will develop a detailed plan for the exploitation and utilization of natural – of our local resources and our human input so that it would be in essence mostly a local project so we can benefit. The consultant will develop a detailed plan of disposal areas in terms of location, site preparation, material management, and compaction procedures and other technical and environmental guidelines to avoid leakage of the disposal material into the Harbour. So these are the environmental impacts that the consultant should consider. The consultant should allow for an area of public recreation of open spaces. So the consultant has to bear in mind the plan that was put in place for the development of the palisades and the protection of it. The consultant will include a quality control plan which is necessary for all projects to go through and include a supervision and monitoring programme that works together with a detailed work implementation schedule.

All of these were provided by the Cubans in a timely manner so once that was done now, once the terms of reference were set out the Cubans came in and did their thing, right.

And their field work includes bathymetric survey – that is, elevation of the sea shore and the sea floor, all of that; determination of sand thickness where they were trying to find out if they could find an area in the ocean where they could harvest sand to do the project. So they didn't want to have to be transporting sand from Yallahs or from Helshire or anywhere outside, they wanted to do it from close to the area so that they don't have an impact on traffic or pollution and stuff like that. So most of the field work was in essence to establish that area. They had to do sediment survey which is finding out the quality of the sediment areas, particle size, chemical composition and stuff like that and they also had to study the current which would be important to model where the plumes of would go once you have disturbed the bed of the ocean, alright.

So the end product, one of the major end products was the identification of a burrow area where they could actually access the sand to actually do the work that they have planned. And it is just a couple metres offshore. The shore will be somewhere up here and the burrow area is in some cases as close as 40 metres to the shore. So they have located this area and so the project is easier.

PARTICIPANT: Is that on the outside of the Harbour or the inside?

MR. BURGESS: On the outside of the Harbour. It is about 600 m from the shoreline.

MR. RICHARDS: 600?

MR. BURGESS: Yes. See the little run-a-round there, I think that's the round-about that heads towards the airport. . .

MR. RICHARDS: Okay, okay.

MR. BURGESS: Actually this is from the round-a-bout to the start of that yellow area here. The actual distance from the round-about to the start of that yellow area. Each of these labels at the bottom of the chart is 200 metres so it is about 600 - 800 metres offshore on the outside.

PARTICIPANT: Where the channel light...

MR. BURGESS: I know what you are asking but I actually have a ...

MR. KELLY: (Indicate on computer) It is the channel light. If you put laser to the top, the apex of the burrow area, come down straight, follow down straight, follow down to the bottom of the screen, probably beyond that, would be down that point. Come down to the bottom of the screen, would be down to the laser point and right now the channel light, way down in the Harbour.

MR. RICHARDS: He has it in his presentation so he will be better equipped to discuss that but they have found there are burrow areas where they can harvest and do their construction.

Now the strategy for the protection of the harbour, keeping in mind the intensity of the erosion process because they have done their studies and they have seen that erosion processes are very aggressive at some points of the Palisadoes and they are considering that and the vulnerability of the road after Ivan, the evidence that the Palisadoes requires the application of management and protection measures that respond not only to a strategic vision for its development but also to the urgent need of avoiding the formation of breaches and breaks in the road. And based on this the Cubans came up with these proposals. So they want to protect the 5 km, the urgent 5 km and they are saying the most advisable option is dune reconstruction since these dunes were out there protecting the Harbour before Ivan, in the past. So they are saying that the most feasible thing is utilizing the dunes, reconstructing the dunes. The most vulnerable areas within this 5 km is to be reinforced with rock revetment and you will see what I am talking about later on in the presentation and the possibility to have sand deposits very near the Palisadoes critical sector reduces sand transportation costs by using a trailing suction hopper dredger. So you can now harvest the sand from close to the point you need it and dump it on the shore, thus reconstructing the dunes.

Taking into account Palisadoes current situation, the application of artificial sand nourishment has several advantages over other methods of protection. So the advantage of applying artificial sand nourishment is the only alternative that ensures that the construction of an effective protection for 5 km of coast in a term of no longer than six months. So this is the quickest function that we have of protecting the shore. It is a solution totally compatible with the natural characteristics of the Palisadoes which in essence is mostly sand catching onto rocks out there. So this adding more sand is kind of fitting in with what is out there already.

It is durable in the medium term solution and the magnitude and frequency of its maintenance will be conditioned to the occurrence of extreme erosive events, whose return period varies from 3.9 years for a Tropical Storm up to 130 years for a hurricane of category 5 storm. So maintenance shouldn't be so much of a problem if we are looking at the return period of very erosive storm events. And it is an alternative that does not compromise the application of other long term solutions, so even if we put the dunes out there later on we can go on and build a sea wall behind the dunes or we can do other things out there, other protection measures can be implemented after the dunes are put in.

Now, some of the disadvantages of other alternatives: they are not alternatives of the immediate application because of the time required for the process of decision making, projection and execution to protect 5 km of coast. Building a 5 km wall will be an expensive operation, very expensive and stuff like that.

They constitute hard solutions that once executed compromise significantly long-term decision making. So if you build a wall or put in some hard solutions, your options for future development are kind of limited and because the collateral impacts on traffic and viability may be considerable because of the moving material from all across Jamaica and stuff like that for 5 km of protection.

Alright, so what are there plans now? Remember we had said the revetment is to be put in at the most critical area, the area that need the most protection and this is the bird's eye view here, the bird's eye view of what is planned for a section just beside the groyne fields that are out there right now. That is one of the areas that they view as critical so they have decided to put in this rock protection and it is just large boulders. Calculations have been done on the size of these boulders that will ensure that they are not moved during storms that are about category 4 – 20–year return period.

So the design, calculations and all of that have been done and they have assured us that these rocks should sit there throughout, during or not be moved during a storm with a 2-year return period. Was that a category 3 or 2?

PARTICIPANT: Between 3 and 4. Section between the first and second groyne on the left hand side is the section that you see out there now.

MR. RICHARDS: So this section is a hundred and odd metres. It is actually laid down already so we will be spreading on to, another two hundred and odd metres more to put on. So these are out there and these had been through Dean and no movement was seen and there is no impact of Dean on it.

So these are cross-sections. This is a bird's eye view and this is a cross-section of the process of laying down the revetment. So this cross-section is from here and this cross-section would be from here. So what they would do is remove the material that is on the shore at the moment and then fill it with stones and these stones have to be placed to minimize voids and stuff like that and once that is done and Chris is the supervising company that ensures that they are laid properly and he gives us, gives the

NWA reports on a monthly basis, as to the amount of stones laid, the positions that they have been laid in and we are kept in track and we do our inspection on a regular basis also.

We were glad to see that they actually stood up in during Dean. So this is the rock revetment and this will be done for 300 m at one position and – is there a plan to do it on other positions?

MR. BURGESS: The recommendation is another 700 m has been exposed thorough Dean. I don't think that has been formalized.

MR. RICHARDS: Well, Dean has shown us that there are other areas which needs critical protection so rock revetment might be placed or should be placed in these positions. And they will fit a similar profile as these. So you dig, you remove the sand so you get a flat base and then you start laying the rocks and the positioning and the laying of the rocks is supervised by trained experienced people so it is being done properly. So once the revetment has been laid down the other work, the main work, the dredging and placement of sand can be done and this can be done, this is proposed to be done by a medium sized dredger with proper capacity between 2000 m^3 and 3000 m^3 and draught developed between 5 m and 6 m and these are regularly available on the open market. We are sourcing one or we have sourced one?

CHAIRMAN: We are sourcing one.

MR. RICHARDS: We are sourcing one to be here as soon as possible. Maximum transportation distance we are expecting is 3 km so mainly from the farthest point of the burrow area to the shore is probably a maximum of 3 km. An average load of 2000 m^3 per trip, continuous 24 hour a day working regime, which is not uncommon in projects like this; a continuous flow of material, 5 complete load-and-unload cycles per day and that would be 10, 000 m^3 per day. And we need to – the dredger needs to be refuelled every 15 days so you take a day out a there and the days required to change the positions of the pipelines and all of this should give us about a 125 days to place the volume of sand that had been planned, that had been calculated. I think it was 1.1 million cubic metres of sand. So in placing that, in changing pipelines, refuelling should take us about 125 days which in essence is about six months the Cubans say and it is feasible because it is being done in other places.

This is what the dredger would look like so you would see this up here pulling sand in and pumping it back on to the shoreline for a couple of months. And this now is what we would be happening on the shore. Once the sand is pumped it needs to be compacted and shaped and this will be done by bulldozers on the shore.

Now, this is where most of the environmental impacts will occur; the pulling of the sand out of the water and pumping it back onto the shore and our environmental consultants will tell us the plans of how they will mitigate these impacts also our discretion modelling guru will tell us some of the plans.

So this is our plan for the construction of the dunes themself. Materials will be removed, I think these are unwanted materials. They will be removed, the dredged material will be pumped in and these lengths and heights have been decided and the decisions that they are based on are based on the protection for the same 20-year return period. The sand will be pumped in and these are producers that will shape and form the sand as they are placed. This now is another section. It won't be the same dimension the entire length of the shore. Some areas it might be 27 – 8 in, 53 m. This is 30 to 8 in. In some sections it is 70 m in some sections it is 50 m – so it varies and a number of profiles are presented based on where they sit but this final one is just showing you how the rock revetment lies in comparison to the plumes. The rock revetments compared to dunes is quite small. These are the critical protection for the areas here. Now, in case the storm weathers or erodes all sides mud comes up on the rock revetment and I was told that the weathering of the sand in a category 3 or 4 storm will take about eight hours. So eight hours to get to here and then it will take another four or so hours. . .

MR. BURGESS: You will have revetment after the 20 year but it won't be in any good condition, you will have to go and fix it. It is not as if the stones will disappear but stones will still be there but will be moved around and be displaced, you know.

MR. RICHARDS: As you see the road is very close to where the revetment is and there is no – and if you notice – there is no perfect road in essence. So we are just ensuring that the road is protected in the most critical areas. And as I was saying this is supposed to be completed – laying the revetment was supposed to be completed in 3 months and laying the sand was supposed to be 6 months and probably they could have gone concurrently so probably about 7 - 8 months we should be seeing the project to completion once we have started. Funding is available and we need to complete our assessment, the Environmental Impact Assessment for the disbursement and this is just a part of completing that process, alright.

So that is my presentation. Any short questions for the time being while Chris prepares to do his?

CHAIRMAN: What I would like to add, Mark, is that when the Cubans were here we had a number of Jamaican institutions and agencies that assisted them. There was the University of the West Indies, the Airport Authority, a number local consultants, the Lands Department, NEPA . A lot of Institutions assisted them in completing so we have monthly meetings where we review all the reports that were being presented by the Cubans so that at the end now, all the inputs from the local bodies were inputted in the report and was informed and they were very impressed with the knowledge that the local institutions had and they impacted their findings also. So we had a coordinated completion of the project with the Cubans.

PARTICIPANT: I want to ask, the removal of the sand if it only cause an effect on the lower land, cause higher waves?

CHAIRMAN: Well, we will just wait until Mr. Burgess does his.

(Presentation by Mr. Burgess)

MR. BURGESS: Morning again.

PARTICIPANTS: Morning.

MR. BURGESS: The objective of my component of the study for the EIA was to look at the possible impacts of the plume which we could get from both dredging the sand as well placing the sand on the shoreline, as Mark showed you. The sand is first dredged from the burrow area then transported by ship to near to the shoreline where it is connected to the shoreline by a pipe, and then it is pumped on to the land. It settles on the land by creating sand dykes and it is possible that sand or the dredged material could overflow from the sides and create a plume. But in the process of dredging you can also have overflow from the basin of the dredge, from the hopper of the dredge and the objective of my modelling study was just to look at the possible impact of that plume or the possible extent of that plume.

This is the opening slide and there is a reason why that dredge is there or that hopper is there. It is an open hopper; it opens and dumps material. This hopper was in Antigua. They were dredging their harbour, pretty similar to Kingston Harbour although much smaller and one of the reasons we got involved was just like yourself, the fisher folks of Antigua got up in arms about the project because it wasn't being done with any consultation; which is what we are having here today and which has been happening before. And so it is good that we are here at the start rather than at the end. That particular hopper was actually dumping the material very close to what the Antiguan fishermen referred to as their sacred fishing ground and it is a project of the Government as well. The impacts of the dredge are so obvious. The particular hopper didn't close properly and it was creating a plume. We are actually looking at the plume right through the water from 100/ 200 feet, all the way from St. Johns to the dumping grounds which was some 10 km away.

So again it is good that we are here actually, it is good that we are here to discuss the possible issues and to deal with especially the people who could be affected, rather than wait for us – as people of responsibility it is good that we are here, not like others let's say you know.

PARTICIPANT: Like the Port Authority. (Laughter)

MR. BURGESS: Alright I was talking about basically the fisher folks.

PARTICIPANT: The effect on Greenwich Farm.

MR. BURGESS: Well, it goes to show that there is an attempt here to make the approach as best as possible, alright.

So the objective of the study were as follows:

One, to determine the potential extent and concentration of the sediment plume at the extremity of the burrow area.

Remember the burrow area Mark showed you? It's that rectangular area.

And then the second objective was really to determine the extent and the concentration of sediment plume when it is being discharged onto the shoreline. So it is two discreet areas we are looking at.

Okay, and just to put it in context. That is the burrow area. Let's call it a rectangular shape, it is not rectangular, but as you can see it is relative to the round-about to the airport. And a patch that we are looking at as well is the proposed dune, or the extent of the dune. I'm certain in reality it might become a little longer on this side. I think this western extent is more or less fixed but coming off of where we are going to build the dune the proposed location for pipelines where the dredge will sail up to connect to and pump onto the land. So this is basically a layout of what the project will look like. A burrow area which is about a 177 hectares. It's sand and the burrow area you could describe as between medium to coarse sand which is a very good thing and the stretch of shoreline which is about 8.2 km and the dune actually varies in width between 50 and 79 metres wide.

There was a question before – I'm sorry, I don't know your name, sir.

MR. MAYLOR: Maylor.

MR. BURGESS: Mr. Maylor had asked where was it relative on the markers? Here are the markers: (1) (2) (3) (4) (5) (6) relative to the east channel. I would say that southern extremity of the burrow area is somewhere between 2 and 3 km. from the markers to the east channel. Everybody knows where this is?

MR. MAYLOR: The eastern land.

PARTICIPANT: This is Farewell Island.

PARTICIPANT: And the one after that, quite here.

PARTICIPANT: That area, the red area is the area where you are going to take the sand from to put on the land, what depth of water is that?

MR. KELLY: That's anywhere between 10 and 15 metres.

MR. BURGESS: 30 - 45 ft; 30.

MR. KELLY: 6 fathoms to about 8 fathoms

PARTICIPANT: That area, is it a rock area?

MR. WILSON-KELLY: All of this area here, all of the area within which the burrow area is, it's all sand. So when I get to my presentation I will actually show you where the rock is and where the sand is. All of the burrow area there now is sand.

MR. BURGESS: Is it fair to say that – well, Peter, I am certain that you have some understanding now, but what type of fishing happens, is it net or line?

MR. WILSON-KELLY: You have net, you have line, sometimes you have fish pots, but that is a minimum, it is mostly net and line. You have the fishermen who do Palanka fishing especially the Red Snapper (sea, marine). These are the areas in which they fish with the net but also the area which....

PARTICIPANT: . . . they do blasting and net.

MR. KELLY: They will do it in the shallow rock area here and out by Windward Road edge, south along this side.

MR. BURGESS: So we know where the burrow area is and where the dunes are, Everybody has a fair appreciation for it.

PARTICIPANT: One of other thing that the dredging will do; the dredging before that took place, what the dredging do is that same as you were showing how the sediment fall out, when you leave the Kingston Harbour coming straight in the channel come straight up, you dump it about outside here and every once in a while that sediment is washed back to shore and all these rocky areas, all these under water showers and start to affect it; it affect and fishes for maybe three years.

MR. KELLY: You had that...

PARTICIPANT: Excuse me. Wait, let me finish just – mek I finish. What it does when the current change it start to go southwest and come down the sea, it actually go right to Old Harbour Bay.

MR. BURGESS: The plume travel under water.

PARTICIPANT: Under water because it can't go on the see floor in the deep.

MR. BURGESS: It hangs in the water column and moves with the water column.

PARTICIPANT: It fly like dove.

MR. BURGESS: There is something you must know about sediments inside the Kingston Harbour versus the sediments in this small area. As I said before there is coarse sand out there. So you know sand once you drop it in the water it settles out very quickly. That is a very good thing about it. Whereas inside of the Kingston Harbour there is a lot of silt, right, primarily from like the Rio Cobre and other rivers that come into the Kingston Harbour and that silt when you drop that through the water its becomes suspended in the water for a very long time and murky. So one of the good things about this work site is not only its proximity to where you are going to use it but also the quality of sand and to be honest with you I think this is the best work cite I have every seen. Because I can tell you this with the model we use, and the silt sometimes it can stay in the water column for days and then where the mass of it actually dumps on the sea floor can actually stay active for years in terms of just the wave energy passing over it everyday and the current, it resuspends some of that sediment. But remember, in here is silting, out there is sanding.

PARTICIPANT: And I think I understand clearly what you are saying. Well, we – I don't know for everyone, but I can tell you I appreciate the developments that are planned, you understand, is only that we would like the reef, the reef them to be protected.

MR. BURGESS: Well, I'm going to show you what we did, right, just as Mark had shown you, and this is one of the first concerns. When you are placing the sand or pumping the sand in the dikes on the shoreline there is a potential that this dike can break or overflow if it is not watched or managed properly and this is why it is very important when we are doing national projects to have monitoring during the construction to know what is happening and how is it to being done. I am not saying that all contractors focus on money but if you are a contractor assigned to a particular job or doing a particular job, your primary focus is to make sure it is economical and our focus as Jamaicans should be to make certain it is going to be economical and environment friendly.

That is one of the concerns which I had and I investigated how this might affect the shoreline. So the first thing I did was to – remember, now we are considering two scenarios; a dredge hopper overflow of 9.5 grams of near silt per litre at the burrow site at 1.1 cubic metres per second was considered. So in our model now, we have to say okay, how much silt can come out of this sand because there is a certain amount of silt in the sand no matter how coarse it is, there is still a certain amount of silt and what we have determined was a good number to use to the 9.5 grams per litre. And for a broken sand dike overflow on the shoreline we considered 1.5 grams of silt per litre with an overflow rate of 1.1 cubic metre per second. That is how much water you actually have to pump in order to transport the sand in the pipeline.

Now, there is – I am going to come back to this.

PARTICIPANT: What depth would you take off the sea floor, the dept?

MR. BURGESS: Oh. 6 ft. Up to 6 ft. Yes, the dredging is about 6 ft.

Now I'm look for particular slide which unfortunately, looks like I didn't put in there but please remind me of your name again or – just to let you know these numbers are useless without comparing them to an acceptable standard and NEPA, you know who NEPA is? Yes. NEPA has an acceptable standard of 10 milligrams per litre. You notice I said 10 milligrams per litre in comparison to what might overflow from the hopper of 9.5 grams per litre. In other words, 9,500 is the concentration that might overflow from the hopper if it does overflow and at the shoreline is 1.1 gram, 1, 500 milligrams per litre in comparison to comparison to ten.

So in other words, if there is a break of the dike at the shoreline or an overflow at the hopper, it is possible or very likely that the concentration will exceed acceptable standards immediately right next to where it is being discharged. You can appreciate that this is a construction site in effect on the scene, it is not a clean place and it is a place that right next to it so it you might fail the standard. So it is not a matter of if we are going to pass the water quality standard at all times but it is a matter of what extent this unstable plume might persist. You get what I am saying?

Now the first to do was to get the, take that requirement from the information about the currents associated with outside and we know from previous studies as well as the study of the Cubans, they had put down some current metres out there, two current metres, and we know from previous studies the current outside can essentially go almost in any direction. This is a not a situation out there where currents consistently go from east to west or from northeast to southwest, that is not the situation outside Palisadoes. We have current metre data that show us that current can go northeast, current can go southwest; currents can go in a variety of directions our there. There no simplified approach so looking out there we have to consider the worse case scenarios for the sake of what is out there. I don’t know if you would agree with me that in your observation current can go in almost any direction.

PARTICIPANT: We know that currents travel and all directions but it has directions in which it travels majority of the times, you understand.

MR. BURGESS: Well in order the investigate where this plume might go, the first thing you have to do is get a numerical model of the situation and that is the extent of our module. All of Kingston Harbour, Hunts Bay, almost around to Portland Bight, this is well past Harbour View.

PARTICIPANT: Probably Bull Bay?

MR. BURGESS: The model is pretty extensive. The shadowed areas are the reefs and there are some portions of the deep water outside. This project area in the model actually is defined better and each of these triangles that you are seeing here and quadrilaterals are elements of the numerical model area. So what we did was to put more emphasis on the project area to make certain we could get better details. You see what I am saying?

This is the sediment flow. Remember now we had looked at two scenarios. One, is where your dredging hopper overflows accidentally. Now this is the extent of the plume if it does overflow to that 9,500 mg per litre that we spoke about earlier. This scale bar here is 2000 metres and remember before we spoke about the 10 milligrams per litre requirement of NEPA. Actually, let me put it in context. Out in the sea right now, right out there, chances are the concentration of sediment is somewhere between 3 and 6 milligrams per litre. When there is a storm that concentration probably goes up to 20, 40 milligrams per litre. So having sediment in the sea is a natural thing, it is a day to day thing. The corals, sea basks, fish, all animals out there learn to live with sediment.

PARTICIPANT: With the sediment plume quantities.

MR. BURGESS: Right, exactly; learn to live with quantities of sediment plumes. When it rains you can see the sediment from Hope River right down through Kingston Harbour. If it rains for three days and you are flying in, it is interesting to see how the plume comes out from Hunts Bay and out into the mouth of the harbour. So sediment is nothing unnatural, it is very natural. But just to show you we looked at several scenarios and I'm only presenting the worse case ones to you just for the sake of making the presentation as short as possible.

The plumes for an easterly wind as well as for a northeasterly wind, the outside edge of the plume as you are seeing here is the limit to reach the NEPA requirement. The largest the plume gets is somewhere in the range of 200 to 500 metres in diameter and that is within the scale in comparison to this scale which is 2000 metres which is at Plumb Point, this is about Plumb Point. But if we look at a burrow site closer to the Harbour View end – this is not Harbour View but the furthest or the most easterly end of the burrow sites, the plume is a little bit bigger than if you were dredging near to Plumb Point but again it is still relatively small; you ae looking at somewhere in the range of about 500 to 800 metres at the very most, which is about 2000 feet, the volume.

Now if we look at the second bit of scenario which is where you discharge the sand on to the shoreline and the dike which is supposed to contain it if it were to break. If you are doing something a hundred times chances are two or three times it might fail. You don't hope for it to fail but things happen. And if you were working on the shoreline close to Plumb Point you could expect a longer plume somewhere in the range of 1000 to 2000 metres travelling back and forth along the shoreline before it reaches to what you would call acceptable standard for both easterly as well as northeasterly areas. Similarly if you are building the shoreline area with the groin field, where the groin fields are now, out there where the stones are; if you were building the shoreline there and you were to have a break, again you will have a plume somewhere in the range of 2000 metres stretching back and forth against the shoreline because the sediment takes a time before it dies down. If your were building the shoreline up by Harbour View the plume is not quite as long as if you were building its done here, but again it is somewhere in the range of about 1000 to 2000 metres before it reached the background concentration.

MR. KELLY: A quick question what is the width from the shore to the sea?

MR. BURGESS: Somewhere in the range of 100 to 300 metres.

MR. KELLY: I want you all to remember that number because when I give my presentation you will see how that relates to the natural environment out there.

MR. BURGESS: What are the conclusions we can draw from the study? And again there are a lot of things being presented which is the worse case situation. The existing current metre data reveals that sub- surface and surface currents can be expect to be move in both easterly as well as westerly shore parallel directions with a tidal signature. The resulting plumes can therefore be expected to extend to either side of a discharge, depending on the stage of the tide and wind conditions.

Burrow area sediment plumes are not expected to have trajectories or concentrations that would result in any adverse ecological conditions to either offshore or near-shore reefs.

That was based on my understanding of where the reefs are. Peter is absolutely versed on that.

These plumes are only expected to be some 300 to 500 metres in nominal dimension; it could be less. In other words, you see the dredger out there and if for some reason there is an overflow, it shouldn't be more than 300 to 500 metres in diameter; it could be less.

Accidental shoreline discharges of sediment can extend some 1,500 to 3,500 metres in longitudinal dimensions along the shoreline. 3,500 is really the longest.

MR. KELLY: Just up to about 300 metres going seaward in the wind.

MR. BURGESS: The important Kingston Harbour shelf reefs including South East Cay and others are not expected to be adversely impacted by the dredging operation. Again Peter will tell you more about that. Right. Recommendations which Peter has advanced in the main

EIA document: Sediment plumes due to shoreline discharges should be controlled by turbidity barriers and berms to for sedimentation basins at the discharge point. In other words, around where they are making the berms it is not impossible for us to ask contractors to place turbidity barriers.

PARTICIPANT: Something like a dune?

MR. BURGESS: Just in case there is a break because we don't necessarily want this thing if it breaks to get uncontrollable. Now there is another reality to these booms especially when you have them in those rough wave conditions that were in past prime conditions that they don't last very long and they are very difficult to maintain in place because they move with the current, they move with the wind; no matter how much you anchor them they get battered, it is very difficult. So some amount of leeway, some amount of specification of very robust turbidity barriers has to be done, has been to be factored into the cost and although its costly we have to bear in mind that they are not absolute structures; if they get battered by the waves, they get battered by the current within a week or two weeks time and contractors don't have them because they are battered and they need to replace them; or the current might be too fast or the waves are too rough.

The second recommendation: An extensive current and wave monitoring programme should be initiated at least three months in advance of the dredging programme.

The information we have on out there really is for the significance of Palisadoes and the Kingston Harbour is somewhat negative and with a programme like this it is not uncommon to start a current monitoring and wave monitoring programme. Wave monitoring is important from a money perspective because most dredgers they have a threshold within which they work and when things get too rough they stop working and the client actually gets charged for that and so the client needs to have a record of what actual day is worked so as to justify claims. You get what I am saying? Contractors might get frivolous and say waves are rough and if you don't have records then you won't know. But then also from an environmental perspective in terms of plumes, if you have problems with berms breaking it is good to know when they broke and in what wave conditions did they break. In terms of current, to advance our understanding of how the sand might move we need to have a monitoring programme to know how are the currents moving up and down both at the top in the middle and at the bottom of the water column. And most importantly we need a water quality monitoring programme out there to set a baseline, and I am certain Peter has specified one but we need to know in all fairness to both the contractors as well as to the environmental monitoring programme what are the baseline conditions like out there over an extended period of time.

NEPA has become more sophisticated and more demanding over the last few years and in most recent times they are talking about monitoring programmes in order of years. You know they would want to monitor the environment for at least a year before or during the entire project continuous monitoring of the environment and it is not uncommon for the Caribbean as well as the United States for projects of this size to monitor those water quality projects to know that when a contractor might have had a spill, what that spill compares to. In other words suppose he has a spill and the concentration goes up to 60 milligrams per litre at a location, we can compare that to what the reading was like last month or the month before and we can say yes there was a spill and you didn't tell us. You get what I'm saying?

And that essentially is my presentation.

PARTICIPANT: Where is this plan initiated, the project itself?

MR. RAMDIAL: Well initially the Caribbean Development Bank they have funded the project. The loan has been approved. I'm not sure if the loan agreement has already been signed but the loan amount has been approve d. We don't see it starting until about June.

PARTICIPANT: Of this year?

MR. RAMDIAL: Yes, because you know we have go through the tendering process and evaluation and mobilization. Don't quote me you, it's a guess which might not be viable, right, because it is hurricane season.

PARTICIPANT: Even with this consultation process things have been far advanced then basically.

MR. BURGESS: The design; I would say we are half way through the first stage in my own mind.

PARTICIPANT: The time period, you think June would have been an appropriate weather pattern for to do work like that?

MR. BURGESS: Don't quote me on the June, George is actually talking to the CDB at the moment so when he comes back he can address the start up date.

PARTICIPANT: I don't think June would be ha good time why because June and July is a more weather, the hardest weather pattern for the year; June, July, August, by September it kind of taper off.

Secondly the research and the project - excuse me, sir -

the research on the project, do you ever think of using like piles to protect the beach the stones them?

MR. BURGESS: Well as Mark has alluded to, hard solutions prevent you from doing other things or make it difficult for you to consider other options in the future but let me cut a long story short. There are some things which are earmarked very clearly. There are hard solutions that we typically look at in these situations; groins, revetments sea walls just as you are mentioning even if it costs ten times as much as the soft solutions which is what we were proposing. When we mentioned twenty-year term period I hard someone snicker and say probable that was too short. I think even probable before Mark maybe what we should have had when the Cubans were here if somebody had said anything in the way that was presented to you setting out what the parameters are of the different options, I can tell you that to put a revetment and to raise that road and to do hard solutions along this road would be about ten times more expensive and the solution, this approach which is being used and the reason why it is being built so high is to give it a certain robust-ment and longevity. As a poor country, to cut a long story short we have to vice. This is a solution, approach which is being used in Holland, the United States for many years and we must not see it as Third World solution, we must see it as the appropriate solution

MR. MASON : I have a question. I heard everything you mentioned other side, what about the harbour side in terms of planting of mangrove or anything, I don't hear anything mentioned.

MR. WILSON-KELLY: I think the reason for that is because most, if not all of the activities are going to be occurring between this edge of the roadway out to here. There is nothing that is intended for this side.

MR. MASON: You realise that the road is being undermined from this side.

MR. WILSON-KELLY: It is being undermined from this side I agree.

MR. BURGESS: Mr. Mason, there actually is another project looking at that side.

MR. MASON: When you say looking at will it be holistic?

MR. BURGESS: Looking at rehabilitating the harbour side of the road and if Mr. Knight was here he could tell you a lot more about it but constructing is going to start very soon on the harbour side. It is a very simple approach, a very small piece of shoreline revetment and widening of the shoulders, very quick solution, robust solution to prevent it from being undermined in the future. But as for it being holistic, I think it is still consistent with what is planned on the Caribbean sea side so it doesn't jeopardize what is going to happen over there.

PARTICIPANT: One moment. He is from NEPA, please, he represents NEPA?

MR. RAMDIAL: No, no, he is a consultant with the National Works Agency.

MS. LACEY: NEPA is here.

PARTICIPANT: Probably she can mention something about it another time because the mangroves is very important.

MR. RAMDIAL: Or maybe it could be looked at in that context there too because that is where those mangroves are.

PARTICIPANT: The Marine Biology section is not here, I mean surprisingly.

MR. GORDON: So Mr. Hainsley, you know Rae Town was on the local Steering Committee that was managing the mangroves? If we had some material we could continue it but we don't have no funding. Are we going to get a copy of this Cuban Study?

MR. KELLY: They are available.

MR. RICHARDS: It's available.

WOMAN: Blank copy?

MR. GORDON: And we are going to have follow up meetings?

MR. RICHARDS: Well, another meeting we have. There is going to be a public presentation with the EIA once this is finished where everybody is invited to come and critique.

MR. GORDON: We are glad for the participation in the development, it's just that the Local Authority really ge wi a low blow. You can't do this thing there and there is a damage assessment and then you come and ask wi for technical advice and all them thing deh. It don't really right because wi nuh go a nuh big, big school whey wi a think them kind of things there. But wi used to this and wi have a part to play as the stakeholders. We hoped that you are going to have another meeting and we could get the copy of this meeting, we among ourselves coulda sit dung and even have a little talk.

MR. RICHARDS: We were planning to send a soft copy to the Cooperative Society because we weren't able to get into contact with most of the people at such short notice. So I will endeavour to send a soft copy to you guys so you can probably disseminate it.

MR. DRYSDALE: In addition to that I am going to say it now that we need to also sensitize other fishers, in particular fishers who are not present even though there are representatives here they will also pass to some of those folks because you know fishermen are not easily led. So the electronic print and whatever there is you can also put that in for us just to advise them, we will play our part in the process.

WOMAN: With the inclusion of other environmental agencies.

PARTICIPANT #2: Just to add to what Mr Drysdale has said, it would have been much easier to have the Consultants on the different areas because you know, fishermen don't really leave their areas and focus mainly on the electronic details: one and one is how they really look at things. We would go back and advise them of what we have learnt here but it would have been more accepted from you guys coming there and saying it

MR. RICHARDS: Coming out there?

MR. MASON: Yes.

MR. KELLY: Well, we had tried through the Fisheries Division for them to organise a meeting but it fell through.

MR. MASON: But just as how you contacted the Head of the Cooperatives of each location we could say kind of organise a meeting with you.

MR. RICHARDS: The reason why we reach here is because we are late. We wanted to set a meeting from a very long time so we had to take this initiative.

MR. KELLY: It's a good point, I would have preferred to have taken the presentations to the respective beaches. I don't know if we can then now put that in your report to ask you to see if you can facilitate that to us. We will bring the laptop and the screen and so on but you will gather the persons together, give us an indication as to when it would be convenient and then we could come down there, you gather the people together and we can sit down chat, discuss the thing and get the viewpoints from them. I would have preferred it, to be honest with you.

MS. COX: That would be the ideal thing.

MR. MASON: I think that we need somebody here from UWI or even the private sector in terms of because even the last time when the Port Authority - I mean there wasn't proper regard for the reef them after that was done.

MR. RICHARDS: Mr. Mason, there is a management plan for the works after this has been put in. So this part is just for NWA. We are planning to hit the road so there is a large management of the entire project being put forward. This is why we have TDPCo here because we are planning to liaise with them in the management of the area, replanting, protecting the dunes; vegetating, putting in – remember I had told you about the plans for the protected area, the trails and all of that, so there is a big scheme to put all that into place and the CDB is providing – I see you smiling but the CDB is providing funds for this.

MR. MASON: So this is a guaranteed thing, not just a promise saying that will be done?

MR. RICHARDS: Put it that way.

MR. KELLY: Well, that’s the very simplest. You will see in my document here that at the very onset we were recommending that UWI play a part in ensuring that the dune that we created here is re-vegetated. I think it is the most natural of the solutions coming out of that and from that you can put all sorts of other things.

MR. MASON: And it would be good if the environmental organizations play their part as well. Diana McCauley is the person who usually works on that strip, I don't see her or hear anything of her. There are several different environmental organisations that should be part and parcel of what is happening.

MR. RICHARDS: I agree. Mr. Mason, this is the second in this series of meetings. The first one we had the other stakeholders, we had invited a number of people, nobody showed up. This morning when we saw 10 o'clock coming and we didn't see anybody we were saying, 'Again!'

MR. KELLY: But at the end of the day we represent information to NEPA, it is NEPA's prerogative to give us full lists of persons who they think should be brought into bear where this is concerned. But at the same time, there is a responsibility that we too have to ensure that as many people are accounted for, we are going to take that on.

But where fishing interests are concerned, I would very much like for you to see if you can organise some...

MR. DRYSDALE: To be frank Mr. Wilson Kelly, I have my concerns about NEPA.

MR. KELLY: Mr. Mason, and please Mr. Drysdale, I hear your concerns about the environment, I have a concern about the Palisadoes and the Airport and the accessibility of what is one of two international airports in the island. I have been through several projects – Peter has been through much more that I have – environmental projects of this nature. I am reasonably certain that securing the strip of Palisadoes is high, it should be very high on the national agenda. If you look in today's paper you see that one of Air Jamaica's suitor is thinking about putting forward funds to repair the roadways which we are insisting on it too.

MR. BURGESS: I am surely certain that if this Palisadoes was broken in the next hurricane season say, in another seven or eight months and we were here sitting down talking about the esoteric or marginal issues I think it should rest on our conscience how much of our roles play in that.

MS. COX: I am saying that is true, that's all our concern is just that we want to solve one problem and then create two or three more.

MR. BURGESS: I think we all need to focus as Jamaicans and be mature about this process and there are others who are going to come into this process who might actually try and make it protracted, who might actually try and criticise it and it has other reasons to start it. I don't what powers the National Works Agency has but I am certain if they read their Act and if they look at other Acts which the Prime Minister has at his disposal too – frankly, if it were me leading this project I would do the consultations over the next two or three weeks and I would be looking to start this project in April with or without consensus because every time I drive to the Airport I say to myself another year has passed since Ivan and we don't fix this thing. If this thing gets busted the criticism that the government would get would be so severe for not doing anything. I can tell you as a young Jamaican, I see where this project is heading, it's heading to be studied three or four times just like Kingston Harbour that has been studied eight times and with eight different consulting bodies and as a country we need to stop studying and start doing.

MS. COX: And do some action.

PARTICIPANT #4: There have been several studies on that strip; vegetation, the type of life form you have out there in terms of animals...

MR. BURGESS: Well, can I tell you there is another one silently taking place.

MR. DRYSDALE: The groynes have been there and the groynes want to fix for several years and nobody pay it any mind. But when Ivan came everybody seh ray, ray; everybody come in the media and saying all kinds of things; just to be seen or heard.

MR. BURGESS: Mr. Drysdale and Mr. Mason, the only thing I am saying to both of you and to others as Jamaicans is, let us not kill this one or suffocate this one until the road is busted in five pieces, there is a reason why I said five because there are five little islands that join it up.

MS. COX: No, we might nuh have nuh road at all.

MR. BURGESS: There you go. I actually think, to be honest we need to push this project and there are others who are going to start putting their two cents into this process and we need to make sure that we keep everybody focussed.

MR. DRYSDALE: Even by Plumb Point, I don't see any much emphasis being placed there and it is a very dangerous area. That is the most dangerous area right now as far as I am concerned.

MR. GORDON: So concern and priority according to you, because a wi a go wash 'way. But what we want is that, we are willing, as a man who has something to lose – we have plenty to lose you know – we have to defend the Kingston Harbour. But that gentleman who has something to lose, are you willing to take this struggle wid wi, sir? You know the consequences?

MR, BURGESS: If it fails.

MR. GORDON: Not fail, to get these people who polluting the Harbour and all them thing deh. This thing is a deep thing you nuh, sir, both on that side and the Harbour side, and we going to come strong so we are willing to – not in the violent way, nothing like that, but we have people polluting the Harbour with industrial waste on this side and we want to get on with this programme, the real thing. Over eight times you say Kingston Harbour? And the 'this' and the 'that', we want to make a urge now because we've been trying...

MR. BURGESS: Come let's focus, this outside, this is the road, let's hurry up and fix it.

MR. GORDON: And if the road wash away wi a go wash away. So you consider it a priority; we are going to do our best. So I want to say, do you willing to go all the way?

MR. RAMDIAL: The Government of Jamaica...

MR. GORDON: When them to come to turn it down, we going to turn it up.

MR. RICHARDS: This has to go on so...

MR. BURGESS: I am telling you, I am going to fight this project.

MR. GORDON: We don't have nuh job to lose. I want you to understand me, you nuh. If it is right – because we are going to wash away, you nuh.

MR. BURGESS: We are on the same side.

PARTICIPANT #4: I don't have a problem, the only concern is that we will communicate between Mr. Wilson Kelly and NWA. My concern is just to have dialogue with the fishers to sensitize them with what is happening, that's all. I am not really interested in the 'red points', that's not my concern.

PARTICIPANT #2: The 'red points' that would be stated won't be from way below, it based on you say, you need approval to be signed off and so first.

MR. BURGESS: No, that's not us.

PARTICIPANT #2: So you have the grant here to do the project is just to get the official documents signed.

MR. BURGESS: Yes, but I have to use your name as well. Some people said, Oh, this would affect Fisheries negatively and use your name, Farakhan". But telling you, you just make sure you listen to that.

PARTICIPANT #4: The last dredging you did for Kingston Harbour affected fishing adversely.

MR. BURGESS: You had any consultation like this?

PARTICIPANT #3: Not before but after the problem. I personally would like....

PARTICIPANT #5: Some of the problems wha' caused it we wondering if this project will cause similar.

MR. RICHARDS: This is why we have our Environmental Consultant here and he will tell us what the NWA plans, what the CEAC plans and what the company who is doing the work will have to do to ensure that there are no significant impacts on the environment.

MR. KELLY: And additionally, since we all don't know it all, we also want to get the necessary additional information from those persons who are out here twenty-four hours a day so that we can put that into the document and bring that out.

MR. RICHARDS: And this is the importance of the survey. So I am asking a couple questions and here it is, I am asking you to just fill them out and get them back to us as soon as possible.

MR. KELLY: One last paragraph.

PARTICIPANT #4: Just one thing still. You see the level of commitment each person would like to have in seeing this thing happening and happening properly is one but I am somewhat concerned about the harbour side, and I wouldn't mind if some of the persons here now would be committing to assisting in that area as well.

MR. BURGESS: But there is a project on the harbour side.

MR. KELLY: On the road.

PARTICIPANT #4: It's the level of commitment that is important, whether some persons would be willing to certain thing as well, where that is concerned.

MR. BURGESS: My recommendation to the Works Agency is that they take the same sort of approach that we will be taken for this side and to ensure that all persons have a role to play. I am glad you remind me about Rae Town, the Rae Town groyne'.

MR. KELLY: All right people, my presentation has a whole lot of slides inside here, I want see if I get through them quickly. But I needed to start with this one just to illustrate to you all that this is not the first time that we have gone down this path. After '51 Storm when this location here had gotten battered pretty much like how Ivan had battered it, the then Public Works Department with a gentleman by the name of Makepeace Woods put these structures here; these groynes have been up here fifty-odd years now. That was the solution that was entertained at that time. New time, new technology, new understandings – both Mark and Chris have outlined what is proposed in terms of present day situation and what is intended. You would have seen probably from Mark's presentation, all of this area here is what was deemed as being the area as the most critically impacted and the solution is to create a combination of dunes and revetments to secure that location.

Note this picture here, just to show the difference this arrow points to where the next slide – that's the groyne here and basically all of this material here was scooped up by the waves and either thrown over here or washed back out. So there is no doubt as to what has happened out there.

You would have seen these too but I want you to take specific attention to this particular diagram here because Mr. Burgess spoke to the possibilities for impacts of sedimented waters out in the sea. This I believe, is one of the critical things that we will have to pay attention to; that sort of holding basin that would then receive the materials that are being dredged from the sea. If we don't get this part right we are going to have problems.

But you have seen these diagrams already so I don't necessarily have to go through that, you would have seen the fact that the proposal is to take material from this borrow area here and come back to land and the amounts to be dredged, approximately 1.1 million cubic metres and the proposal is to use a dredge: Substance from the borrow area is pumped on the sand and the use of bulldozers to shape it up. You would have seen all of those before and you would have seen these also as specific response to the most critical area; use of both the dune and a revetment.

Now Works Agency is required to receive environmental permission from the National Environment Planning Agency so they made the necessary applications to NEPA. NEPA requires them to do an environmental assessment and basically, when we were going through the process of deciding on how the EIA should be done we came to the following four or five points in terms of impacts. The first is:

* **Impacts due to marine sedimentation caused by dredging**;

Meaning, the dredge working out at the Borrow area, it might pick up sediments which might affect the natural fish life that is out there.

* **Impacts due to sediment coverage caused by dredged material deposition on land**;

Meaning, when you put that material on land it might cover something that is of importance on the land itself.

* **Impacts due to near-shore marine sedimentation originating from the deposition of dredged materials**;

Just a big way of saying if the dike breaks or if the water gets into the sea while you are pumping it on it would have impact near to the shore;

* **Impacts on the fishing access and catch;**

Meaning your ability to get to the fishing areas and your ability to catch things out there. And finally;

* **Impacts on aesthetics and recreation**.

People used the area out there before. If you are not able to access it anymore, that is also an impact.

So **terms of reference** that was created for the EIA basically covered twelve points ranging from determining where all of these sensitive resources are; whether it be coral; whether it be sea grasses, whether it be important plants like those that live on the dune; determining whether or not there was anything of importance where the materials are to be accessed from the sea; determining whether all the existing conditions are out there in terms of water quality; determining what could happen while the dredge is working out there and Mr. Burgess spoke to that; determining how suspended material in the water could move and where they could move to; what the current fishing practices are out there, how much fish is out there; types; how much is being caught and how the dredging will impact on that. And generating things like mitigation for the impacts and also the generation of a monitoring plan.

So basically, the Study looked at both the land side and the sea side. The following slides are going to show basically how we determined where it is that we needed to study on the sea side.

So fine, we know that is where the Borrow area is; we know that this is where the affected areas are; we know that the winds in the daytime are going from out southeast, going basically in that direction and at nights, we get north winds basically coming from this side. And that has something to do with how the currents move which in a general way, move in this direction. Now we know that it will change but I remember you said that at some point in time, there is a path that it walked on for most of the time.

PARTICIPANT #2: Where you would find the old boat.

MR. KELLY: Which one that, the one that’s up by...

PARTICIPANT #2: ...the old boat on the Caribbean Sea side, the wreck.

MR. KELLY: Oh, the wreck. You have the one out by the Airport near to the roundabout which is right about here and then you have the old wreck which is right out there.

PARTICIPANT #2: Where you would find wire fence now?

MR. KELLY: Which one is that now?

PARTICIPANT #2: Wire Fence is the Cable Hut is.

MR. KELLY: Gunboat Beach is right here. (Indicating).

PARTICIPANT #2: You see all of that, all of there so is fishing ground. All of that Borrow area is a fishing ground.

MR. KELLY: Well, what I am going to show you next will sort it out for you, hold your thoughts right there.

So we know generally what happens inside here. These were taken from Mr. Burgess' document and it basically shows that his measurement for currents move like so and like so at this point here, moves like so and so.

PARTICIPANT #2: ...you have wind-like current and lowered current.

MR. KELLY: And it move so and so at this point.

And importantly, coming to what you were talking about these lines here show the border of where the reef is. You have one reef here now towards Windward edge which is all of this area here come down to about fifteen metres –

nearly six, seven or so fathoms out there. And then you have another one which is right where you talking ‘bout here now following the – this is the Palisadoes here. You have one which runs right along here. You see the Borrow area here?

PARTICIPANT #2: Yes.

MR. KELLY: So the reef here at this point, is very close to where the Borrow area is. So all of this area along here and you have some around here too, is as you said, good fishing ground. And these pictures here give you a good example of where some of these groynes are. Say one here, one there. See the groynes right here, those groynes were right about here. These here right AE about here and these are closest to where the Borrow area is. I don’t know if you can make these out, these are the deeper ones which are along here. All of this material inside here is sand.

So having defined all of that, what we did was that we said okay, let us look at what happens in the areas of Windward edge going back to Plumb Point where the dunes are supposed to end.; following along the shoreline coming back to about Caribbean Terrace here. Additionally, we said that since we know that the currents tend to be in the southerly direction at some point in time, let us look at a reef area that is close to here, look at the same things that we would look at here and then try to see if there could be any impacts.

So we did some studies out by the Southeast, east side which in our view, the nearest point where we could gather some information. So the Study area was this area here and this area here so the Environmental Impact Assessment covered those areas.

For the **marine side** of things on the **sea-floor** we did three sets of dikes. Now a dike is out there for nearly twenty years so we kind of have a little understanding of what goes on out there. So we decided to choose some shallow areas and deep areas. We had problems with the deep areas because the sea was kind of rough. The day we went to do this deep area it was flat as the table so we grabbed at the opportunity. The other occasions, we kind of had to basically play around before we could get in there because the wave started to pound us a bit.

So we did one dyke here, one dyke here and one dyke here. We collected water samples, we did assessments of population of fish and we looked at the status of the reef itself. We also did that down by Southeast area.

More details of the **water quality** stuff: we took four set of samples along the shoreline right where they would actually be doing the work itself and we took water samples of irrigated dykes. Also, we took water samples out at Southeast Scheme, What we looked at was the amount of sediment that was in the water and how clear the water was and we used that as a basis for setting the standard for what the contractors are going to have to maintain when they are actually doing the work out there.

PARTICIPANT #2: Excuse me, you didn't find any slime?

MR. KELLY: No, I didn't find any slime – where on the bottom itself?

PARTICIPANT #2 Yes.

MR. KELLY: No, not at the time that I went out.

So **findings for the Marine Side**: I have been able to identify six types of corals out there, all of those that were out there were basically big rocks, big sturdy ones. These are their names

PARTICIPANT #2: You mean the fantail rocks?

MR. KELLY: That's what you call them?

PARTICIPANT #2 Them thick and broad.

MR. KELLY: Right, broad. I think I can understand why out there is so rough, I put an 'x' through these types here because the branches can be easily broken. We didn't find any of these out there but basically, these 'x's that you see out there are the types of corals.

MR. RAMDIAL: The ladies would like a five-minute break.

(BREAK)

MR. KELLY: All right ladies and gentlemen, let me just see if I can get through this part so that we can to through the discussion. These are the types of corals that we found. One, we identified the types of corals. Two, we tried to look at the relationship between corals and algae out there because when you look on a reef seeing a lot of algae is a bad thing.

Now before you look at this one up here let me draw your attention to down here (indicating). A gentleman by the name of Humes back in 1991, when he was doing his work upon the reefs on the North Coast, in Discovery Bay, came up with these figures for what was that time, a good reef, 54% coral cover, 4% algae cover. What that basically means is that if you were looking at this table here, 54% of this table would be covered with coral and 4% would be covered with algae; the remainder will be covered with algae. That is a good balanced reef.

What we have seen, the three locations that we examined, two shallow which is average, and one deep and out at South East Cay it's a total reverse; 93% algae, 7% coral; 98% algae, 2% coral. The good thing is that the deeper reefs tend to be better and this is as a consequence of the fact, that you have things like the Hope River, the Chalky River, the Cane River, the Bull Park River bringing down all sorts of things from the Caneland area. All of that material settling out of the water, is all good for the plants to grow. So you have a reef out there that is under problems but it ain't dead.

PARTICIPANT: I didn't hear you mention the sewer.

MR. KELLY: Oh yes, out by Harbour View. Thank you for bringing that up. That's another important thing.

MR. RICHARDS: You are saying, Mr. Kelly, that at best the reef is alive under the algae?

MR. KELLY: What is happening is that the reef itself is still alive but irrespective of the fact that you have these percentages here you still have coral here, that's one. And two, the structured reef is still here so the fish can still have places to hide and feed and breath.

PARTICIPANT: But the reef needs to be cleaned.

MR. KELLY: It needs to be cleaned and when you remove all of those stresses from that coming in there nature has a nice way of recovering itself. So that's all that is required. Just like how you are saying Kingston Harbour needs to sort out, the moment you get that done, a lot of things start to show up.

PARTICIPANT: Water Commission needs to sort out too.

MR. KELLY: Now in terms of the fish that we saw out there when we looked at the sites when we did our evaluations, on the deep side, these were the types of fish that we basically found. This one here lives up in the water column. We actually saw the school when we were surfacing from time to time. But basically different types of Parrot fish and I use one example here, Turbit, School Master Snapper, Fresh Grunt; all of these were basically around the reef itself including the Spanish Hog fish and this one and these were in the water column. They don't really swim down on the reef itself, they basically tend to swim up in the water columns. In the shallower areas here we found these types of fish and I have highlighted these two (indicating). This one is a Lane Snapper - this is the one they call 'Red Snapper' and your Mutton Snapper. So these two are prized fish or quality fish and then you have these others other types now which like to live in the shallow.

Now, what we also did was that we tried to get an idea of how many numbers of fish we could find over a certain area of the reef. So basically what we did was that we swam a line, 30 metres in length or 30 yards in length and we used a ruler 2 yards in length. So basically the area that we swam was 30 yards by 2 yards or 60 square yards and we counted all of these types of fish that we could have found over that area. So the numbers that you would see here for example, would be 13 of the Surgeon Fish per 100 square yards of sea floor examined. It's a rough way of saying how many fish we will have over the total reef but it can work.

Now, we chose these fish here because these are the ones that tend to eat the grass and the algae that we saw growing there, particularly your Parrot fish. Those are the reef cleaners and these here are basically your quality fish. So what you have is fish that will help in terms of cleaning the reef and fish that are important for the fishing trade, some of the types of fish that are important.

The numbers are low, the numbers are low. There was a general fish study that was done back in 2000 and these are how those numbers come here. Generally speaking, we have a problem with numbers of fish but having said that, we want you to pay attention to this number here and this size here. Snappers, these were Red Snappers. Remember I told you where it was that I found what was apparently a Red Snapper nursery out there, a lot of them out there.

PARTICIPANT: You have Sprat nursery too but they mostly come there seasonal.

MR. KELLY: Seasonally. So the mere fact that we were able to find a lot of young Snappers out there says to us, even though the reef is in not so good condition and even though the fish numbers are not so good you still have some life out there and the next slide I think, should show where we found that. This was where we had done one of the surveys and that was where we found the Red Snappers, young Red Snappers nursery right out there, that's basically right off that side and the burrow area is right here.

So it just goes to show that if you are doing work out there you have to be very, very cognisant of how those works can impact on what is happening there.

Water Quality: NEPA's standard, ten milligrams per litre and just to give you a way of comparing that; one teaspoon of dirt is 250 milligrams and one litre is two box juice boxes of water. So if you pour one teaspoon in a litre of water you still have more than what the NEPA standards speak to. But there is one thing that can be said about this area. Generally speaking, this area here is usually rough and generally speaking, you still have a certain amount of sediment in the water.

For example, up by Caribbean Terrace we took a sample up there, it was 90 milligrams per litre and this is above NEPA's limit and nothing happening out there apart from just nature doing its course. Out by Plum Point, 80. Notice that those numbers decrease as you go out to sea, and that's expected.

This just gives you an example of what the sea front conditions look like. This was a normal windy day; 15 to 20 knot wind round about mid morning when the sea starts to pick up. Notice how far out that line of sediment is here, it's about a hundred metres out and this is natural conditions out there. I say that to say this, the reefs out there are to some extent adapted to this type of condition. So just bear that point in mind.

Visibility: The standards, these are not really NEPA's standards but Scientists who study corals say that reefs like waters in which the visibility – sorry, this should not be 'lesser', it should be 'greater than', greater than 4 metres and you measure that with this device here, it's called a Secchi Disc. Basically, what you do, you stay on the boat and you lower the Secchi Disc, and you measure the distance how deep it goes until you can't see it any more. If you can see that thing greater than 4 metres down, it's clear water; less, dirty water. So if you are getting less than 4 metres visibility it means that the water has a lot of dirt in it. Right along the shore line you were getting less than half a metre visibility, and that's expected. Out at Southeast Cay, 7 metres. Out at the deep side, on that very clear day that we were out there we were seeing the bottom at 16 metres. We were really contemplating whether or not we should actually dive because we were seeing everything going on in the reef. But this is on a very clear day.

So we got an idea of what we saw on the seaside; we know that there is reef out there; we know that the reef is in not so good condition but it's still alive; we know that there is fish out there; the numbers are not so great but there is reason to believe that there is a vibrant nursery out there.

On the **land side**: What we did was that we examined everything that was on the big seaside on the waterline back to the roadway. Basically looked at examples of what we could find from Caribbean Terrace here back down towards Plumb Point side.

To show you it from the beach perspective, we basically looked at what was existing from the roadway which was about here and you had three types of vegetation basically. You had the thorny types, the acacia, some cactus, those are thorns. You had Dune vegetation which basically grew on the mountains of sand that is out there – they are very important as a means of holding the sand together. And then you had beach vegetation which as you can see here would have been removed because of the storm. These just represent some of the examples of the plants that we found out there. I apologize because a number of them I forgot to name and to tell you the honest truth, I don’t quite remember their names right now.

Notice, **beach vegetation cover**: These are the types of vegetation that you find towards the beach side; these are the types that you would find on the dune sides and; these are the types that you would find closer towards the roadway side. All of them are important. This one here in particular, is endemic. Meaning, you only find it at a particular location; along the South coast on sandy areas just like out at Palisadoes. So the mere fact that you have a plant here that is only found along the Southeast coast of Jamaica means that there is something important out there. But let’s look at the flip side now. I showed you the types of plants that we found out there. These three illustrations show you how the coverage of that vegetation has changed over time. The top one was taken from a 1961 report, this was ten years after Hurricane Charlie.

We estimated that the total area of vegetation represented by the green, was 7 hectares. That's approximately 14 acres of vegetation, all types; dune, beach and thorn.

2003, fifteen years after Gilbert, approximately 8 hectares. Apparently over the period 1961 to 2003 there was an increase. Two years after Hurricane Ivan, it drops down to 4 hectares and a lot of that was as a consequence of the fact that it was either buried by sand or scraped up and thrown across the other side by the waves.

And this just illustrate that fact. Here is the landfill area in 2002, we took this one from an aircraft and if you notice that area here, that is vegetation of various densities here. All of this area here was covered with vegetation.

Flip up 2007, notice the difference? All barren, all sand. Next set of waves that come through there will just basically take that sand and chuck it away. Now, notice the red, Hurricane Dean. You think that you just had 4.1 waste hectares out there, go check it now. Hurricane Dean had removed even more.

So the long and short of it is that you can hardly have anything out there right now and that is significant in two ways. One, you don't have anything there that you can put stuff on top of it, you still have stuff that needs to be factored in. But the more important thing is that there is no sand there to hold anything so the next system that comes through this area is very vulnerable to that.

Fisheries Usage: And I am going to put some figures up, you can comment on it and tell me whether or not they are reflective, I got them from Fisheries Division.

When we looked at the data and when I spoke to a couple of your counterparts – we basically divided the area into three and like I said, you guys can correct if I am wrong.

Shipwreck, which was basically out there; Lighthouse, Windward Edge. Since talking with a couple of you I have gotten a couple other names still and I would like to put those in there so I can make this more comprehensive, but generally speaking, Shipwreck basically covers all of this area here that is near to the coast. Lighthouse right here and the deeper areas here now basically are regarded as Windward Edge.

Now according to the Fisheries Division, there are representatives from one, two, three, four, five fishing beaches that actually frequent this area; that may or may not necessarily be accurate right now, you can guide me where that is concerned. But they estimate that a total of 140 fishers utilise this area here (indicating) on a regular basis. That's a total of about 79 boats working out there. And of the catch that is obtained out there, these are some of the important ones. I would like to add Sprat to that. The Parrot, Mutton Snapper and the Red Snapper.

Estimated Catch per day from each Boat: Is 2 kilogrammes, 2x2.2, about 5 pounds. Is that accurate?

PARTICIPANT: An estimate a catch, on average.

MR. KELLY: **Estimated value**: And I am sorry, I don't remember the date for this, this might not be correct. But at the time, the estimated value of the catch was nearly a thousand dollars.

Estimated number of fishing days per year: One hundred and eighty as a consequence of the fact that sea might be rough and so.

And total Average Value of the Catch per Year: Is approximately $20,000,000.00. So what that says to me is that on a yearly basis on average this area here generates approximately $20,000,000.00. I don't know about anybody now from a society's point of view but I am talking in my view. This a reason for us to be concerned about how these works would affect this earning capacity here because this is not only buying back fuel and boat, this is also to send the kids to school.

So having gone through all of those points I am going to very quickly go through possible impacts and mitigation. And note, I summarise them here, we will go into more details in the document itself .

Now, this company who Chris Burgess represents, CEAC Solutions Limited or CEAC Limited.

PARTICIPANT: It's not an abbreviation?

MR. KELLY: It is. They predicted that if there was a break in the dike that they would pump the sand into then there could be sedimentation in excess of the NEPA limits right alongside the shore. If you recall from the presentation that Mr. Burgess did you would have seen where those points would have extended to, and you will now understand why it was that I asked him 'how wide that area would be?' Because if you have this happening then it is very likely that at points where it is close to where the reefs are you could have some impacts on it.

Now the **mitigation** that we have proposed and I will harp on this one here. The dike, upon the dike, that thing that the sand could be pumped into, a lot of attention will have to be placed on (a) getting that construction right, (b) ensuring that it is properly maintained and ©, ensuring that you don't put too much into it to cause it to overflow because if you don't get that right you are going to have materials coming out into the sea.

So there is going to have to be a very clear understanding between ourselves which would be the agencies; the user groups and the contractors as to how much they can put in and over what period of time because you really don't want to go there one day and see water just pouring over the sides of the fishing bay. I have seen some pictures of this type of work done and it can be very tidy and it can be very messy.

So persons are going to have to be cognisant of the fact that yes, we have deadlines to meet but if it means slowing down a bit and extending your time a little bit and somebody having to pay a little bit more, a little extra, then you would have the benefits coming out.

Mr. Burgess also outlined this possibility here using flip curves, this is our dooms as you might want to call them, to act as an additional buffer but you must also bear in mind that they might not function well in rough seas and you have to maintain them. And to add to that, monitor for water quality parameters, basically suspended solids. This would be the NEPA's limit, we want it to be less than that.

Visibility using the Secchi Disc, we want greater than this and another one which I didn't discuss before, **settling** which is basically how much sediment settled on the bottom over a period of time. Corals don't do very well if you have more than this over a day settling on top of them. But it all depends on the type of corals and I will tell you that those out there are hardy and are adapted to having some amount of sediment point, you don't want to be too much.

So I harp on this. I put this back here just to remind us of the fact that this part has to be done right: it has to be the right size, it has to be the right length, it has to be designed so that you can adequately accommodate a day's work of

material being placed into it and if you don’t get that part right you are going to have that messed up.

This just gives you an example for those of you who don’t quite know what a boom looks like, this is a very small one but it’s basically divided into two components. We have a float which is despatched outside the water here and a curtain which extends down to the bottom and you have some sort of weight to hold it in. So if you had sediment coming here then it would not get beyond here. When the sea conditions are rough this can flip up, this can drop over, the waves can throw them over, all sorts of things can happen. But it’s an additional buffer.

Now remember I said that the reefs out there may already have some sort of tolerance for the high sediment conditions. This might be familiar to a lot of you. This was the Leonardo DaVinci, cutting out by RADA and Steve Phang back in 2002. I spent a total of 12 days out here and prior to them doing this work here, the Port Authority was required to remove a lot of the corals like the ones that we saw on the slide before, from this location here and those were relocated along this side here. (Demonstrating)

Now when monitoring was done here they found turf, suspended solid levels in excess of the NEPA standard right off to about 110 milligrams per litre and more. But what was found is that, the amount of settling that we were getting here and you can see that the currents were moving along here passed this, this is a sediment plume. The unfortunate thing about this one is that it didn't go to the bottom. But the amount of settling that you were getting here was not of such that it would have caused a problem out there. That's one thing.

Two, under normal circumstances, we do have a lot of sediments being churned out by the waves out there. An important thing to note, this is going on now, you stop this work, leave it for a while, in 12 hours this had cleared to a point where they could actually drop in a little Secchi Disc down and get it down.

So like I said, people are going to have to recognise that if they come close to the limits and stop a little bit, allow the conditions to settle back down, then you can start again and if you slow up, continue to check.

Third thing that needs to be looked at, the fact that you have one, two, three, four rivers – this is two joined into one which ends just east of the Palisadoes area. And the other day when we had the two weeks rain, I think it was about two weeks straight, studies have shown that this particular river here, the Hope River can dump over 8,000 tones of material into here over a 30-hour period. One dredge carries up to 2000 cubic metres, on a day's transport about 10,000.

So there is a certain amount of tolerance but the only thing is that, the dredge is going to be working for not two days, not three days but 110 days. So a lot of attention would have to be placed on trying to ensure that you are monitoring it and if there are problems, slowing down, getting it right, starting again.

Another impact, Beach and Dune Vegetation, currently existing at the cite at which the dune is to be created will be impacted by berm, meaning the sand that you are going to use to create the dune will cover what is there now. This would mean that a significant percentage of this area of dune that remained after Hurricane Ivan will be lost. Note, Hurricane Dean came afterwards, so this amount is less but still there will be an impact.

Here is one of the areas in which we would like to involve the University of the West Indies. They are trying to do some work out there now, they are trying to understand how the new vegetation grows, whether or not they can take seedlings, put them in a nursery, grow them and then plant them from there. I spoke with the then Dean of the Life Sciences, Dr. Webber, and asked him whether or not he would be – I am being previous, but asked him whether or not this could have been a viable option and if they would want to be a part of that process by designing this and he said 'yes', on both accounts.

So prior to actually doing the works out there we will select examples of the plants that are out there, keep them in a protected environment and once the construction work is done, start a process of replanting. Because the truth is, it's important to do this. You put the sand there and the winds start to take its toll again. So over a period of time you would start the process of redoing it. It's going to take some time but I think if you give it a jump start it would help you to go a little faster. So this is going to be a very important mitigation.

Fisheries: In fact, the greatest concern would be the negative impacts that could occur due to the export of a prime nursery for adult fishing areas, the sedimentation from dredge squall being disposed upon the shorelines. Also, dredging and reclamation activities could interfere with the movement of fishers to and from the fishing ground. What I mean by the last point now is that, there is a ship that is going to be out there, there is a pipeline that is going to be running on the surface from the ship to shore and your boats might normally walk between one point to another point.

So you have one problem with – say for instance, the dike breaking and sediments coming down killing off the fish and you are not able to catch it. There is the other issue, the dredge working in a particular area preventing you from moving from one point to another.

Mitigation for that. These are the same as the mitigation for the sedimentation because both of them relate to one another. You can control the sedimentation you can preserve it, that's the view point that EIA is putting forward. So these conditions here are the same as the conditions that we saw before.

In order to be aware that ship is going to be working where the pipe is going to be laid, which is also important, you guys are going to know this. Well, if you know that dredge is working in this location here you can plan your movements so that you don't have to go in and around it particularly at night time. I know a lot of you do night fishing out there.

I need your comments on this particular point because I am aware that there are seasons for fishing out there particularly for your Snapper and our opinion is that Works need to look at that and tell me if these are right or wrong. I think the seasons are December, January, August to October for some of the Snappers and I don't know if I am right. But whatever the seasons are it would be probably best to not have dredging going in a time when you guys would be really wanting to try to get the catching going.

So if we can understand the different types of fish that you catch out there and the seasons in which these things go on then we can try to plan around when it is that the dredging is going to take place. So I heard Mr. Ram speaking about possibilities for starting but he didn't quite say that that was another part of the consideration too.

The study doesn't speak to a need to be knowledgeable of when the fishing seasons are and try to plan around that. So hence, this need for discussion between ourselves and the fishers.

So if these are rightful examples, the best time is to do work from January to October but I am leaving that open because I don't have all the facts.

PARTICIPANT: The Snapper season is from June to August and I don't think that could be proper for the sea in the weather time. The sea and the weather don't work, the sea stirs up and the weather going hamper the work is on the Caribbean side. So it wouldn't be appropriate to do the work in June, July or August.

Now sprat season: We have sprat season from about August now so call it from about December/January to say April/March, said way. The most appropriate time when you would have more calm weather is say September, at the end of September/October back to December. You have a more calm weather when you have the winter because through the weather going come from the north you find that the peninsular break the – the wind comes from north so the peninsular shelters the southside, the Caribbean side so it would be the best time to work because the sea more calm.

PARTICIPANT: The peninsular would break the wind.

PARTICIPANT #1: September/October would be the best time to work because the sea is more calm. You could have weather just spring up suddenly still but it would be a more appropriate time; the calmer weather would be in and around that time.

MR. KELLY: Like I said it is important for us to understand from your perspective when is the best time.

PARTICIPANT #1: In other words, it is more calm weather. It is more appropriate to fix it in the calmer weather.

MR. KELLY: One of the important points from the seismic survey work that was done on the Pedro Banks, the Fishers' Compensation mechanism was developed when it was a fairly extensive consultation process led to a document being prepared. I am suggesting that since that process has been done and we kind of understand how to do it then we could take the opportunity at looking at developing a similar one for the dredging operation here just so that if in the event that there is an issue then there is a framework within which a fisherman can come forward, make a claim and the claim can be vetted, and if it seems sound can get some form of compensation.

Construction work offshore would be curtailing the availability of that location for recreational activities during the periods of construction: People won't be able to do their job, they won't be able to do their recreational fishing, people won't be able to just drive out there and do what they normally do out on the dunes. It is an accepted part of the construction and as the next slide will basically show we just have to ensure that people know when things are happening. And I don't think that construction is going to be happening along the entire dune at the same time, but if they know that construction is happening down like say Plumb Point side now then you don't go down to Plumb Point but you basically come up here back and vice versa.

The positive for that is that once those dunes are done and once they are properly vegetated and if you get the management framework in there and we start setting up other things like trails and so on that is going to be a big selling point for the Kingston Harbour.

Some quick positives: Proposed works would not only result in the re-stabilization of the area but will also create a new substrate for the re-growth of dune vegetation at the site which is important for the stability of the dunes and it is important for recreation, aesthetics and protection of the roads.

It is unlikely that there will be any negative impacts on the burrow area itself because really and truly you don't want to have anything living on the burrow, it is all sand.

It's unlikely that the deep reefs like out at Windward Edge and the Palisadoes area are going to be affected by this because of the location and because of how the currents go.

Now **monitoring**: We need to monitor for the coral and fish populations that are out there using the references that were established in the report. So that if you know that coral cover is ‘x’, that is your baseline. If you see any changes we want to be able to determine if those changes are as a consequence of the dredging or other things.

And this is probably the most important one, monitor the amount of suspended solids in the water and how visible the water is. Use what we have as the baseline, if you see any changes then you can determine whether or not that is as a result of, or say weather the dredging activities and so. And tracking of the plumes from the air. It’s amazing how you can see those things moving from the air. You can use that as a means of determining what areas are dumped current from that, what could be at risk or if there is indeed at risk, if you see a plume moving in this direction you can always direct a man in a boat to take a sample there and validate where the bottom of model is true.

Fisheries monitoring: meaning catch and otherwise, I would presume that the government body that has responsibility for that is Fisheries Division. They need to establish some sort of a monitoring framework with which would ensure that your livelihoods are being preserved. We are going to try to do our part with the remaining components of EIA. I think the Fisheries Division has specialization to deal with your specific needs along with the Coop.

That is for the presentation, I don't know if you have any questions or comments. Bear in mind, ladies and gentlemen, that this is the start of the process. I anticipate that once we start circulating information around you can look through it. I am hoping that you will point out areas if there are any gaps or if there is any information that you have which is additional to that which can help us to further fine tune our decisions, bring that forward, we can do the up dates. Note that the meeting is being recorded; this will form a part of the EIA document to be submitted as an addendum so that we can say this is one of several meetings that were held; these were the comments that were obtained, you need to take this document into consideration.

So I will shut up at this point in time. Any questions, comments? If not, I turn it over to Mr. Ram.

CHAIRMAN: Well, that brings us to the end of our formal presentation of the project. I would like to thank you all for attending and participating in the meeting and we will try to get out to you those documents that you have requested as early as next week. Some of them are in colour and it's kind of difficult sometimes to get the colour prints but if you have an e-mail we can e-mail it to you and we can get hard copies also to you next week. So that's it.

PARTICIPANT: We can't get it on a disc?

MR. RAM: Yes, CD. And we have lunch over there.

(OFF THE RECORD DISCUSSION)

MR. KELLY: One final comment. Mr. Ram, if you could liaise to try and see if we can plan out how to do the presentations at the local level.

MARK: So no question and answer?

PARTICIPANT #2: Everything is clear.

PARTICIPANT: Yes, it is the first of several meetings.

MR. KELLY: But just bear in mind that I for one say I don't think I have covered all of the information, when we get the information out to you please look through it, take your time and go through it. Any bits of information that you think are relevant to it, that's not in there, feel free to put it together and send it to us. If you think there is a particularly important area, location 'x' because of 'y'. Like for example, my friend here said that the seasons for one thing is here, seasons for one thing is there, say it because it all goes into the overall plan.

PARTICIPANT #3: But what you also need to look at is – I am sorry that a representative from Fisheries is not here – the actual amount, let's say a figure as to the amount of fishers who utilise that area.

MR. KELLY: Fishers themselves...

PARTICIPANT #4: ...who utilise that area.

MR. KELLY: I have figures but I would really like to have those confirmed between yourself and Fisheries Division.

PARTICIPANT #4: Because you have fishers coming as far as Hellshire and they will utilise that particular area. So if you could get a first hand figure as to how much...

MR. KELLY: Another thing I would like to know is the number who goes out in the day and the number that goes out in the night.

PARTICIPANT #4: You know that you have persons who Fisheries don't have no record of them? You know that you have some young men who use the tube?

MR. KELLY: Yes, the tube from Bull Bay side.

PARTICIPANT #4: Right, and swim go out there on the tube daily and sometimes you surprise to see the amount of fish they catch out there on the tube. And do you know that it is a lobster area?

MR. KELLY: Yes, I know that it is a lobster area but I didn't have any information on the lobster.

PARTICIPANT #5: I see you identified a nursery area where you saw a lot of Snappers and so forth but it's close to the dredging area. If there should be a problem within that area that affects the nursery and other reefs coming down the south coast, is there any plan in place to restore that area, is there anything in place?

MR. KELLY: Here is my take on it. If you have a problem which results in the total dredging of that area it is going to be impossible for you to bring it back so I would prefer that you put the thing in place to prevent that from happening. So ensuring that you have enough capacity on land to take a days worth of material; ensuring that you monitor the water quality so that you can see whether or not the levels are changing; ensuring that we have the right sort of contacts with the contractors so we can say to them, “this is it, you need to slow down a bit because things kind of picking up at this point”. And we also need to have the ability to say to them at some point, “listen, we need to take a two-day break”.

(ADJOURNMENT TAKEN AT 1:30 P.M.)

Appendix 5

c. Questionnaire on Public Awareness

Palisadoes Protection and Rehabilitation Project

Public Awareness Questionnaire

1. Were you aware of the planned development before this presentation?

   Yes ☐ No ☐

2. If yes to 1, how did you learn of the project
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3. Having learnt about the project, are you?

   Strongly in favour ☐

   In favour ☐

   Neither in favour or against ☐

   Against ☐

   Strongly against ☐

4. Do you know when the proposed project will start

   Yes ☐ No ☐

5. Do you look forward to this?

   Yes ☐ No ☐

6. Do you use the site for any activity?

   Yes ☐ No ☐

7. If yes to 6, what do you use the site for?

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8. Will the development have any impact on your livelihood?

Yes ☐ No ☐

9. If yes to 8, what are these impacts?

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10. What do you think are some of the benefits of the project?

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11. Will the project affect the environment?

Yes ☐ No ☐

12. If yes to 11, what are the effects foreseen?

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13. Are there any natural resources in the development area?

Yes ☐ No ☐

14. If yes to 13, what are these?

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Appendix 6

Terms of Reference agreed with the National Environment and Planning Agency

TERMS OF REFERENCE

COASTAL MODIFICATION IN CONNECTION WITH PALISADOES PROTECTION AND REHABILITATION STUDY.

Notes

This generic Terms of Reference (TOR) is applicable to the Coastal Modification works proposed for the rehabilitation of the Palisadoes peninsular. The TOR outlines the aspects of an Environmental Impact Statement (EIS) which when thoroughly addressed will provide a comprehensive evaluation of the site, in terms of predicted environmental impacts, needed mitigation strategies, potentially viable alternatives to the proposed development and all related legislation.

This project site encompasses a coastal area which is located within a listed protected area. Issues such as coastline stability, coral reef, mangrove and wetland, seagrass impacts, and impact on coastal commercial fishing should be examined. The impact of the development on the specific sensitivities of the protected area should be highlighted. Mitigation of impacts should assess if the post mitigation status would be acceptable in the protected area context. Alternative sites should be rigorously evaluated

Terms of Reference

The Environmental Impact Assessment should:

1) Provide a complete description of the existing area proposed for modification. Detail the elements of the project, highlighting areas to be modified and the areas which are to be preserved in their existing state.
2) Identify the major environmental issues of concern through the presentation of baseline data. Assess public perception of the proposed development.
3) Predict the likely impacts of the development on the described environment, including direct, indirect and cumulative impacts, and indicate their relative importance to the design of the development's facilities.
5) Identify mitigation action to be taken to minimise adverse impacts and quantify associated costs.
6) Design a Monitoring Plan which should ensure that the mitigation plan is adhered to.

To ensure that a thorough Environmental Impact Statement is produced, it is expected that the following tasks be undertaken:

Task #1. Description of the Project

Provide a comprehensive description of the project, noting areas to be modified, areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment. This should involve the use of maps, site plans, aerial photographs and other graphic aids and images, as appropriate, and include information on location, general layout and size, as well as detailed pre-, and post project plans. For projects to be done on a phased basis it is expected that all phases be clearly defined, the relevant time schedules provided and phased maps, diagrams and appropriate visual aids be included. This should involve the use of maps, site plans and other graphic aids, as appropriate, and include information on location, general layout and size,.

Task #2. Description of the Environment

This task involves the generation of baseline data which is used to describe the study area as follows:

- i) physical environment
- ii) biological environment

It is expected that methodologies employed to obtain baseline and other data be clearly detailed.

Baseline data should include:

(A) Physical

- i) A detailed description of the existing **Physical Oceanography** to include a general description of the seafloor and its physiographic features with detailed description of the waves, tides, currents affecting the project area. Any shoreline stability and erosion issues that could arise should be thoroughly explored.
- ii) A basic description of the existing ambient **Water quality** of the coastal waters in the vicinity of the project area. Quality Indicators should include but not necessarily be limited to salinity, dissolved oxygen, Biological Oxygen Demand (BOD), temperature, nutrients, and total suspended solids.
- iii) Climatic conditions in the area of influence, including, wind speed and direction, precipitation, relative humidity and ambient temperatures,

(B) Biological

Present a detailed description of the flora and fauna (terrestrial and aquatic) of the area, with special emphasis on rare, endemic, protected or endangered species. Migratory species should also be considered. Special attention should be paid to any coral reefs and seagrass beds, commercial and /or ecologically important species, breeding and foraging grounds and environmentally sensitive areas. The EIS report should include a basic description of the benthic biodiversity and vegetative cover of the coastal dunes within the project area.

(C) Natural Hazard Risk Assessment

A description on the historic occurrence of natural disasters such as hurricanes, earthquakes, coastal inundations such as storm surges and local and regional tsunamis must be presented. The description should include an analysis of the magnitude and frequency of these events and the likely effects on the project area.

(D) Public Perception

A statement on the general public perception of the project must be included in the EIS document.

Task #3 - Identification of Potential Impacts

Identify the major environmental and public health issues of concern and indicate their relative importance to the design project. Identify potential impacts as they relate to, (but are not restricted by) the following:

- flooding potential
- landscape impacts of excavation and construction
- loss of natural features, habitats and species by modification
- Impact on coastal stability
- pollution of coastal waters
- impact of dredging and excavation and spoil disposal
- impact of spoil plumes generated by dredging
- Air pollution from dust emissions
- risk assessment

- noise
- coral reef smothering, proliferation of macro algal species and loss of sea grass beds.

Distinguish between significant positive and negative impacts, direct and indirect, long term and immediate impacts. Identify avoidable as well as irreversible impacts. Characterise the extent and quality of the available data, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should be represented in matrix form with separate matrices for pre and post mitigation scenarios.

Task #4 Mitigation

Prepare guidelines for avoiding, as far as possible, any adverse impacts due to proposed usage of the site and utilising of existing environmental attributes for optimum development. Quantify and assign financial and economic values to mitigating methods.

Task #5 - Monitoring

Design a plan to monitor implementation of mitigatory or compensatory measures and project impacts during and post development.

An outline monitoring programme should be included in the EIS, and a detailed version submitted to NEPA for approval after the granting of the permit and prior to the commencement of the development. At the minimum the monitoring programme and report should include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit license(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored and should incorporate a control site where no impact from the development is expected.
- Frequency of reporting to NEPA

The Monitoring report should also include, at minimum:

- Raw data collected. Tables and graphs are to be used where appropriate
- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
- Recommendations
- Appendices of data and photographs if necessary.

All Findings must be presented in the **EIS report** as well as references. Eight hard copies and an electronic copy of the report should be submitted. The report should include an appendix with items such as maps, site plans, the study team, photographs, and other relevant information.