JULY
2007

ENVIRONMENTAL IMPACT ASSESSMENT

TREASURES OF TRELAWNY RESORT DEVELOPMENT

[Prepared for Treasures of Trelawny]

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EXECUTIVE SUMMARY

1 Executive Summary

1.1 Introduction

Treasures of Trelawny proposes to establish a five star resort complex at Duncan Bay, Trelawny on Jamaica's internationally famous tourist resort on its Northern Coast. The highly attractive Development, which will enjoy excellent and modern physical infrastructure, is designed to incorporate and make best use of the outstanding and aesthetically pleasing natural attributes of the area.

Natural illumination, ventilation and topography have been integrally designed into the project. This also takes into account natural hazard risks such as hurricanes and wave action and the need for natural resource conservation.

The proposed project has been designed with a number of amenities to attract and meet user needs for land based, coastal and marine activities.

As a result of falling into the National Environment and Planning Agency (NEPA's) prescribed categories of projects requiring Environmental Impact Assessments (EIAs), NEPA directed that an EIA be done in keeping with the Natural Resources Conservation Authority (NRCA) Act of 1991. This EIA Report documents the studies and processes involved in conducting the EIA and the findings of the assessment.

1.2 Project Objective and Concept

The objective of the project is to establish a five star resort complex on 2 hectares (five acres) of land at Duncan's Bay, Trelawny. It is planned to construct Fifty two (52) units containing 112 bedrooms. The units will be built in four (4) six (6) storey blocks.

Treated potable water demand of 454 litres per person per day (100 gallons/person/day), will be supplied by the upgraded Hague water supply scheme. Electricity will be supplied from the National grid. The recently completed Highway 2000 is the main arterial road, contiguous to the property.

The property is located ½ hour away from the recently modernized Sir Donald Sangster International Airport, located in Montego Bay.

Water from the upgraded Hague water supply system will be supplemented by stored rain water and grey water from a tertiary treated sewage system.

The development will also involve the following features:

- A tertiary sewage treatment facility will be installed. Grey water from the facility will be stored and recycled.
- Rain water will be harvested and stored
- The aesthetics of the property will be enhanced through landscaping and roof gardens.
- Low water use toilets will be installed
- Opportunities for maximizing energy efficiency are designed into the project.

Some of the amenities featured in the project are as follows:

- Beach games
- Boating
- Equipment storage
- Restaurant
- Bar and snack bar
- Spa
- Games rooms
- Exercise rooms
- Swimming pool
- Whirlpool spas
- Tennis courts and
- Pool cabanas.

The proposed project is located in the area of some of the finest tourist resort complexes and facilities on Jamaica's North Coast.

1.3 Approach & Methodology

Standard and creative approaches and methods were used by a highly qualified and experienced project development team working in collaboration with the environmental assessment team. The approaches and methods involved a combination of desk, literature and field studies, meetings and investigations, leading to analysis, assessment and preparation of the EIA report.

On receipt of NEPAs approval of the TOR, some of the studies undertaken were as follows:

- Review of the plans and designs
- Analysis of alternatives
- Bio-physical surveys (terrestrial and marine)
- Socio-economic surveys
- Baseline studies on water quality, noise and dust
- Natural hazard vulnerability and assessment
- Review of the regulatory framework
- Impact identification

Impact mitigation

- Identification of the parameters for and outline of an environmental monitoring plan

1.4 Regulatory Framework

The relevant policies and legislation identified and analyzed were as follows:

- Agenda 21
- The NRCA Act of 1991
- The Beach Control Act of 1956
- The Watershed Protection Act of 1945
- The Water Resources Act, 1995
- The Underground Water Control Act of 1959
- The Town and Country Planning Act of 1987
- The Jamaica National Heritage Trust Act 1985
- The Public Health Act, 1974

1.5 Impact Identification

The major potential negative impacts identified were as follows:

- Change in land use
- Loss of vegetation
- Change in the run-off regime
- Sediment transport and pollution of coastal water resources during construction
- Fugitive dust formation and dispersion during construction

The major positive potential impacts are:

- ✓ Substantial foreign direct investment
- ✓ Demand for local goods and services during construction and operations
- ✓ Job creation during construction and operation
- ✓ Foreign exchange earnings
- ✓ Improved run-off water control and coastal resources conservation

1.5.1 *Impact Mitigation*

Standard methods will be used to mitigate the potential negative impacts. These include:

- ✓ Creative conservation of flora, landscaping and establishment of roof gardens to offset loss of vegetation
- ✓ Irrigation for dust control during construction
- ✓ Creation of drains for surface water control
- ✓ Maintenance of construction vehicles for noise control
- ✓ Regulated blasting

1.6 Environmental Monitoring Plan

The critical parameters for environmental monitoring to ensure that the project complies with the regulatory framework and the impact mitigation actions have been outlined. These will be further developed for strict implementation, in the event that the project is permitted by NEPA.

1.7 Conclusions

The project has carefully integrated the features of the natural environment in the excellent, complementary, non-conflicting baseline and setting of the area, to enhance the development, conserve on natural resources and protect the environment. In so doing it has ensured sustainability and protects the investment.

1.7.1 *Recommendations*

Given the baseline and setting of the area, the care with which the project has been designed, its emphasis on resource conservation and environmental protection, the few relatively minor potential impacts (which can be readily mitigated) and the number of substantial major positive impacts, we recommend that the project be permitted for implementation.

PROJECT DESCRIPTION

2 Project Description

2.1 Introduction

Treasures of Trelawny Limited proposes to develop a resort in Jamaica at Duncan Bay, Trelawny. Duncan Bay covers an area of 303 ha (750 acres) with three miles of pristine oceanfront land.

The proposed site for the development is Lot 1A, part of Silver Sands, part of Duncan Bay formerly known as Johnson Pen in the Parish of Trelawny. This being part of the land comprised in Certificate of Title registered Volume 539 Folio 16. The location of the proposed development enjoys access by road, as well as a Bay area with infrastructural utilities and social services to support the project, including electricity, water supply and a beach. The development is located on the north coast, approximately 2.4 km (1.5 miles) north of the town centre of Duncans. Plate 2-1 below shows the regional setting of the proposed resort development. The recently constructed North Coast Highway provides access to and from Montego Bay, the Sangster International Airport and other resorts locations of the North Coast – Runaway Bay, Ocho Rios and Negril.

The two hectare (5 acres) site occupies part of a headland known as Duncan Cliff overlooking the sea at Duncan Bay, Trelawny. Between the headland and the shore line, part of this site is occupied by a small pond or salina. Directly adjacent and East of the site is a low- lying area which is the seaward edge of a drainage basin within which this site exists. This section of the report describes the concepts and design criteria to be employed in the design of roads and drainage, water supply and sewerage treatment and disposal systems. The property can be characterised as being fairly rectangular in shape and includes a relatively long strip of coastline beachfront which abuts the Caribbean Sea.

The vegetation on the proposed site is typical and consistent with the types of vegetation found along the North Coast. The distinction being the inclusion of a relatively small mangrove stands on the north-eastern quadrant of the property. This aspect will be discussed in detail in Section 5.

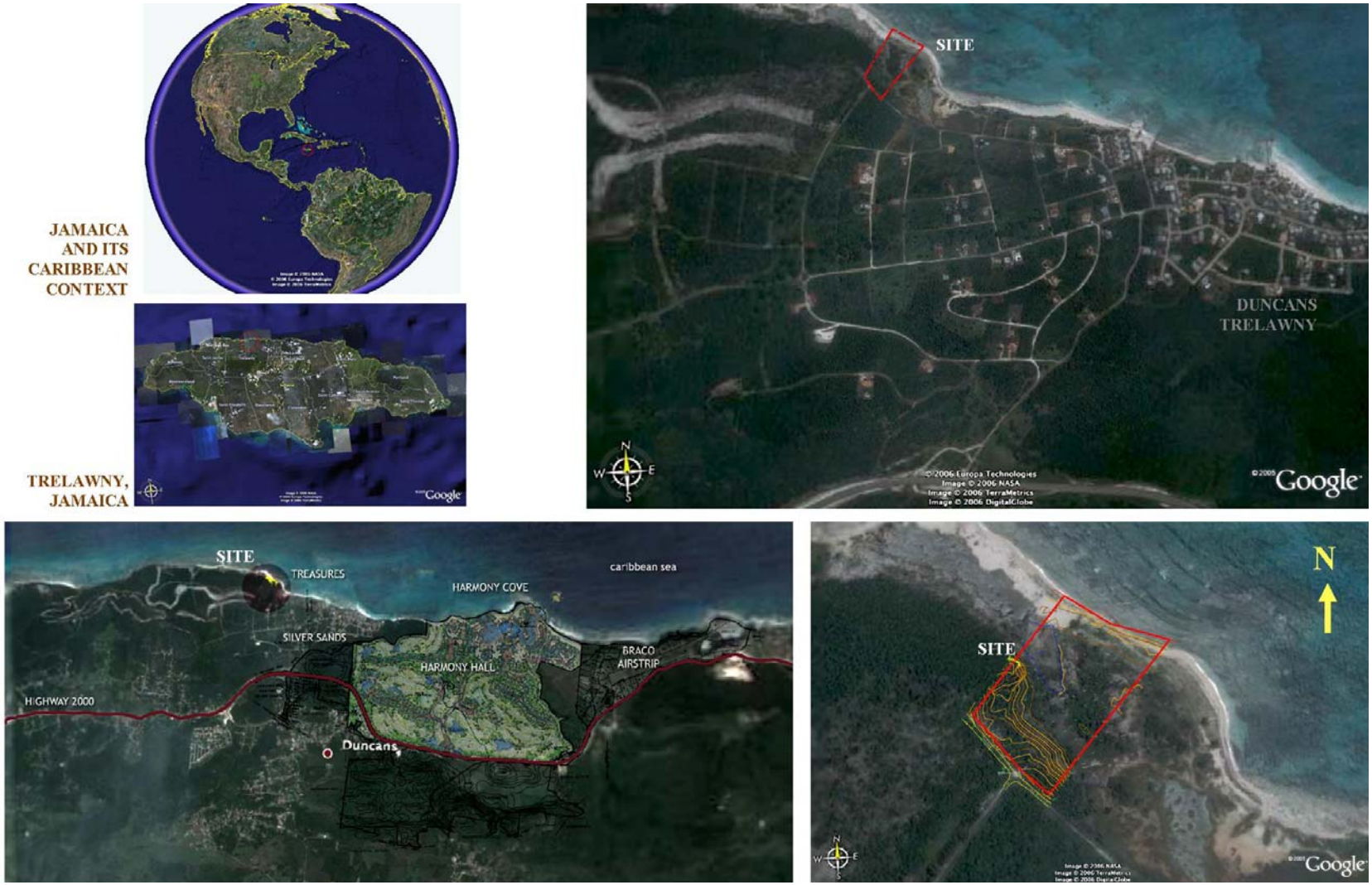
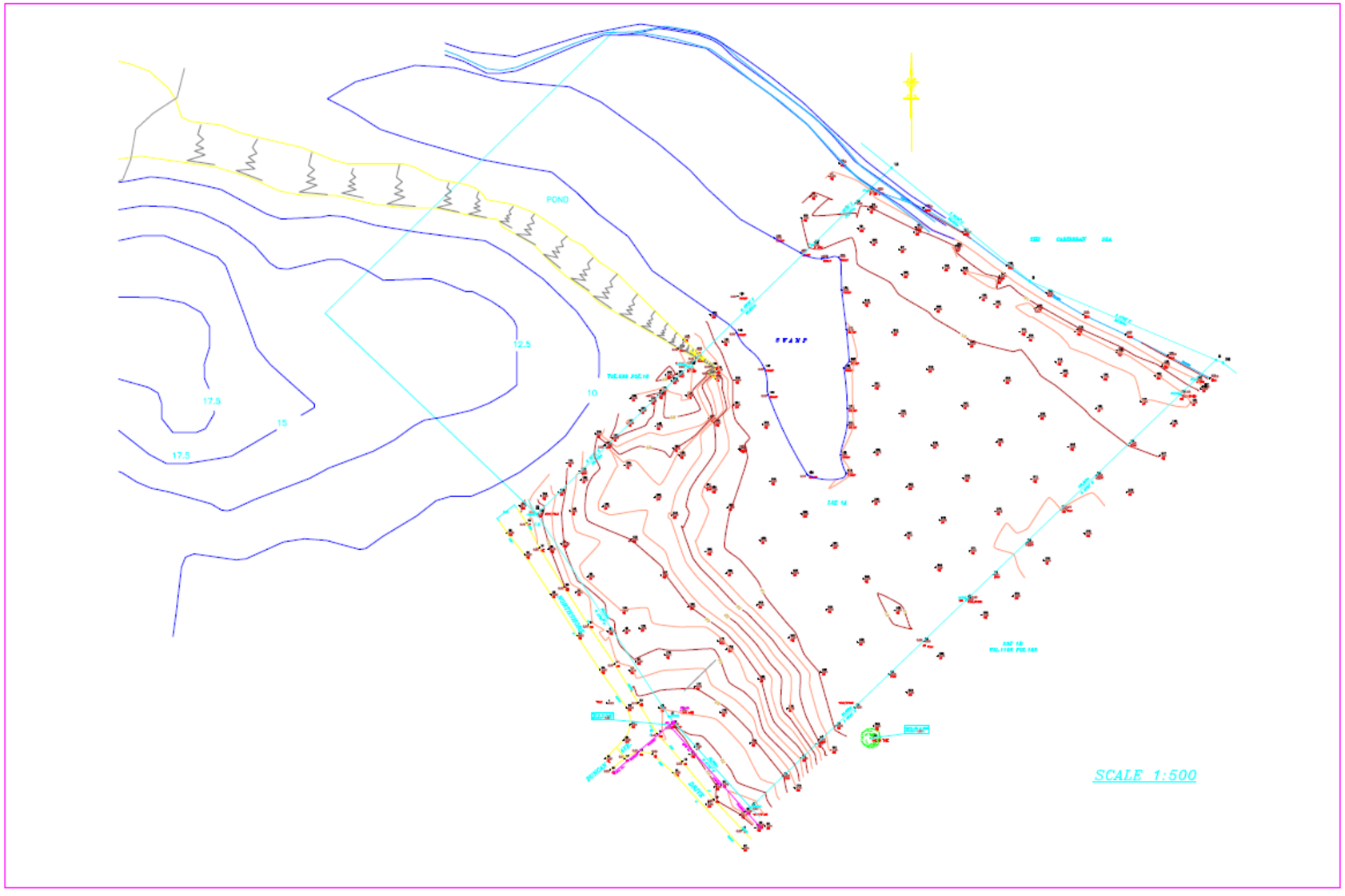


Plate 2-1: Site Location Overview



NOTES	NOTES	DATE	MK	BY	AMENDMENTS AND ISSUES	DATE	MK	BY	AMENDMENTS AND ISSUES	CLIENT	PROJECT
1. DO NOT SCALE SYMBOLS 2. REPORT DISCREPANCIES IF ANY TO THE ENGINEER										CONSULTANT ADeB CONSULTANTS P.O. BOX 92, KINGSTON 10, JAMAICA	TREASURES OF TRELAWNY SUBPROJECT TITLE TOPO PLAN DESIGNED G.L.S DRAWN CHECKED APPROVED DATE OCT. 2006 SCALE DRWG No. J-2157

Figure 2-1: Topography Plan

Figure 2-2: Architectural layout of Proposed Development

2.2 Site Description and Layout

2.2.1 *Drainage Basin*

This site is part of a drainage basin which is approximately 770 hectares in area with a main trunk of approximately 4.0 km. and elevations from sea level to +229m. The basin extends south-ward to the community of Kettering and past the new highway to include the town of Duncans and Windsor up to the ridge line at Samuels Prospect and Spicy Hill.

The Montpelier limestone geology predominates within this drainage basin. This rock is normally of low permeability, producing high run off. The area of the site is, however, characterised by coastal limestone formation. This is a hard, re-crystallised, evenly bedded limestone with many joints and fractures, resulting in high permeability and hence lower run off potential. The result of the presence of the coastal limestone is that much of the overland flows are swiftly diverted into the ground water and overland flows to sea are minimised.

2.2.2 *Site Run-off*

The elevated areas of the site (headlands) are unaffected by any flows within the drainage basin within which the site is located. Access must be provided however for such overland flows that will accumulate on the low-lying area to the East to allow access for this drainage into the salina area.

Stormwater flows will originate from the site itself and these will be based on a 25 year return period for rainfall. Resulting flows will be routed into the salina/mangrove area.

2.2.3 *Design Criteria*

Based on the maximum flow length within the site, the time of concentration of flow is selected as 5 minutes. Rainfall depth at this duration is 12mm (equivalent to 144 mm/hour).

Site run-off from the area above the discharge point to the salina/mangrove area is based on the following rational formula.

$$Q = 0.0028\ CIA$$

Where:

Q = discharge in m3/sec,

C = run off coeff.

I = rainfall intensity (mm/hrs)

A = drainage area in hectares

C is assumed to be 0.5 in spite of extent of hard development cover due to the high permeability of the underlying rock. The area drained is approximately 1.0 hectares.

Q = 0.0028x0.6x144x1.0

= 0.24 m3/sec.

Capacity of the cut-off drain 750mm wide x 300mm depth of flow (freeboard of 200mm) at a slope of 0.5% is 0.038m3/sec.

Figure 2-3 proposed locations of the cut-off drain and other proposed drainage provision.

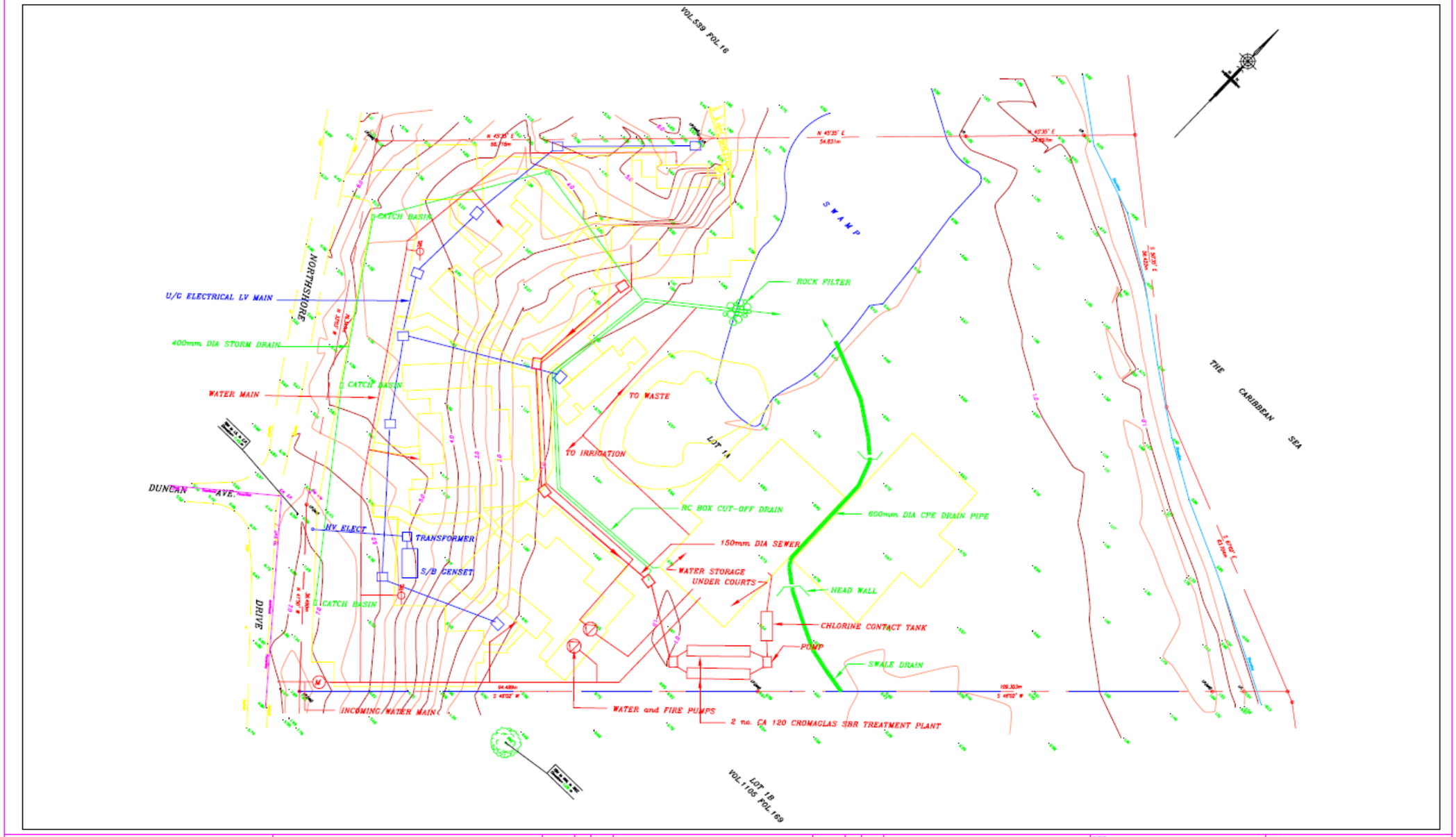


Figure 2-3: Site Services Layout

2.2.4 *Roadways*

Roadways and parking areas are provided along the Southern boundary of the site parallel to the public road. The level of the finished grade will be placed so as to minimise excavations of formation in rock.

In general, base course construction will consist of graded limestone aggregate compacted to a minimum of 95% of the modified proctor density for the material.

2.2.5 *Water supply*

It is understood that the National Water Commission has completed the upgrading of the Hague water supply expansion to ensure availability for the planned development of the area. This will enhance their water supply system within the area.

Water requirement for the resort property is estimated at a minimum utilization of 454 L (100 gallons) per person per day. The total proposed living accommodation at the resort property is as follows:

- **8 No. 3 br. 24**
- **12 No. 2br. 24**
- **16 No. 2/3br. 48**
- **16 No. 1br. 16**

Total 52 No. units with 112 bedrooms

Assuming 2 persons per bedroom, total water demand would be about 101,832 L (22,400 gallons) per day. Three days main storage at say 341,000 L (75,000 gallons) would require 170 sq. m of storage tank at 2 meters deep. The water storage structure can be used to raise levels at low lying areas or below the tennis courts.

The design will include total capture of roof run-off into storage for use in irrigation and toilet flush water system. We anticipate rain water collection at average 2.0 gallons per sq. ft of roof area per month.

Suggested split of storage between potable and rain/grey water is proposed at 50:50

- Potable water will be pumped from the storage tank by a triplex booster pump package. The lead and lag pumps will be sized each for 75% estimated total demand flow to the four blocks. The booster system will be designed to maintain a minimum pressure at peak flow rate of 0.82 bar (12psi) at the highest shower head.
- Grey water will be pumped to roof storage tanks located on each block. These tanks will be sized for one days flush water use and are anticipated to be 18,927 L (5000 gal.) each.
- Fire hydrants within the site shall be connected to the site water main. Spacing along the roadway shall be 91 m (300ft).

See Figure 2-3 for proposed location of the water supply pipes and tanks.

2.2.6 *Sewerage Treatment and Disposal*

All sewerage generated within this facility will be collected by a gravity system utilising 150 mm diameter Class B PVC pipes which will transfer all sewerage to a treatment plant on site. Figure 2-3 shows the route of the sewerage pipes and proposed location of the treatment plant.

A proprietary sequencing batch reactor type of plant is proposed to include also biological nutrient removal (denitrification) and final chlorination of effluent. This will provide a full tertiary system that will facilitate the recycling of effluent for flushing and irrigation and final disposal into the pond on site. The estimated total flow from the development is x litres per day. The proposed WWTP will consist of the following:

- A splitter box
- A two-stream septic tank
- A chlorinator
- Final disposal to a improved salina / wetland, with optional disposal to an outfall

The final effluent will meet or exceed NEPA's Effluent Standards.

Units	Flow Rate
Water Consumption	50,916 litres per day per room
Return ratio	90%
Infiltration	10%

Table 2-1: NEPA Effluent Standards and Projects Design Parameters

Parameter	Design Influent	Design Effluent	NEPA Effluent Standard		Units
			Direct Discharge	Irrigation	
COD	650	10	100	<100	mg/l
BOD	250	5	20	15	mg/l
TSS	300	3	20	15	mg/l
Total Nitrogen	45	1	10		mg/l
Phosphates – P	10	0.77	4		mg/l
Oil and Grease				10	mg/l
pH	7		6		
Faecal Coliform	4.00E+07	73	1000	12	MPN/100 ml
Residual Chlorine			1.5	0.5	mg/l
Giardia Cyst	30000			<1	# per 100 ml

2.2.7 *LPG System*

The complex will require LPG for restaurant kitchen and Laundry. We propose the installation of two (2) no. 1,892.7 L (500 gallon) storage tanks manifolded together with black steel distribution pipes and malleable iron fittings. Underground piping connecting gas storage to points of use shall be wrapped with corrosion protection tape (Denso).

2.2.8 *Swimming Pool Filtration*

The swimming pool will be provided with a filtration system of adequate capacity to turn over the capacity of the pool at least once in eight hours. Backwash water will be routed to the storm drain system.

2.2.9 *Foreshore Lagoon and Storm Drainage*

The foreshore salina or pond will be maintained and used as the final receiving area for storm water discharge and excess treated sewerage effluent. The storm water drains will discharge through rock filters into the salina to reduce to a minimum the transfer of water borne debris and silt into the salina.

It is further proposed to aerate the salina waters by using a floating aerator which also improves the visual aesthetic of the salina environment.

2.2.10 *Beach Protection Work*

The rocky foreshore below the limestone cliff does not by its nature provide any significant storage of beach sand. As a consequence the thin layer of excellent white sand is easily moved by the winter storms and hurricanes producing a shifting beach face during the year. The project proposes to stabilise a section of the beach face in front of the property by locating a pair of shore parallel breakwater structures that will naturally lead to the formation of Tombolos with a stable central pocket beach, without interfacing with the natural processes of the beach environment.

2.2.11 *Landscaping*

No exotic species are planned for introduction at the site. Landscaping will utilise plants that are native to Jamaica and the area. All attempts will be made to preserve vegetation above the mean high tide mark. Creeping and standing vegetation stabilizes the beach and offers protection against destructive erosion by wind and waves.

Recommendations

1) A nursery should be set up with the plants at the site that will be retained for use on the site as well as all other plants to be incorporated

A list of all plants to be used in the landscaping be prepared and approved by NEPA prior to planting.

2.3 Building Design

2.3.1 *Building Structure*

2.3.1.1 Soils and Geology

Limestone formation predominates on the site which appears to be a raised reef. The underlying limestone is not expected to be too hard but the surface has been case hardened. The depth of this hardening will need to be ascertained to get a fix on method and cost for

foundation and other excavations but bearing strength will not be a problem for the six storey blocks considered.

This limestone is anticipated throughout even in the low lying areas of the site adjacent to the waterlogged site next door to the East and underlying the salina. Trenching for services will be difficult and will require careful planning. Increasing site levels in fill may have some benefit as top soil cover is also very thin or non existent.

Soils investigation will be carried out to confirm the depth of cap rock and give some indication of the excavation effort required.

For building foundation it is assumed that mechanical trenching in the lime rock can provide excavation for inverted 'T' beam type reinforced concrete bases under the shear walls at Level 1 and 2.

In areas where structural fill is required to raise levels, the fill specification will provide for bearing pressures of 55.16 m Pa (4 tons/sq. in.).

2.3.1.2 Structures

The use of proprietary structural systems has been considered for providing the reinforced concrete six storey structures. The design facilitates form construction. Such capabilities exist in Jamaica. Alternate construction systems being considered would utilise standard wall formwork for r.c. shear wall construction with precast prestressed hollow core floor slab units.

It is assumed that internal bathroom/bedroom walls would be constructed of light weight partition.

2.3.1.3 Floor Levels

It is recommended that the minimum floor level for normally habitable buildings should be maintained at +1m to be reasonably above storm surge elevation. This will relate to the construction of the Shared Facilities building and swimming pool without excavation into the rocky substrate (Figure 2-4 and Figure 2-9).

Figure 2-4: Level 1 Architectural Layout

Figure 2-5: Level 2 Architectural Layout

Figure 2-6: Level 3 Architectural Layout

Figure 2-7: Level 4 Architectural Layout

Figure 2-8: Level 5 Architectural Layout

Figure 2-9: Level 6 Architectural Layout

2.3.2 *Building Services*

2.3.2.1 Electrical Power

Preliminary electrical load for the property is estimated at 1600A-2500A at (415/220/120V) depending on the final configuration and services required.

Electrical loads of this magnitude will require a sub-station for transfiguration. We are recommending that allowance be made for a transfer within the service area for a 2000A 415/220/120V transformer.

The proposed location of the transformer and main switchroom and standby generator is shown on Figure 2-3.

2.3.2.2 Power Distribution

Each block will have a Meter Room with a distribution board to facilitate metering of individual units.

2.3.2.3 Power to Individual Blocks

Power for individual blocks will be based on a standard 100A, 1 phase, and 1 way panel board.

2.3.2.4 Electrical Allowance

The load estimation is based on the following

i) Air-conditioning for all rooms

ii) General Lighting

iii) Electrical Cooking Facilities

iv) Standard Household Electrical Appliances

v) Electrical Water Heater optional to Solar Water Heater

2.3.2.5 Electrical Power Common Areas

The Common Areas to be serviced with electricity are:

i) Elevator

ii) Fire Pumps to a maximum of 4-8

iii) Thermostat

iv) Three stage package water pipe

v) External Lighting

vi) Common Area Lighting

vii) Central Facilities Lighting

viii) Kitchen Equipment/Restaurant

ix) Laundry

x) Administration

2.3.2.6 Fire Protection

a) **Fire Pumps**

The water supply for the fire will rely on the pool capacity with a bypass which would provide adequate capacity at an economical rate.

The Fire System shall constitute:

i) Three stage fire pump to give a proximately 8 bars (65 psi) at the extension incorporating a Firepak Buster to NFPA standard.

ii) Fire Hydrant to approved local standard

iii) Cabinet type swing non-kink hose reel complete to NFPA standard.

iv) Cabinet to accommodate fire extinguishers

b) **Fire Detection**

Addressable fire detection system with the following features as a minimum:

i) Centralised detection with zone stand-alone capability

ii) Integrated reporting globally for all building units

iii) Addressable smoke and heat detectors for all rooms

iv) Annunciation at all floors and public areas as per NFPA standards

v) Pull Station to NFPA standard to be placed at all floors

c) **Communication Systems**

Security

Integrated Electronic System to include:

- Close Circuit Camera
- Intercom by telephone

- Security lock and access control

2.3.2.7 Telephone Data/Entertainment

- Pre-wired data for telephone and/or cable network integration
- Pre-wired cable network/wireless option
- Programmable Device Control (Optional)

2.3.2.8 Facilities Management Control

- Pre-wired for Electronic Control for individual units
- Energy Management Control for public facilities and Common Areas
- Managed Facility Centralised and Individual
- Lighting Control
- Zone Control

2.3.2.9 Standby Generator

- Standby Generator sized to run the facility at full load with the option to manage the load from the facilities Management System.
- Standby Generator shall be fitted within and acoustic enclosure with a noise nuisance not exceeding 75 dBA at 1m.
- The plant shall be equipped with fuel capacity to last approximately 7 days at 80% load capacity.

2.3.2.10 Elevators

- The elevator shall be capable of 1600 Kg., 8 persons with a return trip time of not more than 42 seconds
- The elevator shall be fully digital with feedback control logic to integrate with Facilities Management and Security System

2.3.2.11 Air-conditioning

The electrical and architectural design will allow for multi-split package and units.

2.3.2.12 Hot water

Individual hot water units of approximately 200 litres will be provided using solar system and allowance for electrical system as an option.

Boiler will be used for the kitchen and laundry. The multi zone lochinvar is an efficient option using solar as a supplement.

2.3.2.13 Domestic Water Storage

Block Storage. The design will rely on gravity to individual units pumped from main storage facility to a ½ day storage capacity for each block, located on the roof.

ANALYSIS OF ALTERNATIVES

3 Analysis of Alternatives

3.1 Introduction

In considering the development options, three alternatives can be exercised. These are:

1. The No Action Alternative
2. The Proposed Development
3. The Proposed Development with modifications
4. Proposed Development in another location

3.2 No-Action Alternative

The selection of the "No Action" alternative would mean the discontinuation of project designs and result in the site being retained in its existing form. There are physical, biological and socio-economic implications of this alternative.

Physically, the site is unlikely to undergo any major changes from its present condition. Biologically, the vegetation present on the site is unlikely to be severely affected, other than the potential for uncontrolled growth of weeds, bushes and trees introduced by avifauna, wind or other means on the proposed lot. Unless the vacant lot is maintained, the possibility exists that the illegal dumping observed could worsen, as well as the area become a possible venue for illicit and otherwise objectionable activities currently taking place.

The "No Action" Alternative is likely to have the greatest implications on the socio-economic environment of the area and surrounding communities. Due to the proposed quality of the development it is anticipated that it would provide a major opportunity for employment, foreign exchange revenue, benefits associated with the construction industry and potentially significant business opportunities for existing and new tourism support businesses. In addition, a development of this calibre will add to the islands' ability to market itself to visitors from markets previously under represented through previous marketing activities. It will also fuel the growth and development of the Duncan Bay area.

3.3 The Proposed Development

This alternative would see the construction of the development as proposed by the developers, and as outlined in this EIA document. This option has good support (based on results of socio-economic survey) by the persons who would be most affected by its implementation, i.e., residents within the Duncan Bay area. Therefore, community support is anticipated for the development.

This alternative will provide positive benefits to the surrounding communities and Jamaica's tourism product. This includes benefits such as employment opportunities, foreign exchange earnings, increased property values and benefits to ancillary supporters/dependents of the tourism industry. If approved, construction at the facility is scheduled to last approximately 18 months, and will provide employment for an average of approximately forty (40) individuals during pre-construction, not including tradesmen and labourers during construction, and between eighty (80) and one hundred and twenty (120) employees during the operational phase. Additionally, the multiplier effects to the construction and support industries during this period are likely to affect a much larger number of persons.

The proposed project will also make a positive contribution to social infrastructure, overall residential development, upkeep and renewal of the residential community. The proposed development is being designed and built to meet or exceed local and international standards and regulations. A key benefit also is the installation of a tertiary level sewage treatment facility that will produce an effluent suitable for use as irrigation water on the facility while meeting, and in some instances exceeding, standards for coastal water quality.

The development, as proposed, is in line with other current and projected developments for the immediate region such as the Harmony Cove Development. A US$40 million water supply system from Martha Brae to Harmony Cove in Trelawny was completed in 2006[1].

[1] Water supply system in Trelawny completed, Radio Jamaica, Fri Oct 6, 2006. http://www.radiojamaica.com/news/story.php?category=2&story=28884

3.4 Site Location Alternatives

3.4.1 *Proposed Development with Modifications*

If there are issues concerning the project that may be enhanced, changed or modified to increase the acceptability of the project, then these issues should be considered. At this time based on communication with residents of surrounding communities, it appears that there are several issues that once resolve satisfactorily whether through modification or compromise would further increase support for the development. These include but are not limited to:

- Guarantees that the sewage treatment system will treat wastewater to be used for irrigation to the tertiary level (the system has been designed to achieve irrigation standards which are more stringent than discharge standards)
- Very few sewage treatment technologies could be implemented that would treat to the same level, with the low operational and maintenance costs and reliability anticipated for this system
- Impact on the existing water supplies in the area
- Established lines of communication with the possibility of a liaison officer between the developers and the community
- Aesthetics, particularly the timely removal of construction fencing surrounding the site and construction of an aesthetically pleasing perimeter border.

Some of these concerns will not exist on project completion e.g. water supply. All other issues are easily resolvable through either modification or compromise and we do not foresee these issues resulting in disapproval of the development by interested community and regulatory agencies. The developers will work with the communities and residents to design, construct and operate a quality facility that will be the pride of all involved or partake in its operation.

This alternative retains the same positive benefits as with maintaining the proposed development option.

3.4.2 *Proposed Development in another Location*

No other locations were considered in conjunction with the proposed location for implementation of this project. The property is owned by the proponents and is in an area designated for this type of development.

The property offers the following advantages over other locations:

- Land ownership guaranteed
- Beach and waterfront location is ideal with beautiful white sand beach and high quality marine environment
- Size of property allowed for inclusion of a tertiary level sewage treatment system with capability to treat to a level satisfactory for use as irrigation water

The recommended alternative is the "Proposed Alternative" because it recognizes the viability and need for the proposed development, is designed to address environmental issues and concerns, meets or exceeds all local regulatory requirements and supports communication and close relations during all stages of the development between the developers and the surrounding communities.

POLICY, LEGISLATION, STANDARDS, AND REGULATORY FRAMEWORK

4 Policy, Legislation, Standards, and Regulatory Framework

4.1 Introduction

The policies, legislation, regulations and environmental standards of the Government of Jamaica (GOJ), which pertain to this development have been researched and analyzed, to ensure that the project complies with all policy, legal and regulatory requirements. The areas examined included environmental quality, health and safety, protection of sensitive areas, protection of endangered species, site selection and land use control at the regional, national and local levels, which relate to or should be considered within the framework of the project.

4.2 Summary of the Legislation and Responsible Agencies

Table 4-1: National Legislation and Responsible Agencies

LEGISLATION	INSTITUTION RESPONSIBLE
NRCA Act, 1991	Natural Resources Conservation Authority
Wildlife Protection Act, 1945	Natural Resources Conservation Authority
Watershed Protection Act, 1963	Natural Resources Conservation
Town & Country Planning Act, 1987	Town Planning Department
Forestry Act, 1937	Forestry Department
The Water Resources Act/UWC Act, 1959	Water Resources Authority
Jamaica National Heritage Trust Act, 1985	Jamaica National Heritage Trust
Public Health Act, 1985	Ministry of Health/Environmental Control Division
Disaster Preparation & Emergency Management Act, 1993	Office of Disaster Preparedness and Emergency Management
National Solid Waste Management Authority Act, 2001	National Solid Waste Management Authority
St. James Development Order, 1983	Town Planning Department

4.3 Development Guidelines

All development applications are submitted for approval to the Town & Country Planning Authority, through the local Parish Council and then forwarded to the relevant authorities including NEPA and the Environmental Control Division (ECD) of the Ministry of Health. NEPA, the governing environmental agency, may require an environmental impact assessment

(EIA) to be considered along with the development plan for the Authority's approval. The ECD imposes guidelines for air, water and soil standards to be maintained after construction.

In this case, NEPA has dictated that an EIA be completed. This section serves to address all applicable policies, legislation, standards, and regulations that may affect this project.

4.4 Relevant Legislation

Legislation relevant to the establishment of a hotel development in St. Ann is outlined below.

4.4.1 *The NRCA Act, 1991*

The NRCA Act (1991) is the overriding legislation governing environmental management in Jamaica. It requires that all new projects, (or expansion of existing projects), which fall within prescribed categories be subject to an environmental impact assessment (EIA).

The regulations require that eight (8) copies of the EIA Report be submitted to the Authority for review. There is a preliminary review period of ten (10) days to determine whether additional information is needed. After the initial review the process can take up to ninety (90) days for approval. If on review and evaluation of the EIA the required criteria are met, a permit is granted. In the event that the EIA is not approved, there is provision for an appeal to be made to the Minister.

Specifically, the relevant section(s) under the Act which address the proposed project are:

Section 10: Empowers the Authority to request EIAs for the construction of any enterprise of a prescribed category.

Section 12: Addresses the potential for contamination of ground water by trade effluent and sewage.

Section 15: Addresses the implementation of stop orders and fines associated with the pollution of water resources.

Section 16: Authorizes the government to intervene in order to prevent the contamination of ground water.

Section 17: Addresses the authority of the government to request in writing, any information pertaining to the:

1. performance of the facility
2. quantity and condition of the effluent discharged

3. the area affected by the discharge of effluent

In keeping with the requirements of this Act, the following submittals have been in support of this project:

- Permit Application (pursuant to Section 9)
- Project Information Form (PIF) pursuant to Section 10 (1)(a)
- Completed EIA document (8 copies to NEPA and one electronic copy)

4.4.2 *The Beach Control Act 1956;*

The Beach Control Act provides for the regulation of activities within twenty-five (25) metres of the shoreline. It includes control of the construction of sheds and huts on beaches, and prohibits the use of public beaches for fishing activities. The Act is administered by NEPA, and also makes provisions for the creation of Marine Protected Areas. The sections of the Act relevant to the project are:

Section 7:

1. Notwithstanding anything to the contrary in this Act, the Minister may, upon the recommendation of the Authority, make an order declaring:
   a) any part of the foreshore and the floor of the sea defined in the Order together with the water lying on such part of the floor of the sea to be a protected area for the purpose of this Act; and
   b) such activities as may be specified in the Order to be prohibited activities in the area defined in the Order, being any or all of the following activities:
      i) fishing by any means specified in the Order;
      ii) the use of boats other than boats propelled by wind or oars where such boats are used for purposes other than for the doing of anything which may be lawfully done under the Harbours Act, the Marine Board Act, the Wrecks and Salvage Law, the Pilotage Act or the Exclusive Economic Zone Act;
      iii) the disposal of rubbish or any other waste material;
      iv) water-skiing;
      v) the dredging or disturbance in any way of the floor of the sea

Section 9:

1. Subject to the provision of Section 8 (this does not apply to docks wharves pier etc. constructed prior to June 1, 1956), no person shall erect, construct or maintain any dock, wharf, pier or jetty on the foreshore or the floor of the sea, or any structure, apparatus or equipment pertaining to any dock, wharf, pier or jetty and encroaching on the foreshore or the floor of the sea, except under the Authority of a license granted by the Minister on behalf of the Crown.

4.4.3 *The Watershed Protection Act, 1963*

This Act governs the activities operating within the island's watersheds, as well as protects these areas. There are twenty-six (26) watershed management units designated under this Act, including the Martha Brae Watershed Management Unit in which this project falls.

4.4.4 *The Wildlife protection Act, 1945*

This act involves the declaration of game sanctuaries and reserves, game wardens, control of fishing in rivers, protection of specified rare or endemic species. The Act also provides for the protection of animals and makes it an offence to harm or kill a species which is protected. It stipulates that, having in one's possession "whole or any part of a protected animal living or dead is illegal.

This Act has to be considered for the proposed project, ecological assessments will determine if rare or endangered species will be impacted.

4.4.5 *Water Resources Act, 1995; Underground Water Control Act, 1959*

The Underground Water Control Act of 1959 is the legal instrument. However, the Water Resources Act is expected to provide for the management, protection, controlled allocation and use of the water resources of Jamaica. Thus, the water quality control for both surface and ground water are regulated by this Act.

Any activity that negatively influences the quality of the existing water, whether ground or surface, would be relevant to this Act.

4.4.6 *The Town and Country Planning Act, 1987*

This Act governs the development and land use (excluding agriculture) in specified areas, through Development Orders, local planning authorities, development planning processes and Tree Preservation Orders. Under this Act the Town Planning Department is the agency responsible for the review of any plans involving development. The Act allows for specific conditions to be stipulated and imposed on any approved plans. The planning decision is based upon several factors, including;

- Location of the development;
- Land use and zoning;
- Effect of the proposal on amenities, traffic, etc.

4.4.7 *The Jamaica National Heritage Trust Act, 1985*

The Jamaica National Heritage Trust, formerly the Jamaica National trust, administers the Act. This Act provides for the protection of important areas, including the numerous monuments, forts, statues, and buildings of historic and architectural importance in Jamaica.

This Act will prove applicable if any structures of archaeological and/or architectural importance are located on the site, affected by the site activities or unearthed during site activities.

4.4.8 *The Public Health Act, 1974*

This Act falls under the ambit of the Ministry of Health (MOH) and governs all matters concerning the handling of food material. In addition, provisions are also made under this Act for the activities of the Environmental Control Division (ECD), a division of the MOH. The ECD has no direct legislative jurisdiction, but works through the Public Heath Act to monitor and control pollution from point sources. Action against any breaches of this Act would be administered by the Central Health Committee. The functions of the department include:

- The monitoring of waste water quality, including regular water quality analysis, using water standards published by NEPA;
- Monitoring of occupational health as it relates to industrial hygiene of potentially hazardous working environments;
- Monitoring of air pollutants through its laboratory facilities.

This Act has been consulted for the proposed sewage disposal system.

4.5 International Policy

4.5.1 *Agenda 21*

In June 1992, Jamaica participated in the United Nations Conference for Environment and Development (UNCED). One of the main outputs of the conference was a plan of global action, titled Agenda 21, which is a "comprehensive blueprint for the global actions to affect the transition to sustainable development" (Maurice Strong). To which, Jamaica is a signatory. Twenty seven (27) environmental principles were outlined in the Agenda 21 document. Those relevant to this project, which Jamaica is obligated to follow are outlined below:

Principle 1 – Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 3 – The right to development must be fulfilled to equitably meet developmental and environmental needs of present and future generations.

Principle 10 – Environmental issues are best handled with the participation of all concerned citizens, at the relevant level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in the decision making process.

Principle 11 – States shall enact effective environmental legislation, environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply.

Principle 15 – In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

DESCRIPTION OF THE ENVIRONMENT

5 Description of the Environment

5.1 Introduction

The project site is located in the community of Duncan Bay on the north coast of Jamaica, in the parish of Trelawny. It is in close proximity to residential villa community of Silver Sands, north of the town of Duncans. The site comprises 2.02 hectares (5 acres) and is an undeveloped real estate. The North Coast Highway runs south of the area. The lot has been allowed to re-vegetate along the coast under natural conditions since the area was surveyed and lots created for the Duncan Bay residential community. The vegetation communities observed, are a remnant of the original vegetation in most instances, and only contain a portion of the species usually found in a typical coastal community. This area is typical of the Dry Coastal Limestone Forests of the North Coast of Jamaica. This area provides habitats that encourage diversity among species promoting Jamaica's floral and faunal endemism.

The environmental setting of the project site and immediate environs were assessed to determine the existing status of environmental resources. This was primarily done to ascertain existing environmental conditions prior to the establishment of the proposed development, and to facilitate the preservation of natural resources within the projects sphere of influence. Aspects of the environment that were assessed, were selected on the basis of the likelihood of the project impacting on these resources, and are discussed in full in this document.

5.2 Physical Environment

5.2.1 *Climate Overview*

Jamaica is surrounded by the Caribbean Sea and is located in the Tropics at approximately latitude 18ºN and longitude 77ºW. Among the most important climatic influences are the Northeast Trade Winds, the range of mountains which runs east-southeast to west-southwest along the centre of the island, the warm waters of the Caribbean Sea, and weather systems such as upper- and low-level low-pressure centres, troughs and cold fronts.

The cold fronts, usually weak after migrating from the North American continent, are evident from mid-October to mid-April; whilst the Tropical Weather Systems, namely Tropical Waves, Tropical Depressions, Tropical Storms and Hurricanes occur from April to December. The official hurricane season is from June to November.

5.2.1.1 Rainfall

Rainfall is the most variable of the climatic parameters exhibiting a bimodal nature. The thirty (30) year (1951-1980) average monthly rainfall values, highlight the typical rainfall pattern for the region (Figure 5-1). The driest period runs from December to March and is associated with cold fronts migrating from North America. There are two distinct wet seasons, May to June and September to November occurring as regularly yearly cycles.

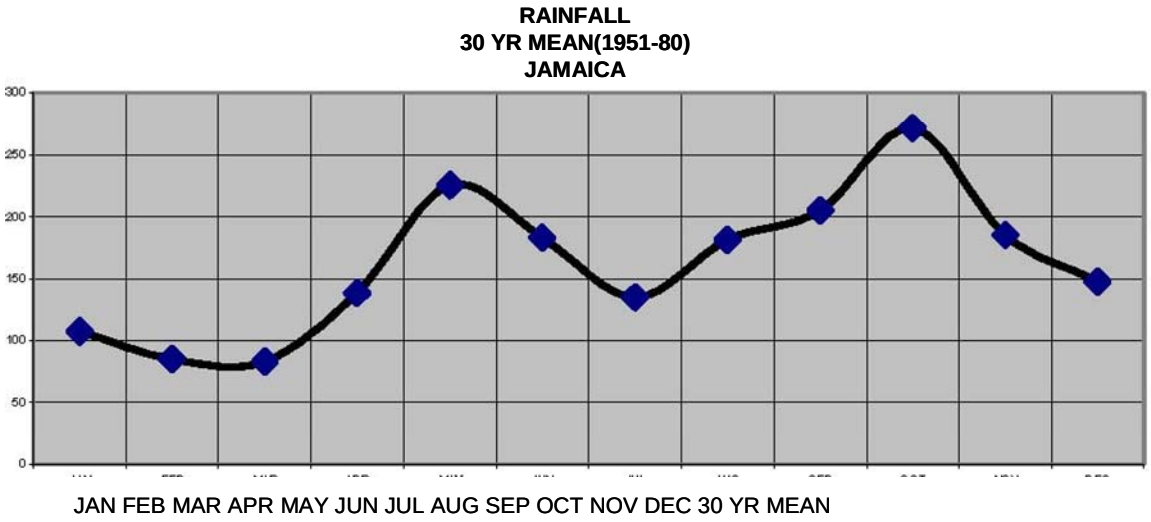


Figure 5-1: Jamaica 30 Year Rainfall Mean (1951-1980)

Of the weather parameters, rainfall is the most variable. Islandwide, during the period 1951 to 1980, annual rainfall ranged from a maximum of 2593 mm (102.09 in) in 1963 to a minimum of 1324 mm (52.13 in) in 1976, with an average of 1940 mm (76.38 in) annually. The hundred-year (1881-1990) mean annual rainfall is 1895 mm (74.61 in). Historically, the wettest year on record was 1933 with an annual rainfall of 2690 mm (116.54 in) whilst the driest year was 1920 with an annual rainfall of 1299 mm (51.14 in). Figure 5-2 shows the mean long-term mean rainfall for Trelawny for 1951-1980.

Whether during the dry or rainy season, however, other rain-producing systems are influenced by the sea breeze and orographic effects which tend to produce short-duration showers, mainly during mid-afternoon.

The parish of Trelawny receives an annual average of 1660 mm of rainfall per year mainly during the rainy period, between the months of May and November. The driest period occurs from January through March, with less than 75 mm per month. Figure 5-3 shows the average yearly rainfall for Braco, the closest available rainfall monitoring site.

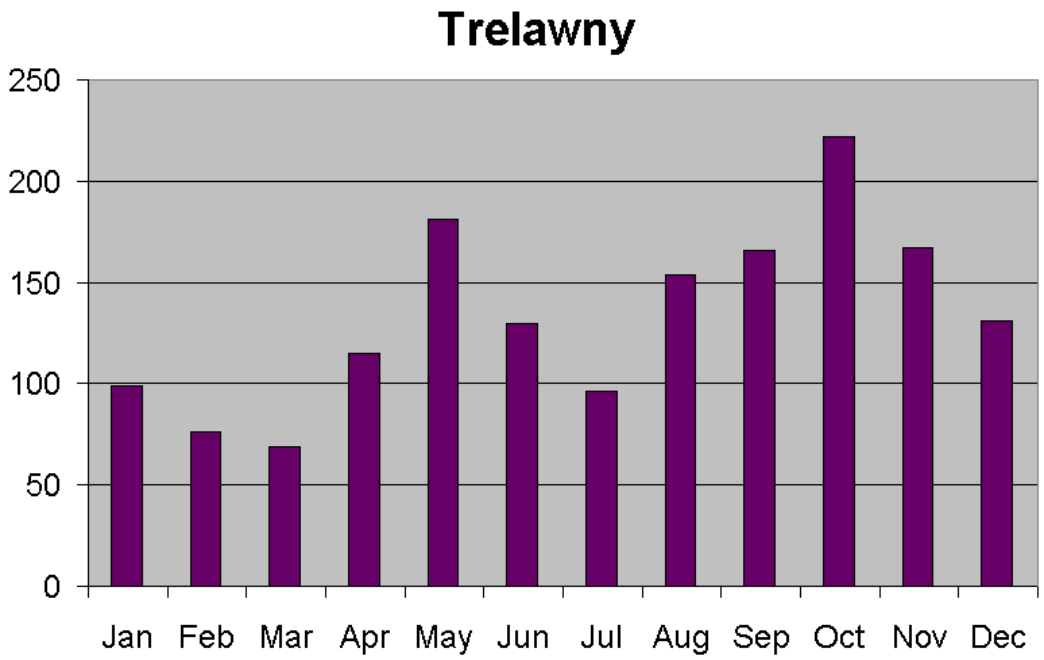


Figure 5-2: Trelawny Long-term Mean Rainfall (mm) 1951-1980[2]

[2] Jamaica Meteorological Service, Climatological Data, Sangster International Airport

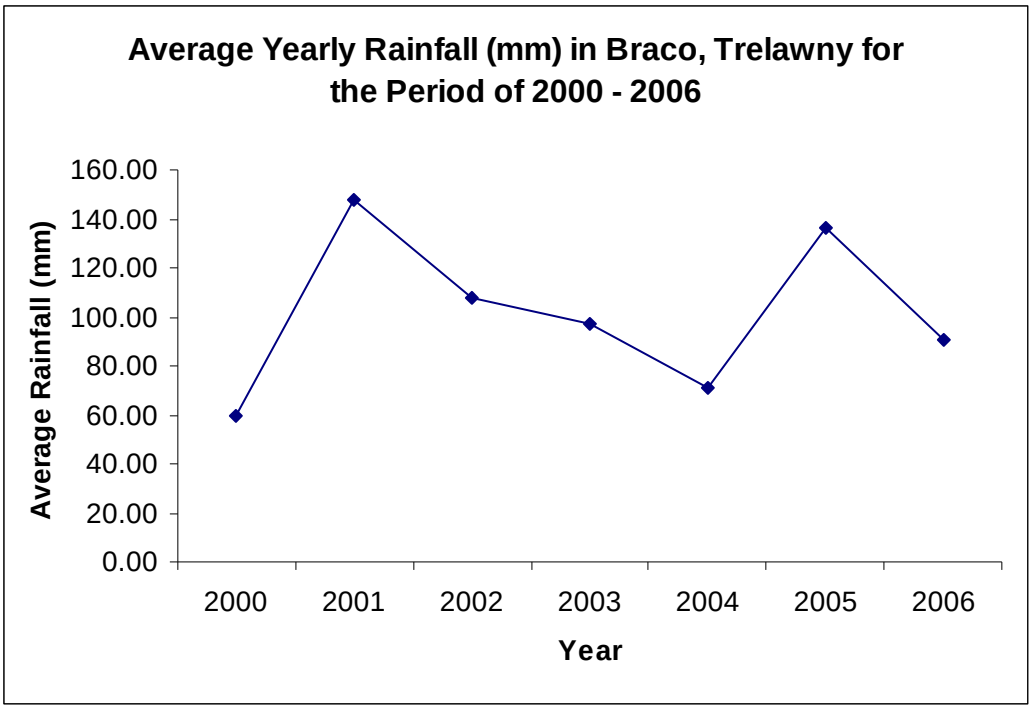


Figure 5-3: Average yearly rainfall for Braco, closest monitoring site to proposed location[3]

5.2.1.2 Wind

The daily wind pattern is dominated by the Northeast Trades. During the day, on the North Coast, the sea breeze combines with the Trades to give an east-north-easterly wind at an average speed of 15 knots (17 miles per hour). In the period December to March, however, the Trades are lowest and the local wind regime is a combination of trades, sea breeze, and a northerly or north-westerly component associated with cold fronts and high-pressure areas from the United States.

By night, the trades combine with land breezes which blow offshore down the slopes of the hills near the coasts. As a result, on the North Coast, night-time winds generally have a southerly component with a mean speed of 5 knots (6 miles per hour). By day, from June to July, mean onshore winds often reach a maximum of up to 23 knots (26 miles per hour) along the North Coast during mid-afternoon.

[3] Jamaica Meteorological Service, Climatological Data, Sangster International Airport

Specific wind data was not available for the project area. The closest available data that could be considered reliable was from the Sangster International Airport in Montego Bay which is approximately 40 km (24 miles) to the west of the project area (Figure 5-4).

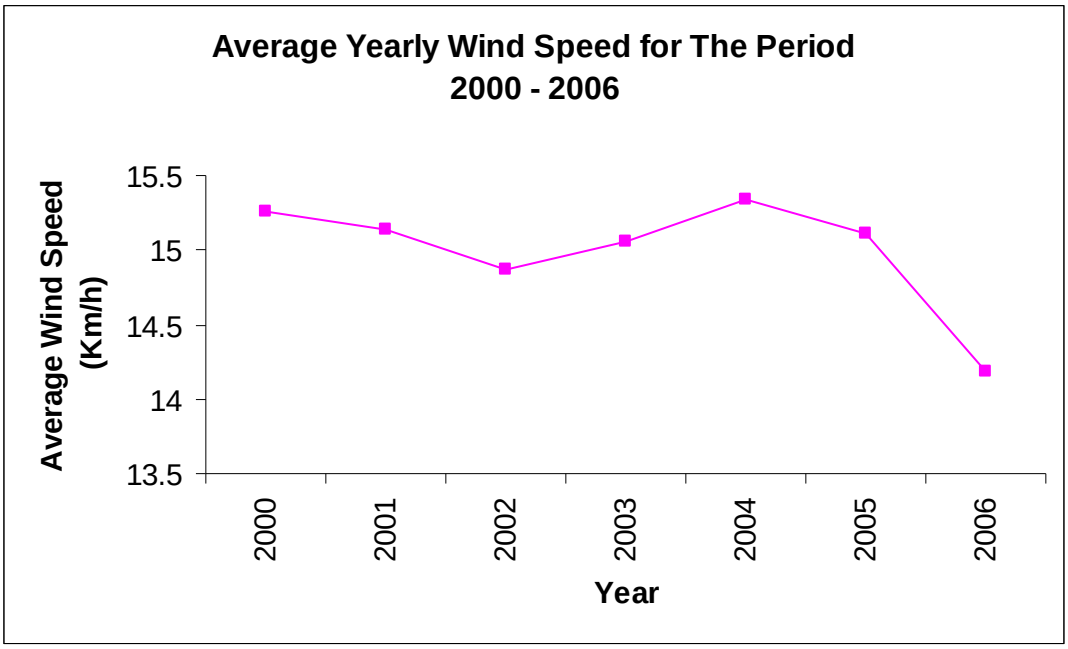


Figure 5-4: Average yearly wind speeds at Sangster's International Airport, Montego Bay[4]

5.2.1.3 Noise

Noise generation at the proposed site will mainly be generated from motor vehicle engines (start and stops), horns, and animal sounds such as dog barks. Based on the distance to the North Coast Highway, limited noise impact is expected. The North Coast Highway is approximately 1.3 km (0.8 miles) south of the proposed project site. Additionally, there is significant vegetation between the community of Duncan Bay and the highway.

The impact from noise will only be significant during construction and this will be mitigated by employing best construction noise management practices. During operation the site will also be a minor noise impediment on the community. Its location at the western end and the direction of the prevailing winds does not allow for any significant measurable noise to the majority of the residential community. The siting of the various infrastructure and the

[4] Jamaica Meteorological Service, Climatological Data, Sangster International Airport

landscaping measures to be employed will ensure that a reduction in the attenuation of noise waves from the facility. The surrounding vegetated lands will also assist with this effort.

5.2.1.4 Temperature and Relative Humidity

Apart from rapid fluctuations associated with afternoon showers and/or the passage of frontal systems, the island's temperatures remain fairly constant throughout the year under the moderating influence of the warm waters of the Caribbean Sea.

In coastal areas, daily temperatures average 26.2 degrees Celsius (79.2ºF), with an average maximum of 30.3ºC (86.5ºF) and an average minimum of 22.0ºC (71.6ºF). The warmest months are June to August and the coolest December to February. Night-time values range from 18.9 to 25.6ºC (66 to 78.1ºF) in coastal areas.

Variations of sunshine from month to month in any area are usually small, approximately one hour. Differences, however, are much greater between coastal and inland stations. Maximum day-length occurs in June when 13.2 hours of sunshine are possible and the minimum day-length occurs in December when 11.0 hours of sunshine are possible.

Afternoon showers are the major cause of most daily variations in relative humidity. Highest values recorded during the cooler morning hours near dawn, followed by a decrease until the early afternoon when temperatures are highest.

Although relative humidity in coastal areas average 84% at 7 a.m. temperatures at this time are in the mid 20's (ºC), therefore, little or no discomfort results. At 1 p.m. the average relative humidity on the coasts is 71%.

Table 5-1 below outlines the average daily temperature and relative humidity at 7 a.m. and 1 p.m. for the period 2000-2006 from the Sangster International Airport Met Station, the closest reliable data source.

Table 5-1: Average daily Temperature and Relative Humidity for the Period 2000-2006[5]

Year	Temp (°C)	Rel. Hum.-7 a.m. (%)	Rel. Hum. – 1 p.m. (%)
2000	27.55	71.08	74.25
2001	27.36	79.50	71.00
2002	27.53	79.83	70.42
2003	27.58	81.42	72.42
2004	27.51	81.5	71.75
2005	27.54	84.58	76.75
2006	27.60	84.75	77.08

5.2.1.5 Ambient Air Quality

5.2.2 *Geophysical Environment*

5.2.2.1 Geomorphology

The area under consideration for development is a beach property located between the western boundary of Silver Sands and Duncan Cliff, Parish of Trelawny. It may be identified on the 1:50 000 scale topographic series Sheet 3 (metric edition) and on Sheet 51D of the 1:12 500 scale topographic map series. Plate 5-1 shows the location.

A survey was carried out over the coastline between Silver Sands and the northern end of Duncan cliff to ascertain the regional nature of the shoreline and immediate nearshore and backshore regions in relation to the site. The general environment is that of a more or less steep, narrow beach resting on a rock ledge and forming a low beach ridge, backed by water-filled depressions, variably described as lagoons or wetland. In the northern part of the area these features are backed by a low (10 m) cliff into which has been eroded a prominent ancient sea level notch. Although not all of them are necessarily within the area of the site, Figure 5-5 indicates the extent of the main geomorphic units described below.

[5] Jamaica Meteorological Service, Climatological Data, Sangster International Airport

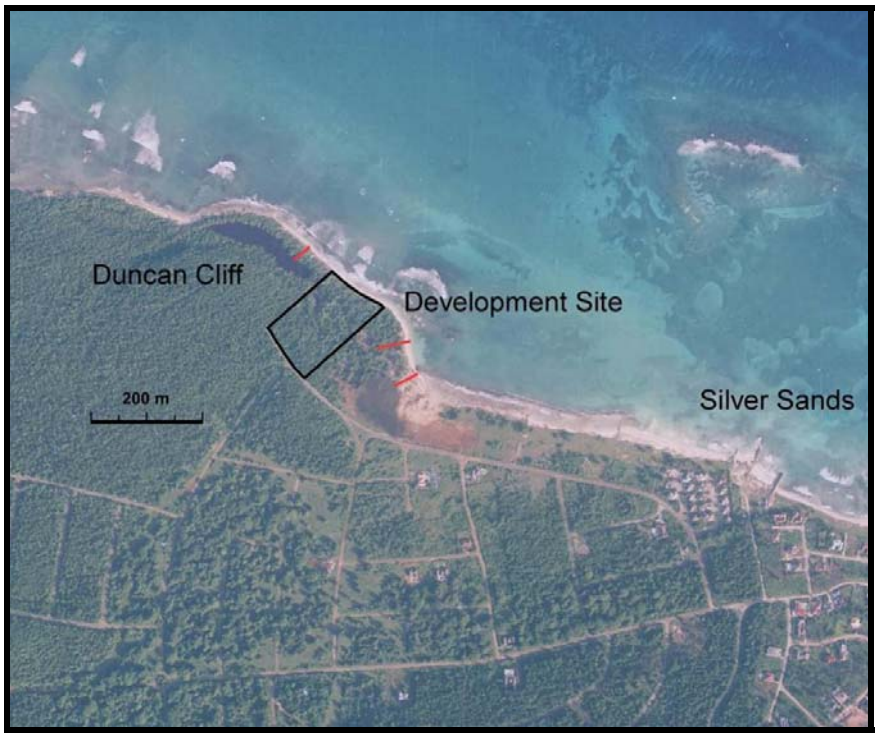


Plate 5-1: Location of the proposed Treasures of Trelawny development site superimposed on 1991 aerial photograph JAM91-002-87. Red lines are locations of beach profiles

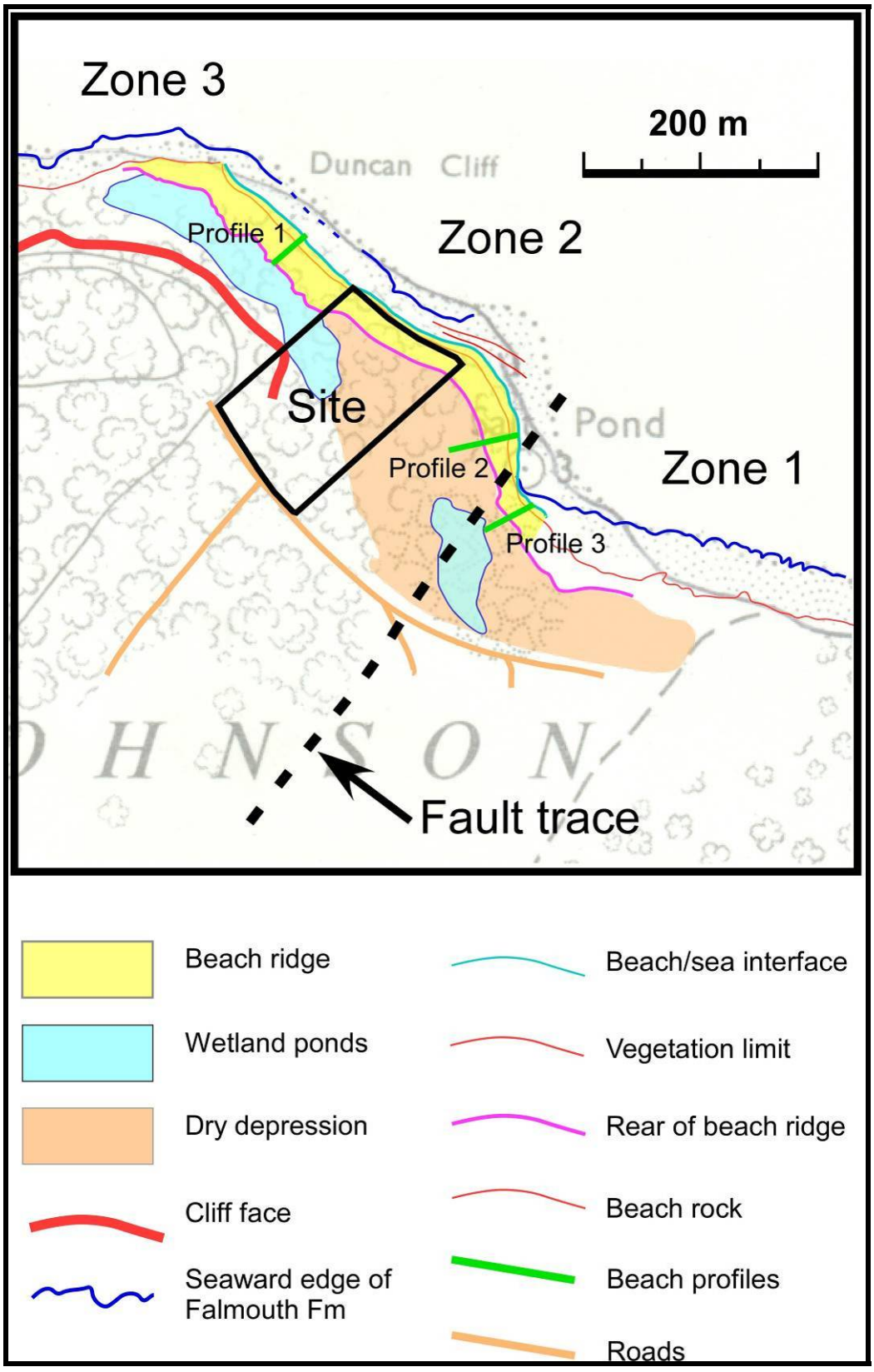


Figure 5-5: Map of geomorphic units in the study area

5.2.2.1.1 The Beaches

The beaches along this sector of the coast are narrow and steep and are of the carbonate "white sand" variety. They vary between moderately sorted to well-sorted fine to medium grained carbonate sand. Carbonate pebble/ rubble deposits are also found landward of the beach rock exposure in front of the site (Plate 5-2). Although more or less continuous, the active beachface varies considerably in width from about 6 m to 10 m or more. The berm and back beach area consists of beach sand, varying between 21 m and 42 m in width and is extensively overgrown with natural and recently planted vegetation. The June 2005 Google® imagery shows bare sand, lacking vegetation, in many places in the back beach zone. These are now at least partially covered with natural vegetation. Older images do not show the bare sand, suggesting that the sand in the back beach area may have been emplaced by a storm event in early 2005 or shortly before. Evidence of sand mining was noted at two localities adjacent to the site of interest.

Plate 5-2: Mixed pebble/rubble and sand landward of beach rock exposed in front of site.

5.2.2.1.2 Beach profiles

5.2.2.1.2.1 Methodology

Three shore-normal, profiles were established. Each extends from the foreshore to the seaward edge of the coastal swamp. The profiles were measured using the stadia method with a Topcon level and the data obtained was used to determine the width and elevation of the beach and relationship to the swamp behind. The locations of the profiles are shown on Plate 5-1 and Figure 5-5.

Plate 5-3: Profile surveys were carried out using a level and stadia rod

5.2.2.1.2.2 Profile Descriptions

In the profile descriptions the heights above sea-level (asl) refer to the heights above actual sea level at time of measurement.

Profile 1 (Figure 5-6) is located at the western end of the beach in front of Duncan Cliff, W 77.54095° N18.4902°. This profile was measured from the edge of the coastal swamp, which has a water level elevation of 0.14 m asl, to the toe of the foreshore. The profile traverses a 16 m wide back berm that is clearly defined on the seaward edge by the berm crest and fronted by a steep foreshore. The entire profile consists of sand which appears to have been deposited as part of a wash-over fan. The fan is defined by the gently landward sloping back

berm area and is stabilized by low grass and running vines. The highest elevation measured along profile 1 occurs at the berm crest 21 m from the edge of the swamp and is 1.1 m asl.

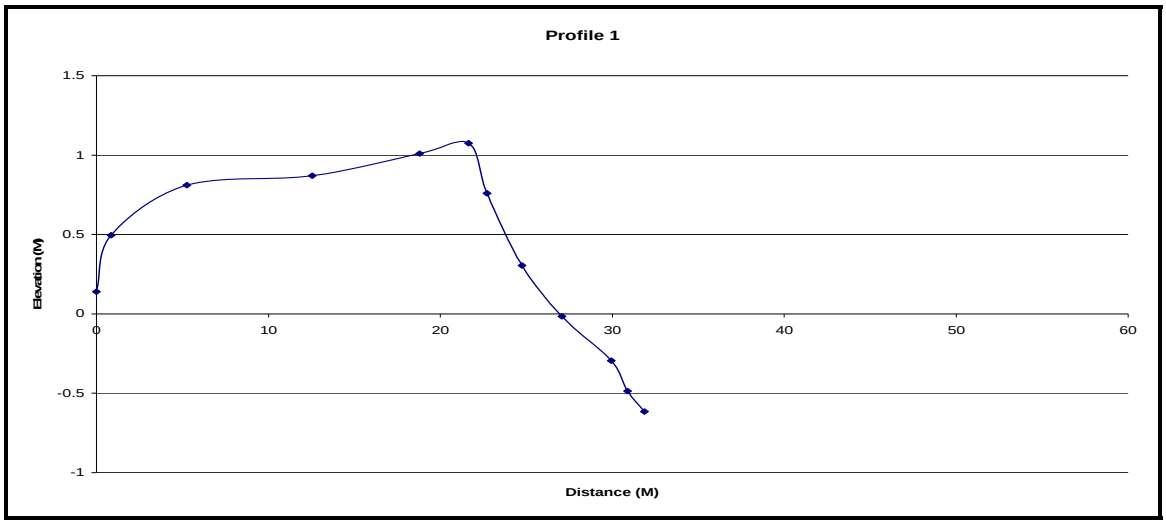


Figure 5-6: Profile 1, which is located just northwest of the site, in front of Duncan Cliff, was measured from the edge of the swamp behind the beach to the lower sections of the beach face.

Profile 2 is located east of Profile 1, W 77.53775° N18.48803°, is also backed by a coastal swamp 0.14 m asl populated by Black Mangrove stands. The 32 m wide back berm consists of sand stabilized by grass and patches of low running vines. Trees including sea grape are also present just off the transect line. The sandy foreshore is approximately 10 m wide and has a steep seaward slope. The highest elevation measured along Profile 2 occurs at the berm crest 33 m from the edge of the swamp (dry at time of survey) and is 1.4 m as (Figure 5-7).

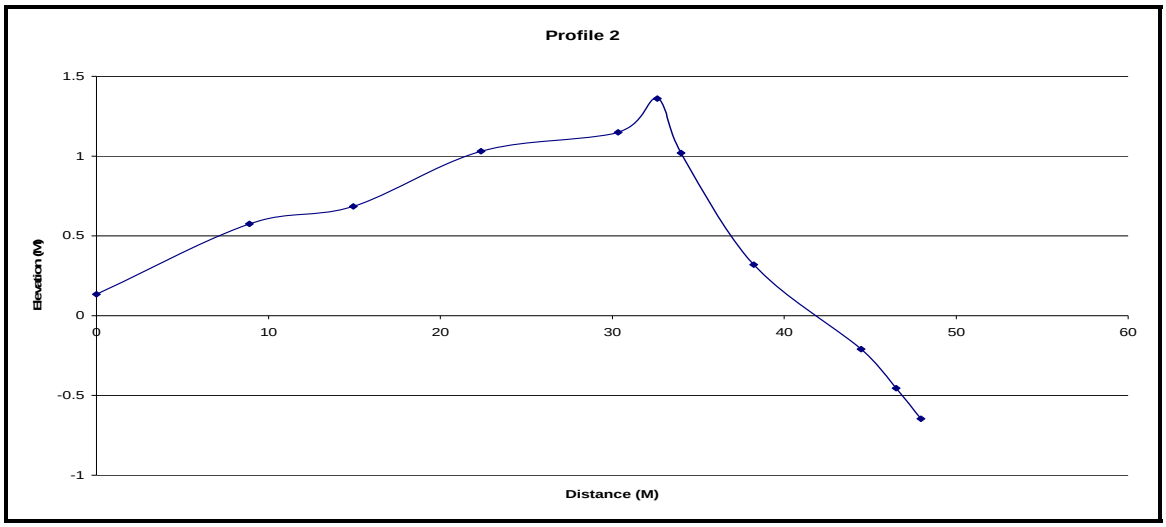


Figure 5-7: Profile 2, east of the site, was measured from the mangrove stands at the edge of the swamp behind the beach to the lower beach face

Profile 3 is located in front of the eastern most coastal swamp, W 77.53762° N18.48756° and was established in line with the western edge of the exposed rock ledge of the Falmouth Formation. This profile was measured from the edge of the coastal swamp, which has a water level elevation of 0.09 m asl, to the landward edge of exposed offshore platform. The profile traverses a 45 m wide back berm that is clearly defined on the seaward edge by the berm crest and fronted by a steep foreshore. The back berm area is stabilized by grass and the berm crest is colonized by low shrubs. The exposed platform is located at the toe of the foreshore and is approximately 12 cm below sea level. The highest elevation measured along profile 3 occurs at the berm crest and is 1.2 m as (Figure 5-8)

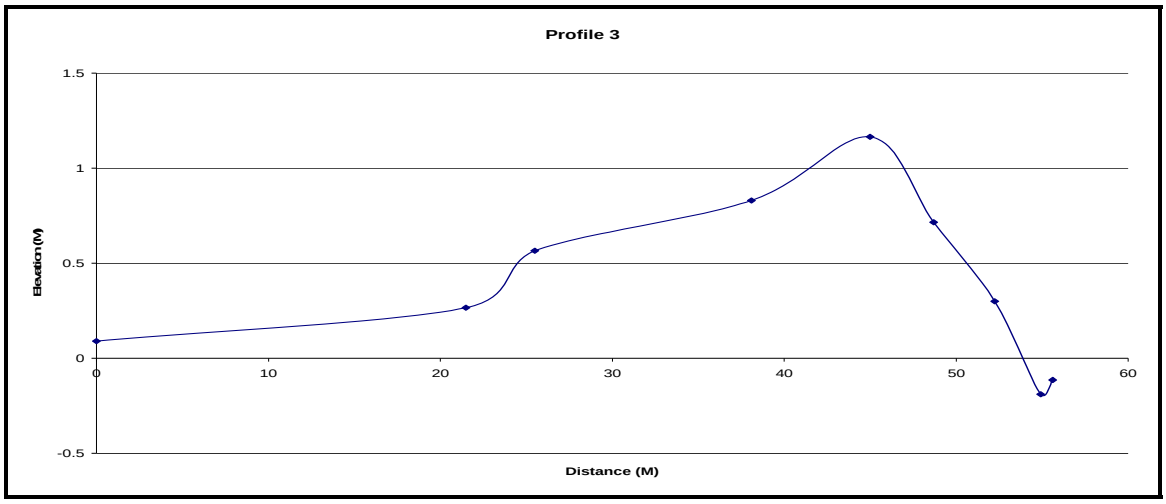


Figure 5-8: Profile 3 was established east of the site to determine the relationship of the offshore platform to the beach system and to the swamp behind

Thus all three profiles show a low but pronounced berm/beach ridge between the beachface and the swamp or wetland zone (see below), averaging less than 1.5 m above sea level. In Profile 3 the back of the berm effectively defines the rear edge of the beach ridge, while the gently sloping profile from there to the edge of the wetland shows some features of the dry parts of the depression.

5.2.2.1.2.3 Beach Sand Composition

Composition and grain size analyses were conducted on samples collected from the eastern section of Duncan Bay at three points across the beach profile the berm, swash and ripple zone.

Compositional analyses of the three samples from this site were combined and identify skeletal and non-skeletal grains as well as minor amounts of lithoclasts which were only identified from the offshore sample. These lithoclasts represent less than 1% of the total samples analyzed whereas skeletal grains contribute between 25% of the total sample; these are primarily molluscs and the coralline algae *Amphiroa.* The most abundant bioclasts contributing to the beach sediment in this area are molluscs and account on average for 11.4% of the skeletal fraction of the sediment, followed by coralline algae *Amphiroa* which account for 8.8%. Other contributors are foraminifera (2.7%), echinoid fragments (1.6%), *Halimeda* (0.4%), and corals (0.2%). The non-skeletal fraction of the sediment includes

amorphous grains (46.2%), crystalline grains (27.7%) and composite grains (1.1%). These results are summarized in Figure 5-9

The major contributing skeletal organisms are commonly found in quiet low velocity sheltered environments and occur at depths ranging from the inter-tidal zone to the lower limit of the photic zone. The molluscs and algae contributing to the sediment grow on sand or gravel and attached to rocks at depths up to 25 m and are commonly found associated with *Thalassia testudinum* beds, the lagoon-back reef-off shore area. Both have been identified as significant producers of carbonate sediment throughout the Caribbean.

The amorphous and crystalline grains which are the major contributors have been interpreted to be diagenetic products of algae and coral fragments produced in the reef and shallow lagoon system and transported onshore resulting in chemical and physical degradation of the grains.

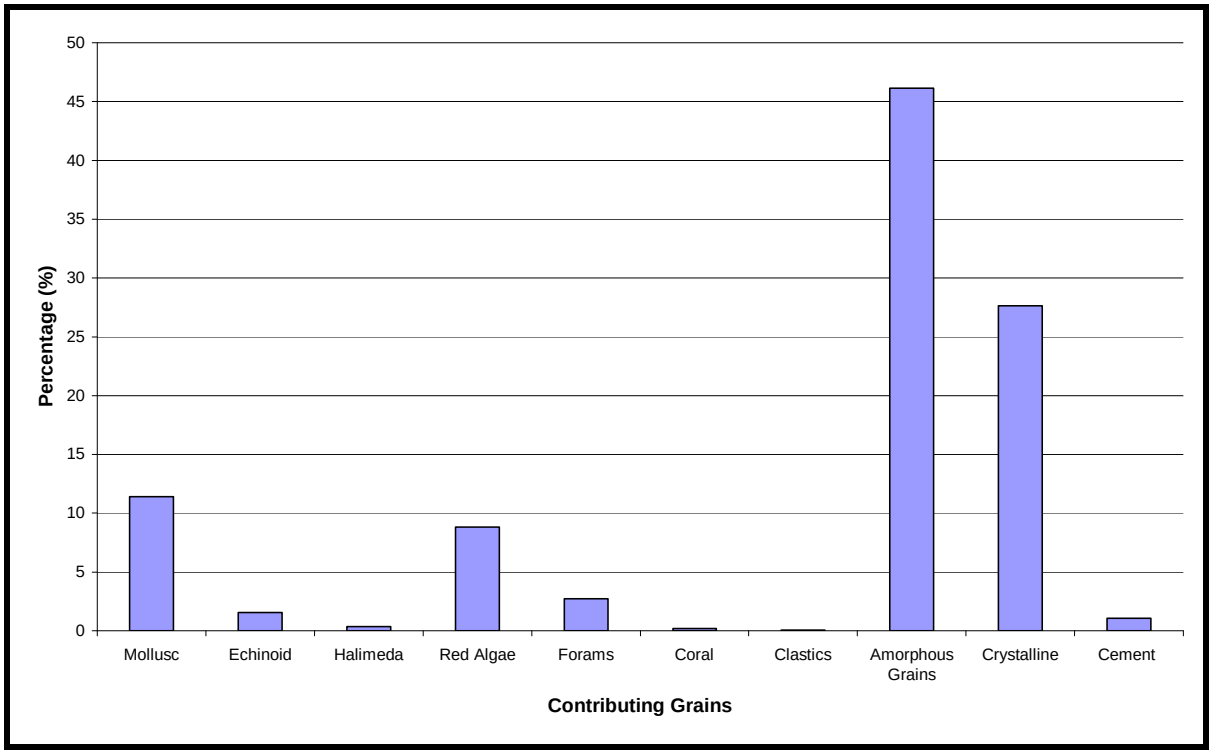


Figure 5-9: Composition of Sediment sampled from Duncan Bay, Trelawny

5.2.2.1.2.4 Movement of beach sand

The predominant wave travel directions, noted in satellite images, air photographs and photographs at and near the site, are from east or northeast towards the west. This implies movement of beach sand along the shoreline from east to west. That this is evident from examination of the existing groynes to the east of the site, at Silver Sands (Plate 5-4). It appears that these groynes are inhibiting the natural movement of sand into the area of the site.

Plate 5-4: Photo taken from Silver Sands looking west, shows westerly moving wave trains along this section of the coast. Note build up of sand along groyne

5.2.2.1.2.5 The Coastal Platform or Ledge

The beaches and wetlands to the west of Silver Sands and as far north as Duncan Cliff are underlain by a prominent Limestone ledge or platform, 25.5 m wide in Zone 1 (Figure 5-5), consisting of rocks of the Falmouth Formation (Late Pleistocene stage 5e). In the area of interest this ledge ranges from being a few centimetres above mean sea level to several centimetres below sea level. As such it has an important, ongoing influence on the quality of the shoreline and beach deposits. At the southern end of the area, Zone 1, rock ledge is about at sea level, and is exposed to continuously breaking waves.

Scattered over its surface is storm debris, consisting of pieces of coral and blocks of the Falmouth Formation derived from the edge of the ledge or near-shore region (Plate 5-5). Beach sand has accumulated at the back of the ledge. Further north, in front of Duncan Cliff and in front of the site the platform is slightly below sea level, Zone 2 (Plate 5-6). Here the beach is mainly sandy, but storm debris from the nearshore area has accumulated in the lagoon behind the beach (Plate 5-7). Immediately north of this stretch of shoreline the ledge is above sea level, Zone 3, (Plate 5-8).

Plate 5-5: Blocks of Falmouth Formation strewn across the platform of the same the lithology, southeast of the site.

Plate 5-6: Platform of the Falmouth Formation exposed just below sea level. Lower section of beach face in fore ground. North part of site and further north

Plate 5-7: Storm debris accumulated in the swamp behind the beach at northern boundary of the site

Plate 5-8: Phytokarst formed along the exposed seaward edge of the platform, north of the site

Here incipient phytokarst weathering is apparent at the seaward edge (Plate 5-8), but the emergent platform behind lacks phytokarst (Plate 5-9), suggesting relatively recent exhumation of the surface from under a cover of sand or thick vegetation. A narrow zone of beach sand lies at the rear of the platform.

Plate 5-9: Platform in zone 3 occurs slightly above sea level. The more landward sections are smooth, lacking phytokarst, which is evident along the seaward edges (right)

5.2.2.1.2.6 Beachrock

Exposures of beachrock were noted in front of the beach at the site (Figure 5-5 and Plate 5-10). It is separately distinguished from the Falmouth Formation ledge as it occurs on top of the ledge and consists of material resembling the modern beach sand.

Plate 5-10: Beach rock in front of site

5.2.2.1.2.7 Depression behind the Beach Ridge

The area behind the beach ridge is at or slightly above sea level, forming a depression between the beach ridge and the limestone cliff and low hill slopes to the rear. It contains two water-covered areas, surrounded by dry parts of the depression which are probably flooded from time to time. The southern part of the depression supports grass and low shrubs, while in the central and northern parts it is floored with dried out sand and silt, largely covered with black mangrove (Plate 5-11).

Plate 5-11: Black mangroves in depression behind beach. Photo taken at southern boundary of site

5.2.2.1.2.8 Northern Lagoon

The northern wetland area is properly termed a small lagoon, filled with reddish coloured water and situated between the beach ridge and Duncan Cliff. It is floored by the Falmouth Formation and contains significant quantities of rock debris (Plate 5-12). The identification of the Falmouth Formation as the main component of the debris means that this material is storm debris derived from the ocean and not blocks that have fallen off Duncan Cliff.

Plate 5-12: General view of northern lagoon in front of Duncan cliff (left)

5.2.2.1.2.9 Southern Wetland

The southern wetland is situated behind a dry part of the depression and the road. The water is clear in comparison with that of the northern lagoon. The wetland, under at least a semi-permanent body of water, supports vegetation and diverse bird life. The entire area, dry and wet (Plate 5-13), is underlain by the Falmouth Formation (Plate 5-14). The significance of this wetland is further discussed in Section 5.2.3: Hydrology.

Plate 5-13: View of Southern Pond, drier part of the depression in foreground. Site is to the left

Plate 5-14: Falmouth Formation exposed in floor of southern depression

5.2.2.1.2.10 Duncan Cliff

The extent of the cliff behind the coastal zone is shown on Figure 5-5. It varies in height from some 10 m in the central part to seven or eight metres at its northern end. To the south, in the site, it becomes less well-defined and is not seen at the road leading up to the site.

There is a distinctive, ancient sea-level notch carved into the cliff along most of its extent (Plate 5-15 and Plate 5-16). It remains one of the most interesting and best preserved sea-level notches in Jamaica since construction of the North Coast Highway destroyed large sections of the same notch in the Discovery Bay and Rio Bueno region. The notch is at about 2 m above the level of the back of the Falmouth Formation and was evidently formed during the high sea-level stand when the Falmouth Formation was deposited. The notch antedates the last major glacial period and, based on dating from other localities in Jamaica and the Caribbean, was formed approximately 120,000 years ago (Horsfield, 1972). The proposed development will in no way affect this coastal feature.

Importantly, the notch and cliff are gently tilted to the north indicating significant earth movements within the past 120,000 years. This is further discussed in Section 5.3.1.

Plate 5-15: View of Duncan Cliff behind northern Pond. Site to left of photo

Plate 5-16: Sea Level notch etched into Duncan Cliff

5.2.2.2 Geology

Four geological formations are distinguished. (Figure 5-10 modified from Geological Sheet 8 of the Mines and Geology Division). The units are described in turn.

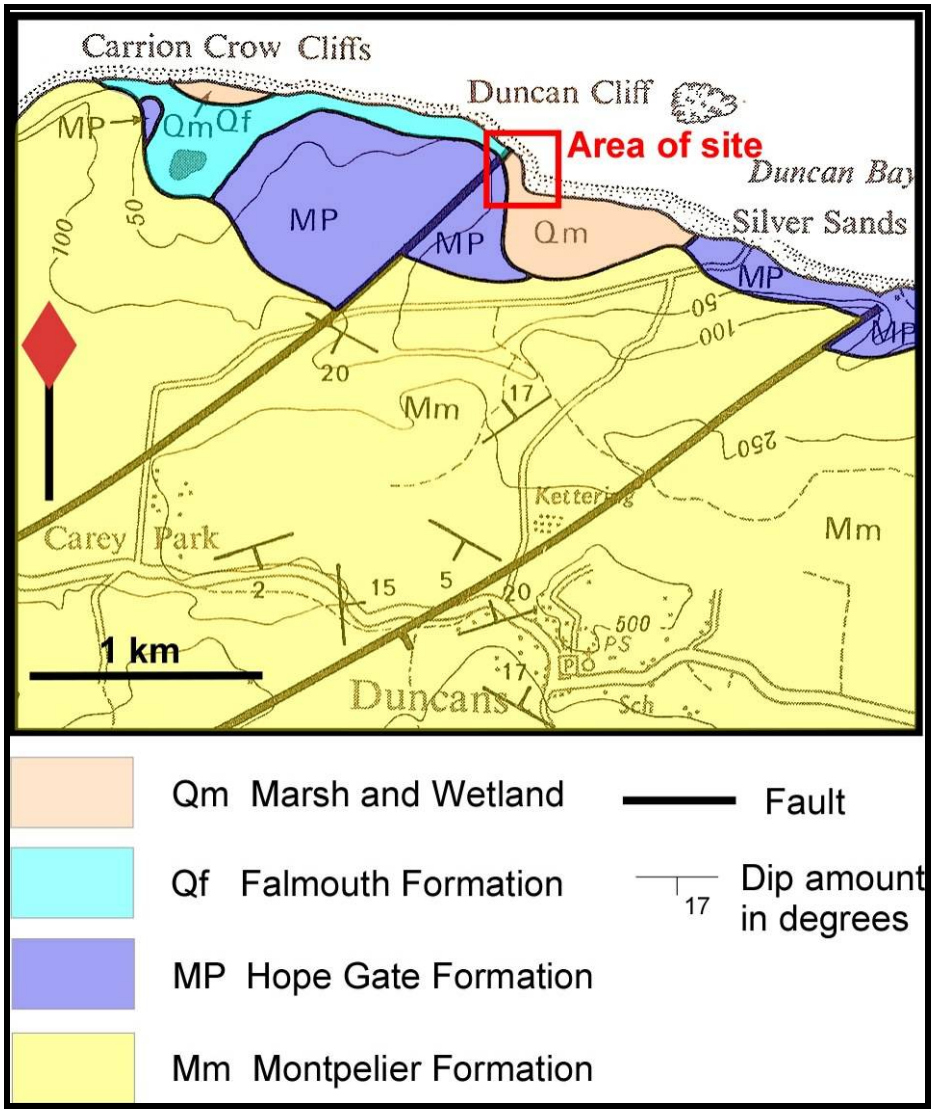


Figure 5-10: Geological Map of the area taken from sheet 8 of the Mines & Geology Division

5.2.2.2.1 Montpelier Limestone Formation (Upper Miocene)

The Montpelier Formation is the major lithostratigraphic unit in the region. It is exposed in the road leading up to the site (Plate 5-17), in contrast to the map, where Hope Gate Formation is indicated. It consists of well-bedded chalky, often friable limestone with occasional chert bands, and forms the hilly region behind the coastal cliffs. As seen in road-cuts of the North Coast Highway this formation has been extensively folded and faulted, between Duncans and Falmouth.

Plate 5-17: Exposure of Montpelier limestone on the road leading to the site

5.2.2.2.2 Hope Gate Formation (Pliocene to lower Pleistocene)

North of the site the samples collected appear to belong to the Hope Gate Formation. Here it is a massive, well-lithified limestone that also forms the escarpment of Duncan Cliff.

5.2.2.2.3 Falmouth Formation (upper Pleistocene)

The Falmouth Formation is the youngest rock unit below the superficial deposits. As mentioned above it forms the coastal platform in front of Duncan Cliff and consists of well-lithified, fossiliferous grains and other debris, formed in a coastal environment during the last

high sea level stand, before the last glacial period (Plate 5-18). On its western side the Falmouth Formation platform is truncated against the Hope Gate Formation of Duncan cliff.

Plate 5-18: Conch shell weathering out of Falmouth Formation, exposed on the coastal platform in front of Duncan Cliff

5.2.2.2.4 Superficial Deposits

Superficial deposits consist of wetland sediments, beach sand, modified (weathered) beach sand around the wetlands and blocks of rock forming storm deposits.

5.2.2.2.5 Structure

All the formations apart from the superficial deposits have been folded and faulted (Geological Sheet 8 of the Mines and Geology Division). The map (Figure 5-10) shows a northeast trending set of faults cutting and offsetting the boundaries of the Montpelier and Hope Gate Formations. Horsfield (1972) has shown that the Falmouth Formation itself has undergone significant warping and fracturing since it was deposited. Of particular interest is the fault which is shown to pass near the site on Figure 5-10. This fault was re-located slightly south of its published position on the official map, to correspond with the offset in the Falmouth Formation ledge and the southern truncation of Duncan Cliff. The relocated position is shown on Figure 5-5.

5.2.3 *Hydrology and Groundwater Resources*

Regionally the Montpelier Formation is regarded as being an aquiclude (sidebar on Geological Sheet 8), while flow in the Hope Gate and Falmouth Formations is probably secondary, through fractures in the limestones. In any event the surface area (catchment) of these two units is very small (Figure 5-5). On the other hand the major fault indicated extends back for several kilometres through the Montpelier Formation. It also passes below the site of the southern wetland. Despite the general impervious nature of the regional rocks, it is possible that the fault plane acts as a conduit for groundwater, possibly even with some connection to the southern wetland. These possibilities require further work, including water analyses of the two wetlands and extended monitoring of the southern pond. While it is anticipated that drilling locally for a water supply would not provide significant yields, the possibility of such a supply is noted here.

Both the wetland water surfaces and the dried flats with black mangrove behind the beach ridge were measured and all three profiles found to be several centimetres above sea-level on a rising tide (Figure 5-6 to Figure 5-8). This suggests limited connection between the wetlands and the sea.

5.2.3.1 Surface Water Quality

The results of the water quality analysis, generated from one sampling period, indicated that almost all baseline parameters analysed for the salina did not exceed NEPA standard (Table 5-2). Sampling occurred after a recent rainfall event, as such, it is possible the results obtained may be elevated in comparison to normal. Total suspended solids (TSS) and total dissolved solids (TDS) were higher than the standard accepted range. The pH was also higher than expected, being more in line with marine waters which are usually of a pH of 8-9. It is therefore possible saline intrusion may be associated with this result, though not identified in the section on geology.

Similarly, there were higher than expected values for the mangrove area, namely, TSS, TDS, biological oxygen demand (BOD), and nitrates. However, the results obtained are not substantially uncharacteristic of mangrove areas as the fine silt particles present become easily suspended (which accounts the high TSS). The high organic content provides food on which the micro-organisms thrive, thereby utilizing the oxygen present in the area to respire

aerobically (respiration with oxygen) which result in increased level of BOD and low DO level.

The results from assessment corroborate that the conditions existing at both areas are fairly normal and in a good state based on standards stipulated. The proposed development will take into consideration the characteristics of both sites in the design and make every effort to ensure that the area is maintained in a better quality atmosphere with conditions being no less than what presently obtains.

Table 5-2: Water Quality Data for Proposed Site [Mangrove & Salina]

ANALYTICAL METHOD	PARAMETER	Mangrove [Site 1]	Salina [Site 2]	NEPA Standard
SMEW Method 9221	Total Coliform (MPN/100ml)	<3	<3	<500
SMEW Method 9221	Faecal Coliform MPN/100mL	<3	<3	<100
HACH Method 8190	Total Phosphate (mg/L)	<0.3	0	5
SMEW Method 2540D	Total Suspended Solids (mg/L)	286	232	<150
SMEW Method 2540C	Total Dissolved Solids (mg/L)	59.08×10^3	19.08×10^3	1000
SMEW Method 4500-H	pH	8.80	8.4	6.5 – 8.5
HACH, Method 8043	BOD (mg/L)	94.5	0.6	<30
	DO (mg/L)	1.55	10.12	>4
HACH, Method 8049 & 8171	Nitrate (mg/L)	11.88	0.88	10
YSI/SCT	Salinity%	35.5	25.5	

5.2.4 *Existing Land-Use*

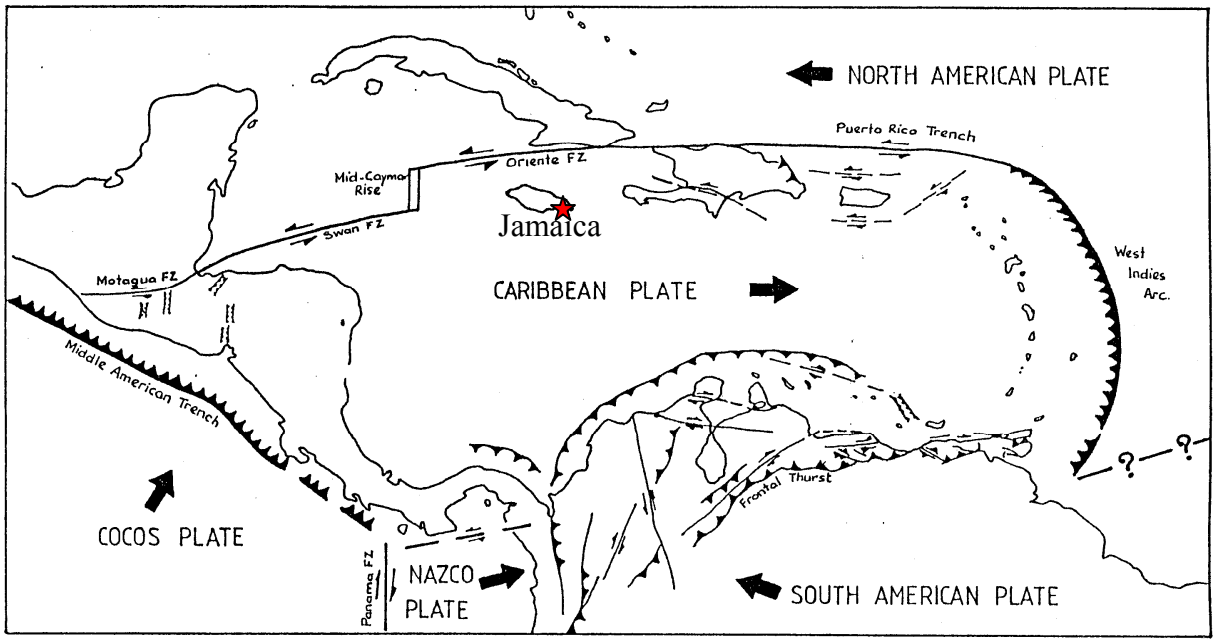
The Duncan Bay area is primarily a residential and privately-owned villa community. Aside from tourism, there are no other existing land-use characteristics. A very small boating community is also in the area.

5.3 Hazard and Risk Assessment

5.3.1 *Seismic and Tsunami Vulnerability*

5.3.1.1 Seismic Vulnerability

The island sits on the Bartlett (Cayman) Trough, which is the major seismic feature in the region. The region's demonstrated susceptibility to liquefaction and ground failure during moderate sized earthquakes makes it extremely vulnerable to economic disruption as well as loss of life (Figure 5-11).



Tectonic Setting of the Caribbean
(after Molnar and Sykes, 1969)

Figure 5-11: Tectonic Setting of Jamaica

The presence here and at other places between Falmouth and Discovery Bay of extensive fault systems affecting the youngest rocks observed (Falmouth Formation) indicates that some at least of these faults must be considered as still active. At White Bay (Horsfield, 1972) a single faulted offset of the sea level notch of more than one metre occurs within a set of fractures, downthrowing the notch to the west a total of about three metres. As an example, assume a constant rate of stress build-up, and assume a uniform, intermittent strain accommodation of 1 cm displacement per seismic event. To give the observed offset of 3 m

over 120,000 years, there would be, on average, one such seismic event about every 400 years.

There is no direct evidence of very recent fault activity at Duncan Cliff. Also, although local faults might still be active, the potential damage that would result from a large regional seismic event needs to be considered. Figure 5-12 shows the frequency of events of Modified Mercalli VI or greater over Jamaica. The site lies within the zone of 5-9 such events per century.

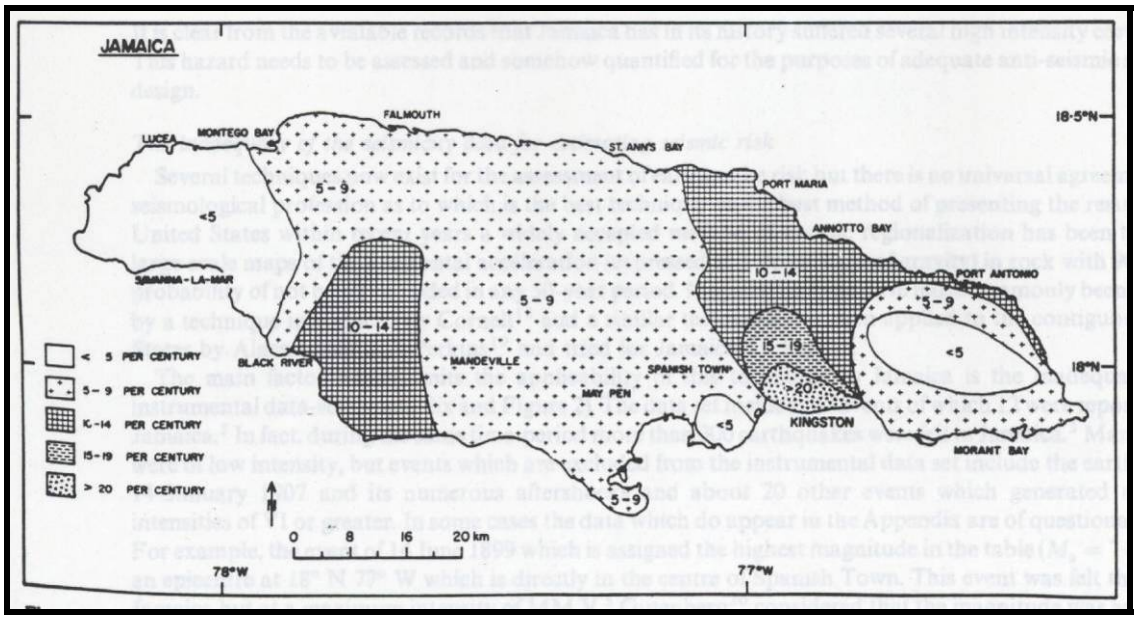


Figure 5-12 Map showing number of times per century that intensities of MM VI or greater have been reported, 1880-1960 (from Shepherd & Aspinall, 1980).

According to the USGS Earthquake Density Map, Jamaica fall in the lowest category regarding the average number of earthquakes per year with a magnitude 5 and Greater at all depths (Figure 5-13). However, it should be noted that Jamaica also peak ground acceleration of 2.4 - 4.8 m/s with a 10% probability of exceedance in 50 years which is high in respect of all Caribbean countries. The last major earthquake felt was the magnitude 5.1 earthquake of June 12, 2005 that took place on Sunday night 10:58 pm near Aenon Town in Manchester. Prior to that only three major events are recorded that had significant damage histories; the 1993: Blue Mountains – St. Andrew, 1907: Kingston, and 1692: Port Royal events.

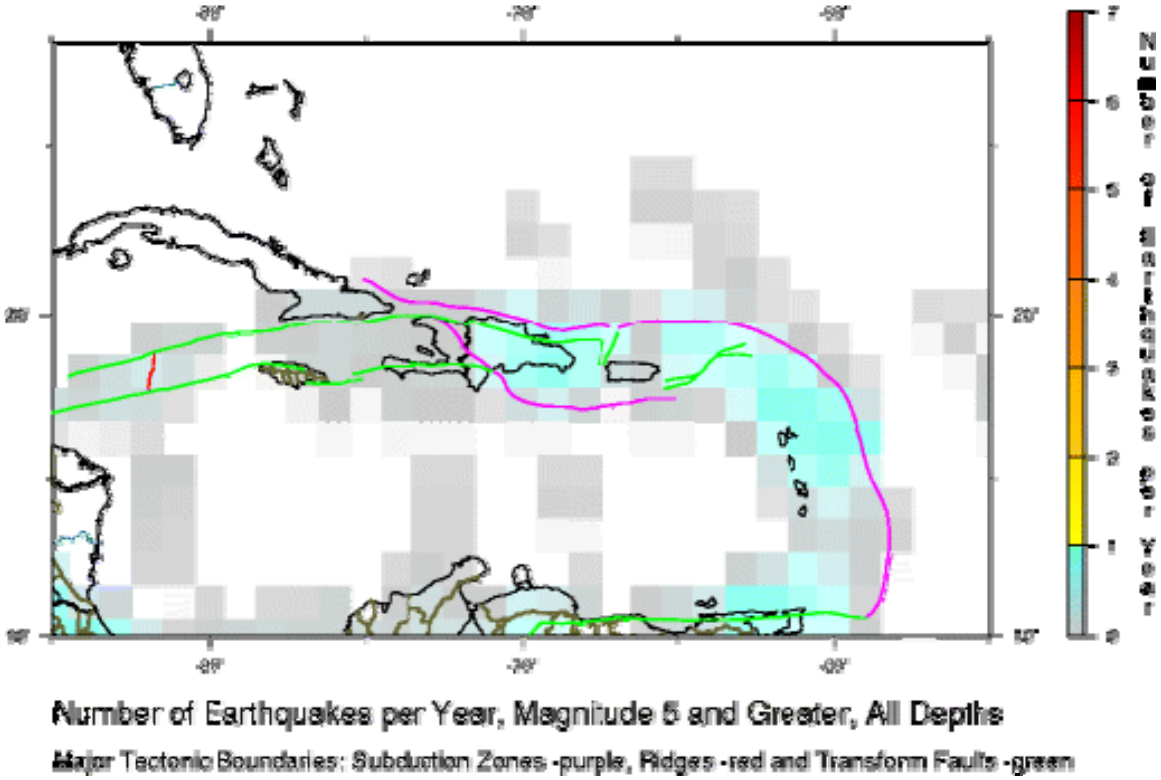


Figure 5-13: Average Number of Earthquakes per Year, Magnitude 5 and Greater in the Caribbean[6]

The severity of an earthquake is generally expressed in two ways, magnitude and intensity. The intensity as expressed by the Modified Mercalli intensity scale, is a partly subjective measure which depends on the effects of a quake, such as damage, at a particular location. Although there is only one magnitude number for a selected earthquake, there may be many values of intensity. On the Modified Mercalli intensity scale, values range from I to XII. The most commonly used adaptation covers the range of intensity from the conditions of MMI - not felt except by very few, favourably situated," to MMXII - damage total, lines of sight disturbed, objects thrown into the air." While an earthquake has only one magnitude, it can have many intensities, which decrease with distance from the epicentre. The Duncan Bay site has an expected Maximum Mercalli Intensity of 6 (MMVI) - Felt by all: many frightened and run outdoors; damage minor to moderate (Figure 5-14 below).

[6] USGS Earthquake Hazards program, http://earthquake.usgs.gov/regional/world/caribbean/density.php

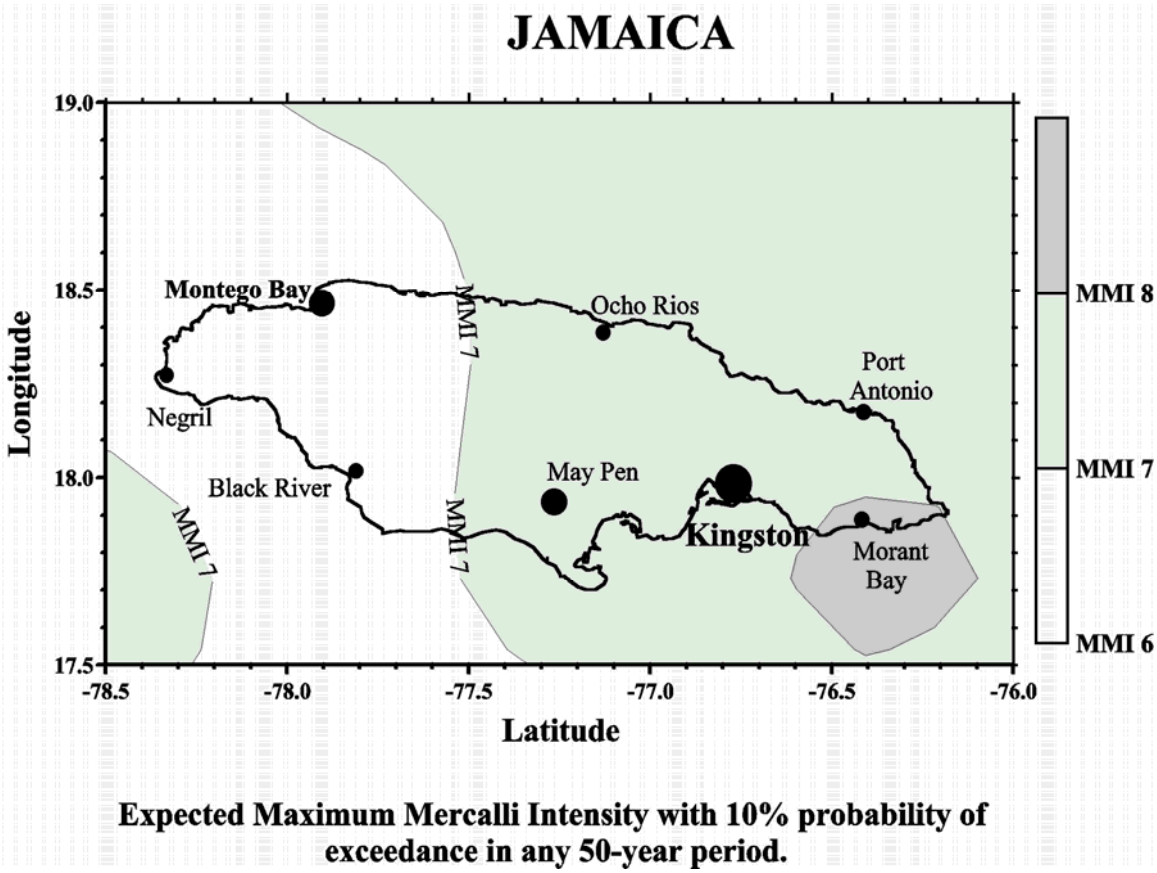


Figure 5-14: Expected Maximum Mercalli Intensity[7]

With respect to seismic risk, the present design approach calls for adoption of the Uniform Building Code (UBC), which categorizes varying locations in the world into Zones. An increasing Zone number implies a greater risk of more frequent and intense, earthquakes. For Jamaica, the UBC recommends Zone 3 in general outside the Kingston Metropolitan area (Zone 4). Zones 3 and 4 correspond approximately to Richter magnitudes 5-6 and 6-7 respectively.

5.3.1.1.1 Bedrock Stability

The presence of a sea level notch in Duncan Cliff leads to the possibility of ancient sea-cave formation within the cliff. A small example of this was noted north of the site area. Due to impenetrable undergrowth it was not possible to examine that part of the cliff terminating in

[7] Caribbean Disaster Mitigation Project, http://www.oas.org/CDMP/document/seismap/jamaica.htm, Accessed August 2006

the area of the site. However, checking for ancient sea caves and other possible weaknesses in the limestone bedrock should be carried out when the site is cleared.

5.3.1.2 Tsunami Vulnerability

The possibility of tsunami inundation cannot be ruled out. Jamaica lies within the fault complex associated with the boundary between the Caribbean Plate and the North American Plate (Figure 5-15). As such the island and its vicinity experience frequent earthquakes. The north coast of the island is particularly vulnerable to possible tsunami events. These may result from direct displacement of rock strata during an earthquake, or may be propagated by submarine slides resulting either from earthquake vibrations or, possibly, from unusual meteorological events, such as a severe hurricane The Jamaican experience indicates that tsunami events are dominantly of local origin, probably from submarine slides. However, along the north shore tsunami emanating directly from displacements along the Oriente Fracture Zone (Figure 5-15) could be destructive.

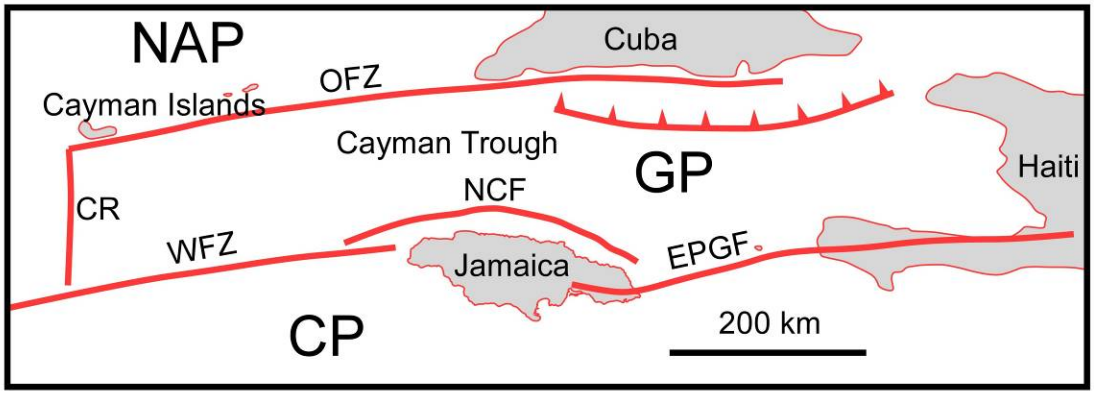


Figure 5-15: Simplified structural map of the Cayman Trough and surrounding islands. Thick red lines are faults/ fracture systems. CR, Cayman Ridge; OFZ, Oriente Fracture Zone; WPZ, Walton Fracture Zone; NCF, North Coast Fault; EPGF, Enriqillo-Plantain Garden Fault; GP, Gonave Microplate; CP, Caribbean Plate; NAP, North /American Plate. (Data redrawn from various sources)

Should a Magnitude 9 event occur off the south coast of Cuba, say at a distance similar to that of February 4, 2007, from a magnitude 6.1 earthquake on the Oriente Fracture Zone, 100 km west-north-west of Montego Bay and felt island-wide (Earthquake Unit website: www.mona.uwi.edu/earthquake/) the first tsunami waves would arrive at the Jamaican coast less than ten minutes later. The last documented tsunami resulted from the 1907 earthquake, perhaps through submarine slope failure. The affected coast extended from Port Antonio to St. Ann's Bay (Figure 5-16) and run-up heights were reported to be up to 2.5 m across the

shore and up to 9 m against higher ground at Annotto Bay (Taber, 1920). Tsunami return periods are not known for Jamaica. Perhaps one per century is possible on average. No tsunami is known to have affected the coastline near Duncan Bay.

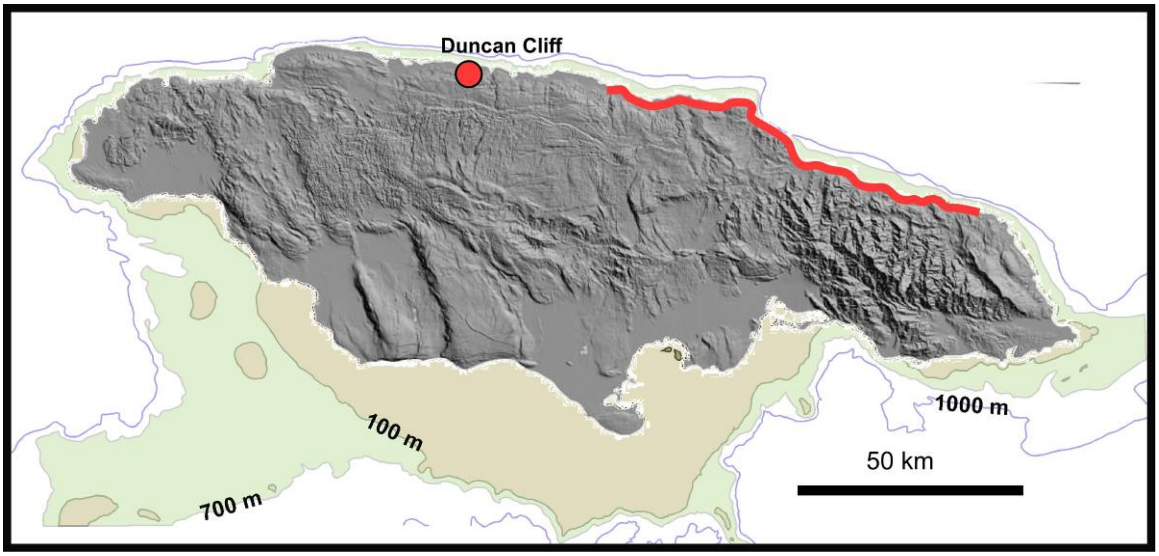


Figure 5-16 Map showing location of Duncan Cliff in relation to the known extent of the tsunami of 1907 (red line; data from Cornish, 1908).

The World Map of Natural Hazards prepared by Munich re shows the entire coastline of Jamaica exposed to tsunami. Duncan Bay is located behind the fringing coral reefs that ring most of the North Coast. Despite the protection from the coral reefs, the area does bear some risk, albeit negligible.

Table 5-3 is list of historical events that are suspected or have affected Jamaica in the past 400+ years based on a preliminary list of Caribbean Tsunamis generated by the University of Colorado in USA[8].

[8] Caribbean Tsunamis: An Initial History, James F. Lander and Lowell S. Whiteside CIRES, University of Colorado.
http://poseidon.uprm.edu/lander/tabla1a.htm

Table 5-3: Suspected Tsunami Events to have affected Jamaica

Origin Data		Tsunami Data		
Date	**Area**	**Location of Effects**	**Run up** Amn (m)	**Comments**
1688 03 01	Jamaica	Port Royal, Jamaica		Shocks felt throughout the island and waves damaged ships in Port Royal. A ship at sea was damaged by a hurricane. No hurricane was reported.
1692 06 07 [11:40 Local Time (LT)]	Jamaica	Port Royal, Jamaica		Earthquake and subsidence destroyed 90% of the buildings in the city. Ships overturned, a frigate washed over tops of buildings. A wave 6 ft high traversed the bay. Along the coast of Liganee (possibly Liguanea Plain) the sea withdrew 183 or 274 m, exposing the bottom; upon returning the water overflowed the greater part of the shore. At Yallhouse (possibly Yallahs) the sea is said to have retired about 1.6 km. At Saint Anns Bay a large wave was reported. 2000 people killed by the earthquake and tsunami.
1766 06 11 [4:05 UT]	Cuba	Jamaica		An earthquake lasting 1-1/2 to 7 minutes hit Santiago de Cuba and Bayamo. Ships at sea 7.2 km from the coast of Jamaica rolled so much that their gunwales were immersed in the water. Ships in deep water would not experience a tsunami. Either the ships were near the coast or in shoaling water or the wave was a storm wave but no storm was reported
1780 10 03 [22:00 LT]	Jamaica	Savanna La Mar, Jamaica	3.0	An earthquake occurred during a hurricane at 22:00 LT The sea rose to a height of 3 m at 0.8 from the beach and swept away a number of houses. Ten people were killed by the wave and about 300 more by the storm. All vessels in the bay were dashed to pieces or driven onshore. Waves may have been storm surge
1781 09 01 [14:20 LT]	Jamaica	Jamaica		In 1781 a series of waves and disastrous earthquakes nearly ruined the Island. There are no reports of earthquakes for this day, but there are reports of a major hurricane on Aug I at 14:20 LT.
1787 10 27	Jamaica	Montego Bay, Jamaica		A small local shock was felt at Montego Bay and the vessels in the harbour were agitated. Mallet reports earthquakes in Jamaica on Oct 1 and 21 at Kingston and Port Royal. This would be a low validity report as no wave was cited and the agitation may have been a report of a seaquake effect.
1812 11 11 [10:50 UT]	Jamaica	Jamaica		The sea was much agitated following an earthquake. This could describe wave action or seaquake action.
Caribbean Tsunamis: An Initial History, James F. Lander and Lowell S. Whiteside CIRES, University of Colorado.				

5.3.2 *Hurricane Vulnerability*

Hurricanes are a serious seasonal threat from June to November; since 1886, 21 hurricanes have made landfall in Jamaica, while over 100 have passed within 240 km (150 miles) of the island. Tsunamis are also a major risk.

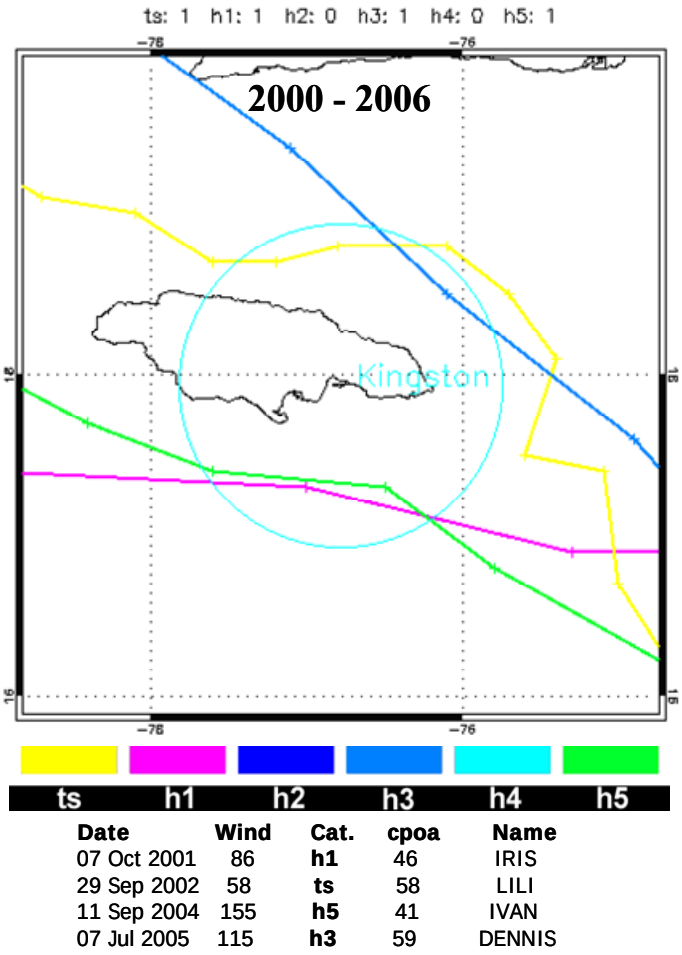
Considerations have been given to issues related to storm water and potential for erosion during the construction and operational phases of the development. As such, a storm water management system, involving the use of drains and absorption pits (French drains) has been recommended.

Using Sangster International Airport in Montego Bay as a reference point location: 18.50N 77.92W, all recorded tropical storm and hurricane activity over a period of 100 years are considered to estimate any trends related to the hurricane activity and the return period of such activities to the island[9]. This can be done confidently as Jamaica is a small island and is likely to be affected wholly regardless of the point of approach of a tropical depression or storm system.

So far this year, no hurricanes have affected the island. However, the island was last affected during the 2005 cycle by two storms, both considered big hurricanes (Category 3 and above) on either side of the island. No significant storm surge activity was recorded along the north coast that affected the property.

Analyses of tropical systems passing within 60nm (= 60mi.) of the island is shown below. Latitude/longitude coordinates (18.50N, 77.92W) used is for Sangster International Airport, one of the island weather stations. Figure 5-17 below shows the storm track for tropical systems passing by for the period 2000-2006. Figure 5-18 shows whether there are more storms lately or which 5-year period in the last 60+ years was most active.

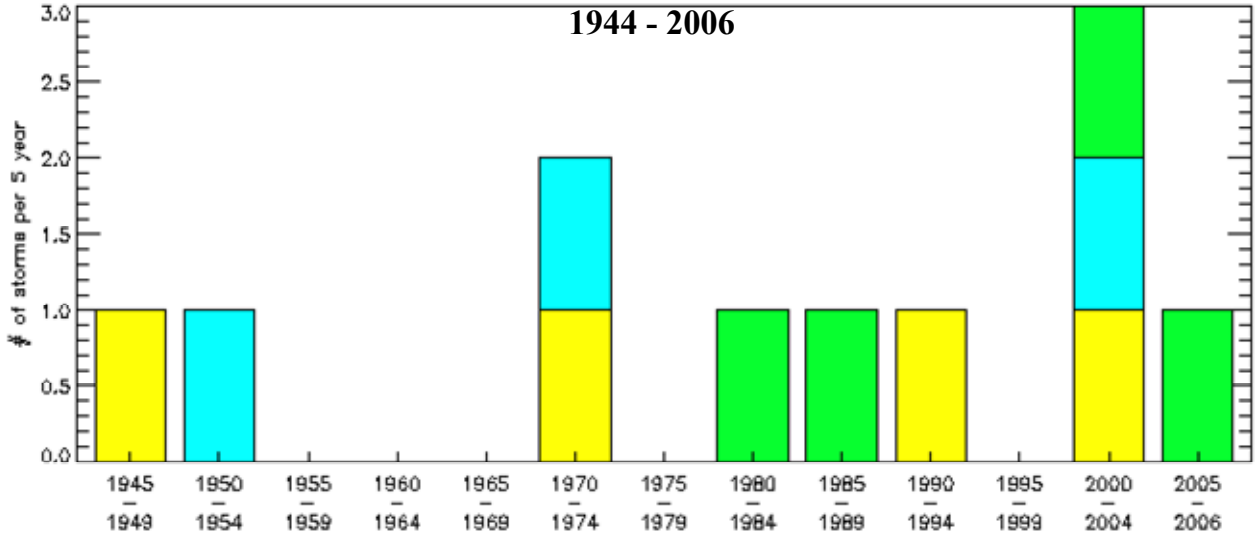
[9] StormCarib – Caribbean Hurricane Network
http://stormcarib.com/climatology/



Date	Wind	Cat.	cpoa	Name
07 Oct 2001	86	**h1**	46	IRIS
29 Sep 2002	58	**ts**	58	LILI
11 Sep 2004	155	**h5**	41	IVAN
07 Jul 2005	115	**h3**	59	DENNIS

Figure 5-17: Hurricane Storm track for the Period 2000-2006[10]

[10] StormCarib – Caribbean Hurricane Network
http://stormcarib.com/climatology/MKJP_dec_isl.htm



Most active 5 year period since 1944: **category 3-5 hurricanes: green; category 1-2: blue; tropical storms: yellow**

Most storms: 2000-2004 (4)
Most hurricanes: 2000-2004 (2)
Most severe hurricanes: 1980-1984, 1985-1989, 2000-2004, 2005 only (1)

Figure 5-18: Hurricane Activity for the Period 1944 – 2006[11]

5.3.3 *Flooding and Storm Surge Potential*

The area experiences marginal ponding in the vicinity of the salina. However, this area appears to be adequately drained by the adjoining mangrove swamp. The proposed lot is of higher elevation and does not experience any flooding. It is situated on limestone bedrock and drains well. No reported incidence of flooding has been found in the literature reviewed.

The general Duncan Bay area is fairly flat and in itself may be prone to instances of ponding. However, the topography of the lot does not compound this potential problem because it drains towards the mangrove swamp and salina, and away from the general community.

During extreme precipitation the normally dry drainage channels and depressions carved into a limestone landscape can become torrents and lakes as the infiltration capacity of the soil and underlying rocks is overwhelmed. At the site the main result of extreme rainfall will be at least temporary flooding of the entire depression. This may extend across the approach road from Silver Sands.

[11] StormCarib – Caribbean Hurricane Network
http://stormcarib.com/climatology/MKJP_dec_isl.htm

The presence of storm debris, including small boulders, in the depression is evidence of past inundation and potential damaging effects from hurricane surges that have exceeded the 1 to 1.5 m high beach ridge. The last major hurricane to affect the north coast was Hurricane Allen (August 1980). The subsequent survey of this hurricane's impact has not shown anything unusual for the then uninhabited Duncan Cliff area, but flooding and damage to buildings was reported from Silver Sands (Wilmot-Simpson, C., 1980). Watson (2000) estimated storm surge heights of approximately 1 to 1.2 m for the 50 year storm, and about 1.5 m for the 100 year storm for this general section of the coastline. That these estimates may be on the low side is suggested by the report on surge height return periods for Montego Bay, where surge heights of 2.0 to 2.4 m were calculated for the 50 year event and 2.6 to 2.7 m for the 100 year event (Figure 5-19) (Smith Warner, 1999). The main buildings will all be at higher elevations than can be expected from such an event.

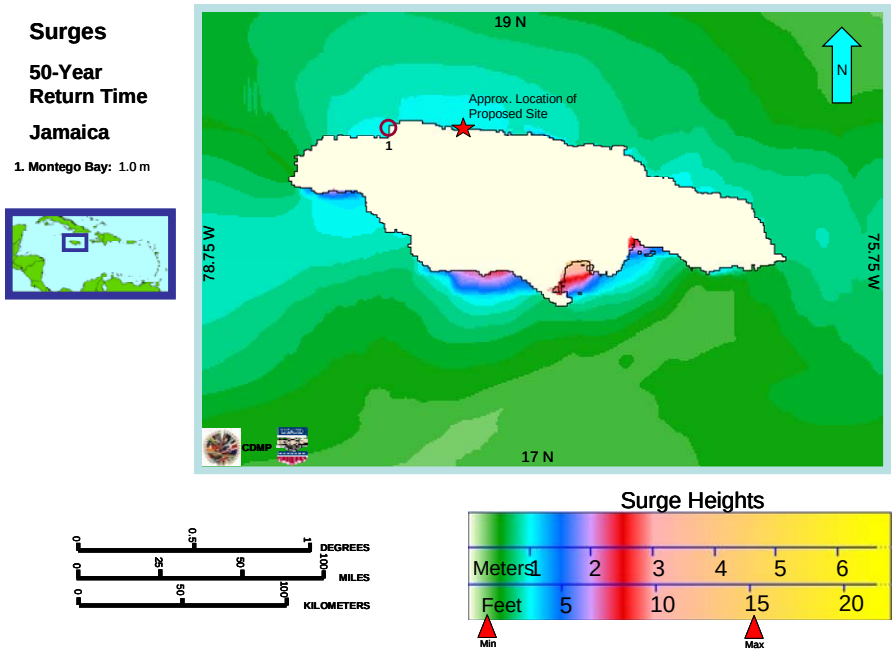


Figure 5-19: Surge Potential for a 50 Year Return Period[12]

5.3.4 *Sea Level Rise*

Most scientists agree that sea level has been rising for at least the last 100 years as a result of global warming. Presently the rate of rise is about 3 mm/yr but this will probably accelerate

[12] Storm Surge Mapping for Montego Bay, Jamaica, USAID-OAS Caribbean Disaster Mitigation Project, Report prepared by Smith Warner International Ltd, September 1999

into the future. The rise is the result of a) the expansion of the surface waters of the ocean due to the rise in temperature, and b) because most of the world's glaciers and ice caps are melting, adding the meltwater to the oceans (Robinson et al. 2006). The latest report from the Intergovernmental Panel on Climate Change (IPCC) suggests that the rise will reach as much as 0.59 m higher than present by the end of the century. Greater increases are possible if certain ice sheets become unstable.

5.3.5 *Overall Assessment of Natural Hazard Vulnerability*

The site is not prone to any significant hazard vulnerability that cannot be overcome through the typical construction techniques currently in use in Jamaica. All best practices will be utilised during construction and operation of this facility.

The main conclusions evident are:

- The bedrock at the site is limestone that appears suitable as foundation for medium-sized buildings. However, the site should be inspected for cave systems within the limestone. Given the friable nature of the Montpelier limestones along the road, the normal complement of boreholes should be drilled to an adequate depth for geotechnical assessment.
- The beach and beach ridge are relatively narrow and deposited on the Falmouth Formation rock ledge at no great depth. Sand replenishment may become a problem due to presence of groynes up-current of the westerly longshore drift if natural replenishment from the nearshore area does not occur. This aspect should be further investigated by taking current measurements and visually assessing the sand offshore.
- The implementation of any groynes should take note of the natural currents and direction of longshore drift. As such, only groynes allowing the normal movement of sand are recommended, similar to Palisadoes Groynes, using the existing patterns of designs to prevent erosion and encourage more strengthening of the shoreline.
- Flooding of the low-lying area (depression) will occur in times of heavy rainfall.
- The coast is susceptible to surges of at least 1.5 m from severe hurricanes.
- The coast is also vulnerable to seismic events generating tsunami.

- The pond/wetland hydrology immediately south of the site may be partly governed by fault plane-related groundwater.

5.4 Biological Environment

5.4.1 *Floral Resources*

5.4.1.1 Methodology

The survey entailed ground-truthing using GPS and an assessment of the flora and fauna of the general area. Avifauna was recorded by site and sound. Aerial photography (video and still) and satellite imagery were also used in the analysis. A literature review of the flora and fauna of the area was also conducted

A "walk-through" survey was conducted throughout the entire property. All macroscopic plant species were recorded and, where possible, identified in the field. Unidentified species were collected and compared with a Herbarium collection for classification. Each species was then checked against known Jamaican plant taxonomy literature for endemism and rarity.

The buffer zone used to properly characterise the area was 300 m.

5.4.1.2 Findings

The area can be characterized as a coastal limestone forest with trees and/or tall shrubs. The proposed site is a distinct lot of 2 ha (5 acres) within the Duncan Bay community. The majority of the lot is on limestone bedrock and forms the beginning of the eastern abutment of the Duncan Cliff, the western boundary of Duncan Bay.

A total of 117 species of plants were identified (Table 9-1). A photo-inventory is included Appendix V

Three zones were identified during the assessment:

1. The Salina, Mangrove Swamp and Beach
2. The Higher Limestone Forest
3. The lowland scrub thicket of nearby vacant lots

The salina and mangrove swamp areas are highlighted by plants that are tolerant of salt and dry conditions. The salina is approximately 100-150 m long and 45 m wide. These are plants that can withstand high saline and drought conditions. The salina was characterised by a large inundated area bordered by plants such as *Ipomea pes-caprae* and *Batis maritima* (salt wort) to the west and north, black mangroves (*Avicennia germinans*) to the north and east, and various adventitious and invasive plants such as Acacia to the south (roadway). Black mangrove pneumatophores were found particularly around the salina. The salina appears to be fed via run-off from the roadway and limestone forest through east trending honey-comb limestone channels, as well as saltwater intrusion from the Caribbean Sea. This area then drains south-east to north-west into the mangrove areas, extending around the seaward edge of the cliffs. It appears that levelling activities may have been attempted in the past in the region of the salina because red sandstone was found towards the eastern end on the salina. This type of material is not indicative of the region which is primarily of the white limestone group.

The mangrove swamp area was inhabited by four mangrove species, black, red (*Rhizophora mangle*), white (*Laguncularia racemosa*), and button (Conocarpus erectus). The red mangrove was found mainly fronting the seaward extent of the swamp, with black mangrove predominant bordering the other areas. Mangrove trees were 3-5 m tall with an average diameter at breast height (dbh) of 32 cm. Along the beach were found sea grape (*Cocoloba uvifera*), seaside mahoe (*Thespesia populnea*), *Ipomea pes-caprae,* seaside tuna (*Opuntia dillenii*), seaside purslane (*Sesuvium portucalastrum*) and various grass species such as *Distichlis* sp. and *Cenhrus* sp.

The limestone forest comprised plants with dbh in the range 35cm to 63 cm, and dominated by trees such as red birch (*Bursera simaruba*), *Plumeria obtusa* and *Ficus* sp. Tree heights of in this area ranged between 3-4 m on the cliffs due to wind and 5-10 m inland. Crown cover above 4 m off ground was less than 20%, but total leaf cover between 0.8-8 m off ground was greater than 20%. This zone also comprised a few endemic species such as *Hohenbergia spinulosa* and *Bromelia pinguin* (both bromeliads), orchids: *Broughtonia sanguinea, Brassavola chordata*, and *Oncidium tetrapetalum*, cacti: *Hylocereus triangularis* (God okra) and West Indian ebony (*Brya ebenus*). The agave was also found to be numerous

in this region, with many flowering and providing food for various bird species. Ground cover was minimal with good leaf litter in most areas, on average 1.3 cm deep. This area was primarily undisturbed.

The adjoining vacant lots and road verges showed high disturbance. These lots have large trees, between 8 and 15 m tall and dbh of 58 cm on average. Trees represented in this zone include; *Acacia tortuosa*, *Samanea saman* (guango), *Melicoccus bijugatus* (guinep), *Morinda citrifolia* (noni), *Haematoxylum campechianum* (logwood), and *Helicteres jamaicensis* (screw tree) to name a few. The shrub layer was dominated by *Commelina sp., Sida acuta* (broomweed), *Antigonon leptopus, Capparis sp., Urechites lutea* (nightshade), and *Pisonia sp.* (cockspur). Crown cover above 4 m off ground was less than 20%, but total leaf cover between 0.8-8 m off ground was greater than 20%.

Anthropogenic influences such as dumping was observed in close proximity to the site, at the end of the bordering roadway and within the mangrove (to a much less limited extent). Similarly tracks can be seen running throughout the nearby vacant lots, with one or two found within the limestone upland. Tracks were also observed between the salina and the mangrove and individuals (mainly spear fishermen from nearby communities) were observed using them. Vehicles are also regularly seen on the beach front. Tracks were observed extending from the beach at Duncan Bay going west along the beach to Carrion Crow Cliffs, at least 2 miles west. Minimal tree removal activity was observed.

5.4.2 *Faunal Resources*

5.4.2.1 Avifauna

5.4.2.1.1 Methodology

For the evaluation of bird species the following methods were utilized:

Point Count Census Method

This Point Count method is based on the principle of counting birds at a defined point or spot and determining the distance of each bird census. A point is selected and then all bird contacts (seen and heard) are recorded, with a determination of distance given (< 25m or >25m) for each contact. This is done for a predetermined time, usually 10 minutes, before

moving to another point at a specified distance away (this can be either 100m – 200m) (Bibby et al. 1998). Points for this survey were 150 m apart. It should be noted that any avifaunal species observed between point counts were recorded.

Advantages of this method include:

- Greater concentration on the birds and habitats without having to watch where you walk (Bibby et. al. 1998).
- More time available to identify contacts (Bibby et. al. 1998)
- Greater opportunity to identify cryptic and skulking species (Bibby et. al. 1998)
- Easier to relate bird occurrence to habitat features (Bibby et. al.1998).

Line Transect Census method

Due to the size of the area and the easy accessible roads, transects were also used to compile the preliminary bird list (Plate 5-19). The line transect method entailed walking slowly for a given distance or time period along selected routes, noting all the birds seen or heard in the area (Wunderle 1994).

Observance of Pool Areas

This method is based on the principle of counting birds at an area where water has accumulated. Species and their numbers are then recorded for a time period usually 20 – 30 minutes. Identification of species was done through sight (visual identification) and sound (audio identification). Anecdotal notes as to the behaviour of the species were made during that time period.

Night Survey

This method entailed walking the Duncan's property at night and noting all the nocturnal birds present (heard and seen).

Technique Weaknesses

As with all survey techniques, there are weaknesses, which influence overall results. Below are factors which affect the census techniques used.

- Time of Day – the best time for conducting a census is in the morning from sunrise until about 10am in the lowlands. It is recognized that as the day continues it gets

hotter and the ability to detect birds decreases due to lack of movement. (Wunderle 1994).

- Time of Year – the change in behaviour of birds during the breeding and non-breeding seasons affects detection. However for this report, the assessment was done in the non-breeding season, when birds are less vocal. (Wunderle 1994).
- Weather – things such as wind, rain, fog or heat, affect the conduct of a census (Wunderle 1994).

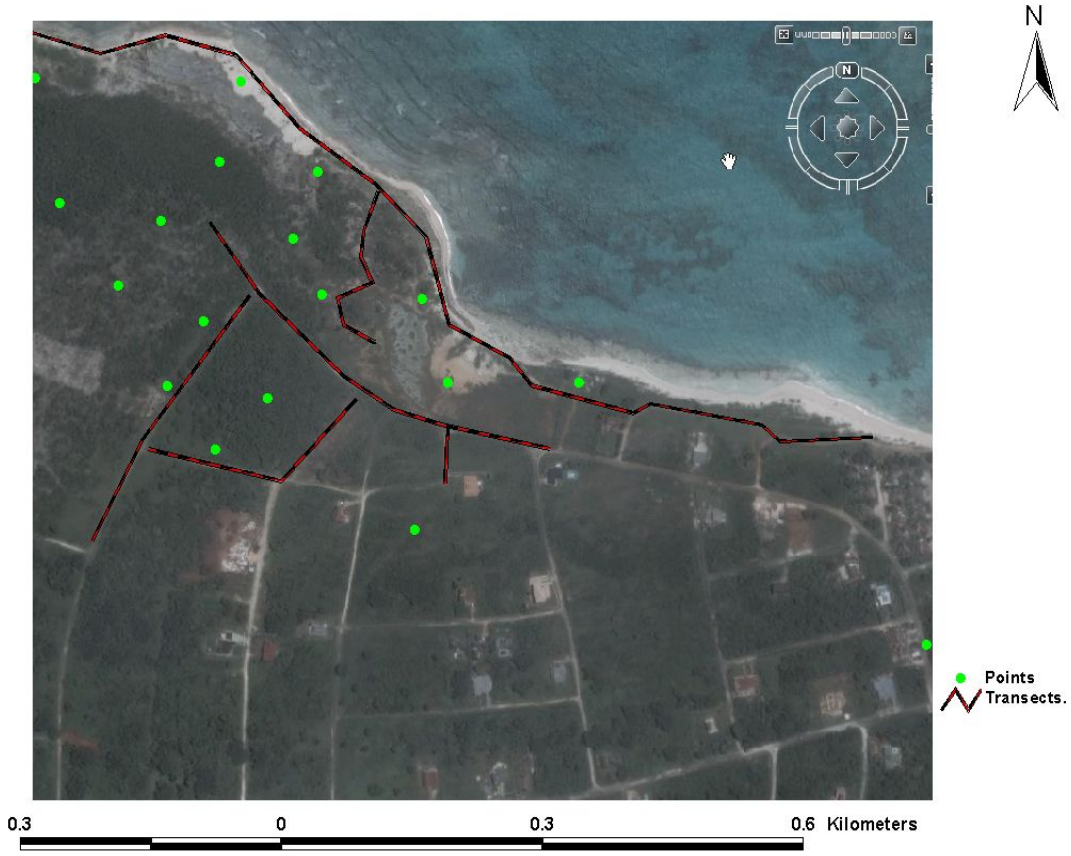


Plate 5-19: Map showing the points and the transects used in the bird survey

5.4.2.1.2 Findings

21 point counts and 4 transects were used to generate the bird lists (Appendix IV). A DAFOR scale was also used to categorise the various birds observed (Table 5-4).

Table 5-4: DAFOR Scale

	Total number of birds observed
D – Dominant	≥ 20
A – Abundant	15 – 19
F – Frequent	10 – 14
O – Often	5- 9
R – Rare	< 4

The coastal area supported both wetlands and shore birds. The Salina had a large number of wetland birds and a few shore birds foraging in it. Wetland birds included the Glossy Ibis, Killdeer, Black-necked Stilt, Common Moorhen Blue Heron, and Cattle Egret. Shore birds such as the plovers were also seen foraging on the banks of the Salina. The Black-necked Stilt was the most dominant bird in the coastal area. They were seen foraging in the Salina and nesting in the area. *Buffo marinus* adults and tadpoles were seen in the Salinas which indicates that the water is not completely saline, receiving freshwater from rainfall and drainage through limestone channels.

The rocky shore on the coast had a number of small pools with diminutive fish and marine invertebrates. Shore birds such as Ruddy Turnstone, Sanderling and Plovers were seen foraging on the rocky shore. The Yellow-crowned Night Herons were also foraging on the rocky shore in the night. Other shore birds such as the Brown Pelican, Royal Turn and the Magnificent Frigate birds were seen.

The mangrove patches had a few land birds such as the Yellow Warbler, Northern Mocking Bird, Grey Kingbird, Great-antillean Grackle and the occasional Columbids (White-wing dove and White-crowned pigeon). Great-antillean Grackle, White-wing Dove and Yellow-crowned Night Herons were nesting in the mangroves. The shorebirds were seen foraging in the pools on the rocky shore. These pools were formed as a result of the low tide. The Plovers were seen foraging on the mudflats and the rocky shore.

The bird species composition did not differ greatly between the disturbed and undisturbed dry limestone forest. Typical birds of the dry limestone forest were observed during the survey (Downer 1990). Birds such as Columbids (White-wing Dove, White-crowned Pigeon,

and Caribbean Dove), Parakeets, Hummingbirds, Jamaican Woodpeckers, Orioles and Warblers were observed.

Only 6 endemic birds were seen during the bird survey of which only one species is dependent on good forest. Hummingbirds and Banaquits were seen feeding on the flowers of the Agave. White wing doves were seen nesting in a Red Burch tree.

Necessary mitigation measures

The Salinas need to be managed properly and incorporated in the development of the area. The Salinas serve has an important refuge for both wetland and shore birds including migratory water birds such as Gulls, Turns and Ducks.

The removal of the vegetation will change the bird species composition in the area. In order to reduce the negative impact of the development, trees can be planted which could attract various birds.

5.4.2.2 Other Fauna

A cursory evaluation of the insect population, including the presence of rare, endangered, and/or endemic species was also conducted during the field visit. The insect population of the site was very sparse, no rare, endangered, and/or endemic species were observed. The usual termites, ants, dragonflies, bees, and mosquitoes were observed on-site.

Several species of butterflies were observed on the site of which none are rare, endangered, and/or endemic species.

Table 5-5: Butterflies observed on-site

Species	Common Name
Ascia monuste eubotia	Greater Antillean Whites
Danaus plexippus	The Monarch
Dryas iulia delila	Julia
Euptoieta hegesia hegesia	The Tropical Fritillary
Pyrgus sp.	A Common Skipper
Heliconius charitonius	Zebra butterfly
Eurema sp.	Sulphur Butterfly
Brephidium sp.	Little Blue

Two species of common lizards were observed, both being *Anolis spp.* The salina was found to have tadpoles belonging to *Bufo marinus*. Frogs belonging to the genera *Eleutherodactylus* were also heard in the limestone forest. In addition to the hermit crab found in the limestone forest, the burrowing sand crab (*Cardisoma guanhumi)* and ghost crab (*Ocypode sp.*) were observed.

5.4.3 *Aquatic & Marine Resources*

The boundaries of the marine assessment area were defined as the shoreline to the south, a position on the shoreline 100 m to the west of the property's western boundary, a position on the shoreline 100 m to the east of the property's eastern boundary and positions set 100 m to seaward, measured perpendicularly from the shoreline. This was done to not only examine the features existing within the boundaries of the development area but to also determine the extent to which these features extended beyond these boundaries. This area is defined on (Plate 5-20)**.**

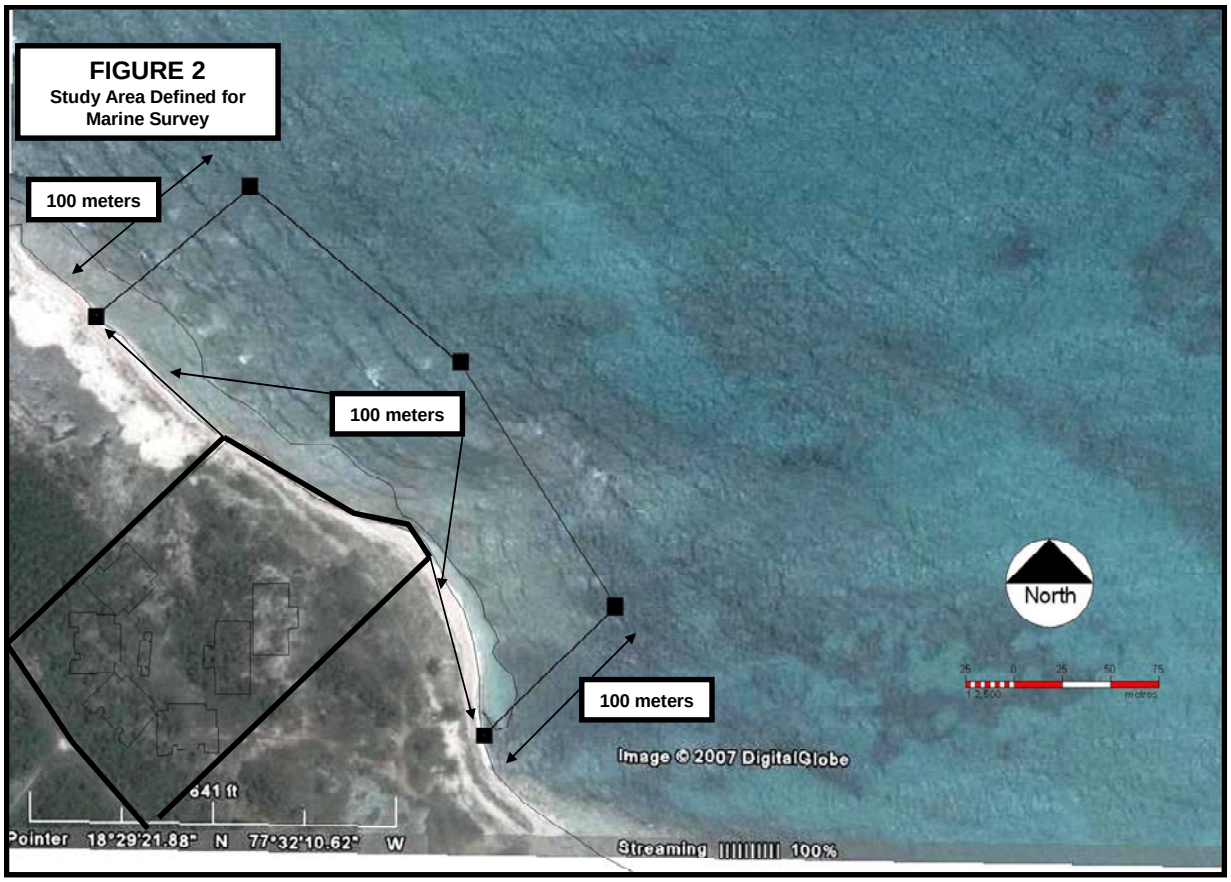


Plate 5-20: Study Area - Marine

5.4.3.1 Methodology

The seafloor defined on Plate 5-20 above was identified for detailed assessment to determine the following characteristics:

1. Depth
2. Substrate character
3. Benthic Life-form character
4. Mobile Life-form character
5. Water quality characteristics
6. Oceanography
7. Shoreline character and stability

Several techniques were utilized to assess the characteristics of the shoreline and marine environment adjoining the development site. These are listed as follows:

1. Initial character interpretations and spatial extent determinations were conducted with the aid of aerial photogrammetry[13]. Base imagery used for the photo analysis were 1991 aerial images provided by the survey department and 2006 satellite images obtained from Google Earth.
2. Depth (in meters) was assessed with a hand-held depth sounder.
3. Substrate character was identified as being either hard or sediment through visual observations
4. Benthic life-forms were identified through the use of photographs taken along wading shore-perpendicular transects for shallow areas less than a meter deep and from swimming transects deployed randomly within the deeper (>1 m) locations within the study area..
5. Mobile life-forms (benthic and free-swimming) were identified visually during the deployment of transects for benthic life-form identification.
6. Water quality characteristics (total suspended solids, biochemical oxygen demand, faecal coliform, nitrates, total phosphorus) were obtained through the collection and analysis of water samples at two stations selected from the shoreline within the

[13] 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.PhysicalGeography.net

boundaries of the property. Samples were analysed by the Scientific Research Council using the SMEW 2540E Method[14] .

7. Oceanography was assessed through the interpretation of wave patterns and shoreline characteristics illustrated on the base imagery used for photo interpretation. Additionally, information on the direction and speed of nearshore current movement was obtained through the tracking of shallow water drogues.
8. Shoreline character was identified visually as being either sandy or rocky in nature, with variations in the locations of these features being mapped.
9. Shoreline stability was defined as the change in the horizontal position of the shoreline horizontal stability was assessed through the comparison of shoreline positions on map-referenced examples of the 1991 and 2006 images used for the study. Areas of significant horizontal change were then further illustrated through the examination of the vertical character of the adjoining beach area. This was done through the measurement of the change in the angle of slope of the beach with the use of a surveyor's level and measuring staff, with cross-sections being drawn with.

All data collected was positioned with the aid of a Garmin Foretrex Global Positioning System (GPS) and spatially rendered with the use of Mapmaker Pro geographical information system software. Additionally, all observations made for marine lifeforms, both benthic and free-swimming, were rated according to their numbers using the DAFOR abundance scale method.

Attached compact discs shows a presentation on the Marine aspects of this project EIA.

5.4.3.2 Findings

5.4.3.2.1 Initial Spatial Mapping

Plate 5-21 below illustrates the substrate and lifeform character of the marine environment adjoining the study area, as interpreted through the use of photogrammetric techniques and through the extrapolation of marine characteristics data obtained from an environmental

[14] Standard Methods for the Examination of Waste and Waste Water – 20th Edition, 1998.

impact assessment document submitted for the Amaterra Hotel and Golf course development[15], which adjoins the project site to the west.

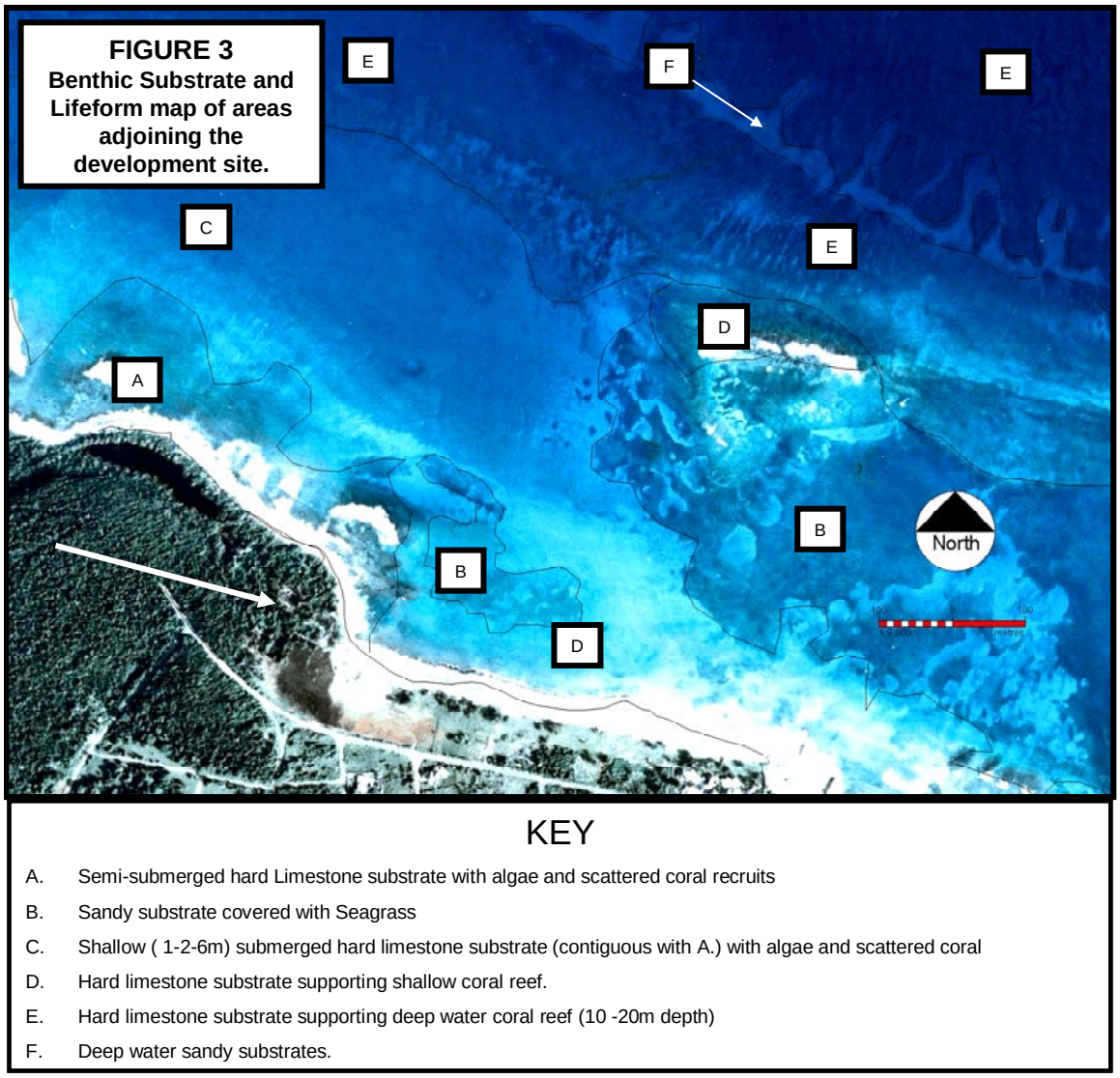


Plate 5-21: Benthic Substrate and Life-Form Map

[15] EIA prepared and submitted to the National Environment and Planning Agency by TEMN ltd -2004.

5.4.3.2.2 Observations - Depth

Plate 5-22 outlines the water spot depths recorded within the marine study area adjoining the proposed development site.

Water depths within the study area were shallow, with depths of between 0 to 0.8 m existing within 12 m of the shoreline. Seaward of this point, and extending out to 100 m from the shoreline, the water depths deepened to only 1.8 m.

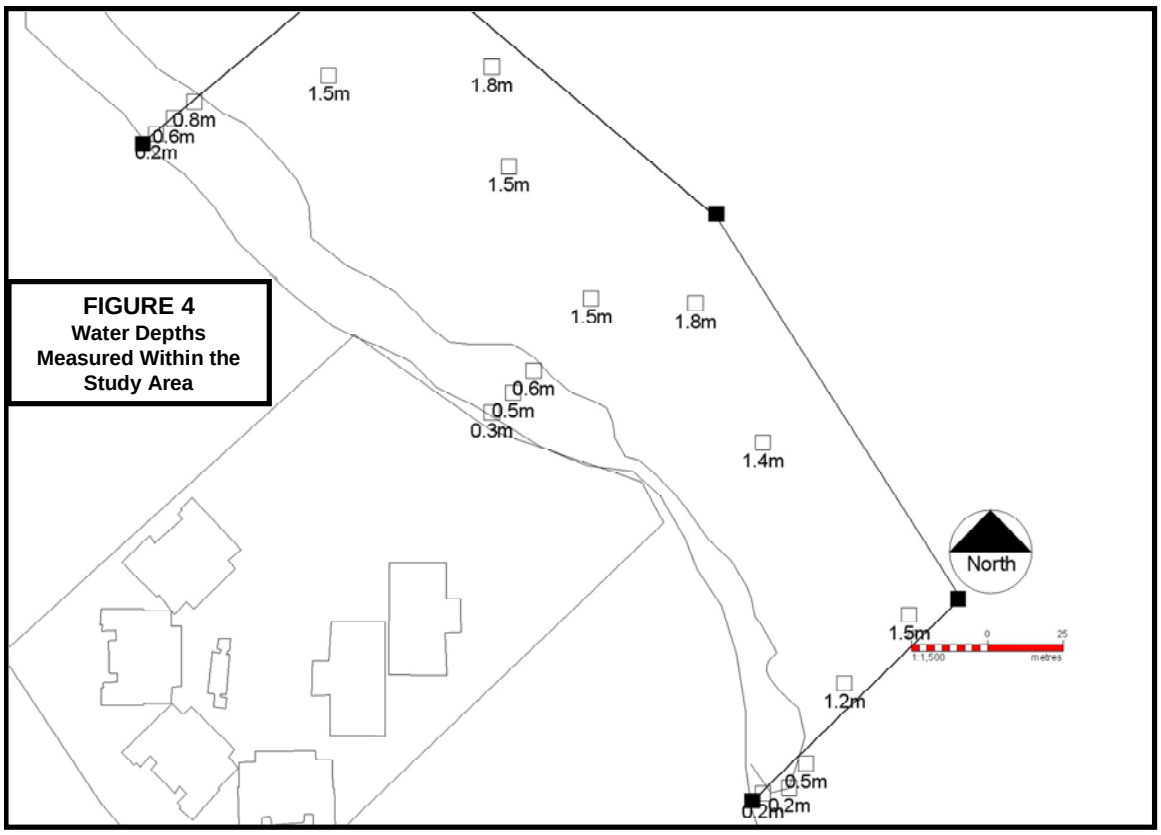


Plate 5-22: Water Depths Sampling Points

5.4.3.2.3 Observations – Seafloor Substrate and Benthic Character

The seafloor within the study area could be described as a shallow, submerged carbonate platform, which appears to be geologically continuous with the limestone features (Falmouth formation) found on the adjoining land. This platform extended from the shoreline –seaward and was divided into two components, based primarily on depth.

The shallow nearshore area is defined by shallow, hard carbonate substrates (< 0.8 m depth) colonized predominantly by turf and macro algae, with scattered coral recruits, mainly mustard hill corals. These coral recruits had diameters of up to 5 cm. Additionally, scattered turtle grass (*Thalassia testudinum*) rhizomes were observed in areas of this zone. In deeper waters deeper rubble-covered hard carbonate substrates (>1.2m depth) colonized predominantly by turf and macro algae across the entire study area. There were small pockets of sand interspersed within this zone.

Scattered turtle grass rhizomes were observed growing in some of these sand pockets.

Scattered coral individuals, mainly Mustard Hill (*Porites asteroides*), Brain (*Diploria sp.*) and Smooth Starlet coral (*Siderastrea radians*) varieties were present in water depths of up to 1.8 meters. Diameters for coral individuals observed within the deeper sections of the study area were 10-40 cm.

5.4.3.2.4 Observations – Mobile Life-Forms

The dominant mobile life-forms observed at the study area were urchins and fish. The Red Rock-boring Urchin (*Echinometra lucunter*) was found growing in cracks in the carbonate platform existing within close proximity to the shoreline, while the Black Spiny urchin (*Diadema antillarum*) was found in deeper water within the study area.

Fish were observed throughout the study area and were predominantly juvenile such as: Yellow Tail (*Ocyurus chrysurus*), and damselfishes such as Dusky (*Stegastes fuscus*) and Sergeant Major Damselfish (*Abudefduf saxatilis*), along with juveniles and adult phases of Bluehead Wrasses (*Thalassoma bifasciatum*). Sizes observed were less than 5 cm in length.

Though not seen during the surveying of the marine environment, photographic evidence has been seen to suggest that the beach areas adjoining the development are used by turtles for nesting (Plate 5-23).

Plate 5-23: Possible Turtle Tracks

5.4.3.2.5 Observations - Oceanography

Waves approach the site from the north-west. This orientation coincides with the direction of the prevailing wind and indicates that waves in the area are primarily wind generated. Upon approaching the shore, they are refracted, or bent around a shallow reef area existing just outside of the marine study area, creating what appears (from photogrammetric interpretation) to be a sheltered area landward of the reef (see cd-rom presentation). This sheltered area may be responsible for the seaward projection of the land and beach area found immediately landward of the reef, which appears similar to the shoreline adjustments common immediately behind shore-parallel breakwaters.

Sea currents measured at the site at the time of the survey trended towards the northwest and moved at a speed of approximately 0.1 ms^{-1}. Plate 5-24 and Plate 5-25 visually summarize the oceanographic processes occurring within the marine assessment boundary for the development site

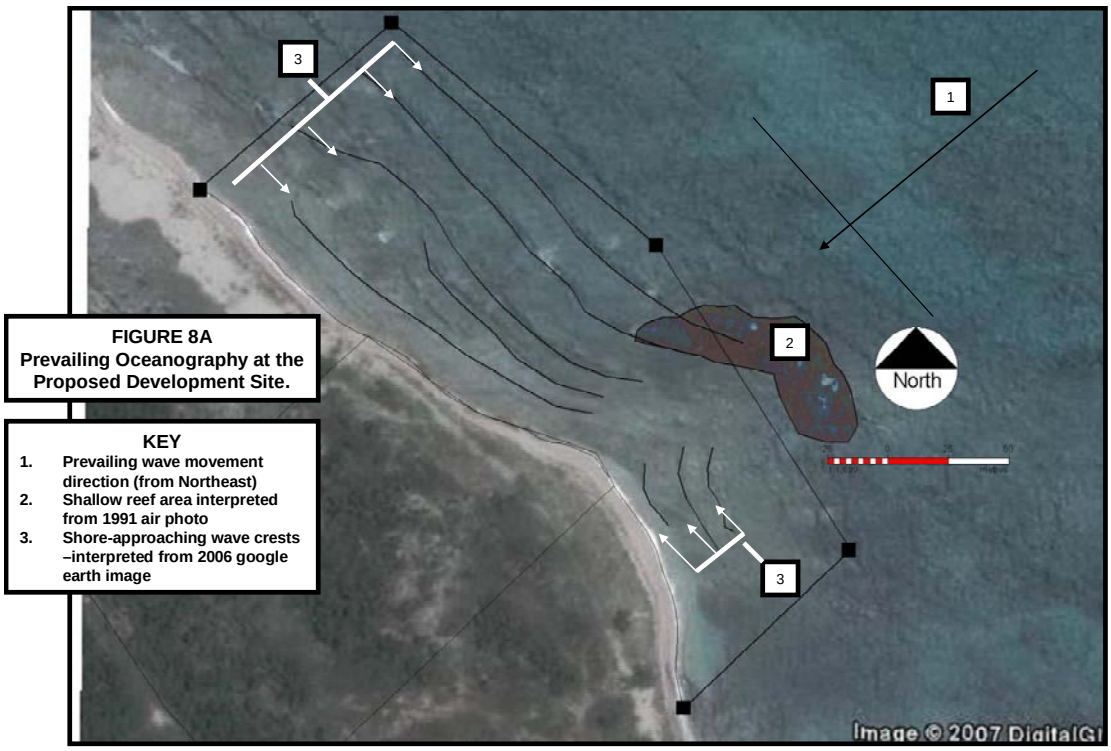


FIGURE 8A
Prevailing Oceanography at the Proposed Development Site.

KEY
1. Prevailing wave movement direction (from Northeast)
2. Shallow reef area interpreted from 1991 air photo
3. Shore-approaching wave crests –interpreted from 2006 google earth image

Plate 5-24: Prevailing Oceanography Interpreted

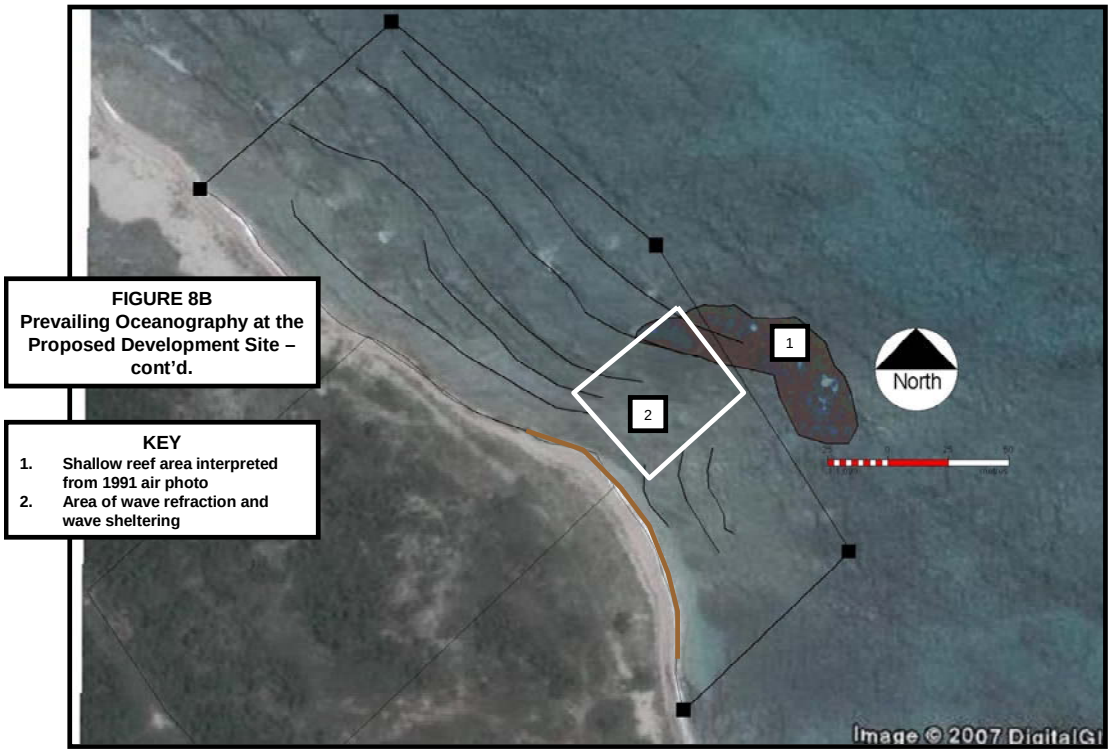


FIGURE 8B
Prevailing Oceanography at the Proposed Development Site – cont'd.

KEY
1. Shallow reef area interpreted from 1991 air photo
2. Area of wave refraction and wave sheltering

Plate 5-25: Prevailing Oceanography Interpreted 2

5.4.3.2.6 Observations – Shoreline Character and Stability

Colour contrast on the 1991 image obtained for the assessment prevented the accurate identification of the shoreline. Therefore a comparison of shoreline positions (1991 vs. 2006) could not be done. It was, however, possible to compare the change in position of the inland beach limits between 1991 and 2006 shorelines, which suggest sand had been deposited inland beyond the western boundary of the development site on shore, effectively changing the width of the beach at this location. Hurricane Ivan may have been the event that caused the sediment distribution observed west of the property's boundary.

Despite the "beach width" observations made at the property's west boundary, there has been some loss of beach volume within the development site shoreline.

5.4.3.2.7 Observations – Water Quality

Plate 5-26 below outlines parameters analysed at two locations within the study area at Duncans, Trelawney. With the exception of total suspended solids, all the parameters were better than the NEPA recreational water quality standards. The samples were collected within 2 meters of the shoreline and were subjected to surf action. Sediment re-suspension due to wave action would have been the likely cause of the elevated total suspended solids values observed.

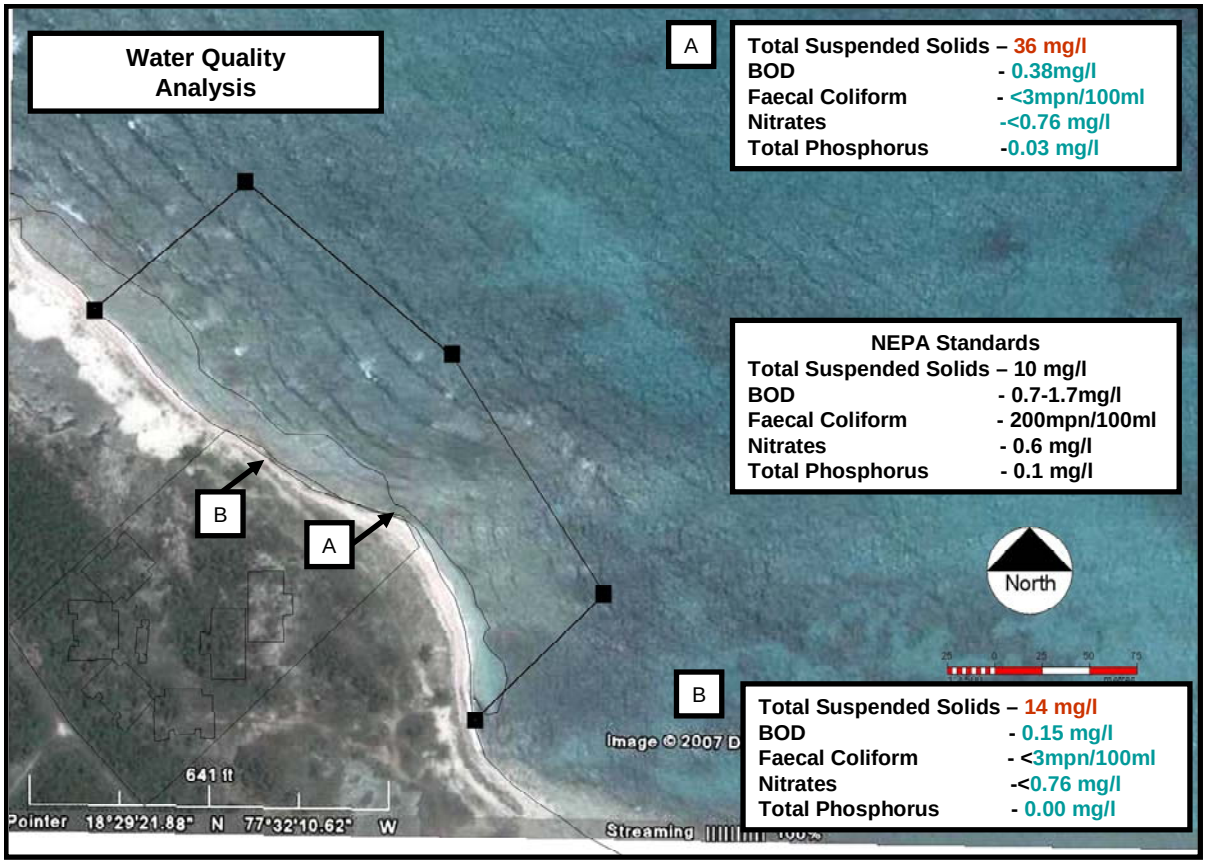


Plate 5-26: Marine Water Quality Sites & Results

5.4.3.2.8 Conclusions

Conclusions have been summarized below as follows:

1. The marine study area represents a shallow area underlain with a hard carbonate substrate that apparently is an extension of the prevailing land-based geology.
2. The presence and sizes of coral life-forms found within the study area suggest that coral recruitment is occurring within the environment.
3. Scattered coral and seagrass life-forms present within these areas support fish and urchin populations that, by their size, can be regarded as juveniles – defining the area as a marine nursery.
4. The prevailing shoreline represents a combination of sandy marine deposits overlaying hard carbonate deposits. While the stability of the shoreline, as represented by changes in the position of the shoreline over time, could not be determined, it was obvious that beach volume changes had occurred at the site. A tropical disturbance may have been responsible for these observations. The same

tropical disturbances may also have been responsible for the "carpet" of sand observed towards the west of the property.

5. Wave movements appear wind-driven with current movements trending towards the west. Wave movements at the eastern section of the property appeared to be dampened somewhat by the presence of a shallow reef area offshore, which may be responsible for the volumes of sand observed at this location.

5.4.3.2.8.1 Implications for development

Any development contemplated at the site must be cognizant of the fact that the area does appear to exhibit marine nursery characteristics. Property surface drainage and sewage disposal will have to be carefully managed so as not to result in direct (or increased indirect) discharges to the marine environment.

The shoreline of the property is not conducive to wide-scale recreational bathing, due to the substrates underlying the shallow waters adjoining the shoreline and the presence of boring urchins in these substrates. Underfoot trampling could impact negatively on marine resources present on the hard nearshore pavements.

Any modification of the shoreline to accommodate wading (through dredging etc) may have implications for shoreline stability and will certainly result in the loss of nearshore marine resources, if these impacts are not mitigated against.

Any modification of the beach vegetation to facilitate development could result in de-stabilization of these deposits, with ensuing loss during tropical disturbances. Additionally, such actions, along with the effect that improperly positioned lighting, could disturb turtle nesting that may occur on-site.

It is therefore strongly recommended that the proposed development be designed to maintain and promote the character of the shoreline and marine environment and to utilise this existing character to enhance the product being offered.

Table 5-6: Marine Flora & Fauna

Scientific Name	Common Name
Algae	
Amphiroa sp.	Red algae
Caulerpa racemosa	Green algae
Penicillus sp.	Green algae
Dictyota linearis	Brown algae
Padina sp.	Brown algae
Udotea sp.	Carpet algae
Sea Grasses	
Syringodium filiforme	Manatee Grass
Thalassia testudinum	Turtle Grass
Fishes	
Abudefduf saxatilis	Sergeant Major
Stegastes fuscus	Dusky Damselfish
Thalassoma bifasciatum	Bluehead Wrasse
Ocyurus chrysurus	Yellow tail Snapper
Invertebrates	
Diadema antillarum.	Black Sea Urchin
Echinometra lucunter	Red Rock boring urchin
Lytechinus variegatus	Green sea urchin
	Mantis shrimp
Nerita versicolor.	Nerite
Littorina sp.	
Acanthopleaura granulata	Chiton
Corals	
Diplora strigosa	Symmetrical Brain Coral
Porites asteroides	Mustard hill coral
Siderastrea radians	Smooth Starlet Coral
Vertebrates	
	Marine Turtles

5.5 Cultural Heritage Resources

The parish of Trelawny has various cultural heritage sites scattered throughout, some protected. Within the geographic sphere of this project is represented some of these cultural heritage. The town of Duncans is allegedly named after the Peter Duncans in 1784, the original property owner. The community of Kettering, a Free Village, in Duncans was named after the birthplace of the late Reverend William Knibb in Northampton, England.

The Duncan Bay Cave[16]

Not much is known of this cave but it has a close resemblance to the Green Grotto Caves in Runaway Bay along the North Coast Highway to the east Inside the cave are the remains of buildings that were once in use. This cave is one of many near the ruins of an old Great House (Stewart Castle). Such caves have been found with traces of Arawak occupation. It is said that church members from the Kettering Baptist Church hid the emancipator Rev. William Knibb and his family in these Caves when irate Slave Owners burnt his Manse and were seeking to arrest and accuse him of treason.

The Clock Tower - The Duncans Clock Tower, located in the heart of the town of Duncans is considered a national monument.

Official JNHT Heritage Sites in close proximity are:

The Kettering Baptist Church

Kettering Baptist Church is located in Duncans, Trelawny and is associated with William Knibb, who founded the Kettering Free Village in 1840. Kettering Baptist church was built in 1893. It was named after Knibb's native town in Northamptonshire, England. The Church, which has Georgian features, is constructed of brick, stone, mortar, and timber. The building is completed with a steep hip roof. At the entrance of the church is a small porch on top of which is a belfry which appears to be a later addition.

[16] The Duncan Bay Cave http://xaymaca.info/places-to-visit/duncans-bay-arawak-cave-2.html

The Stewart Castle Ruins

To the west of Duncan Bay can be Stewart Castle. On this site is located the ruins of an impressive cut stone mansion, which became known as Stewart Castle. The building was originally fortified for protection against attack. There are loopholes for fire muskets placed strategically around the entire building. From all indications the building seemed to be of three storeys consisting of a cellar, ground floor and first floor. It is a rectangular stone building with square towers at opposite corners.

In 1957 Mr. Charles Cotter excavated a Taino Midden found on the property. It was found that the site offered valuable insights into the dietary habits of the Tainos.

Material excavated included a variety of marine shells perforated and unperforated e.g. giant conchs, giant crab limbs, breast bones of birds and turtle bones. Ownership of the properties on which the ruins and the Midden are located was transferred to the Jamaica National Heritage Trust by Kaiser Bauxite Company.

SOCIO-CULTURAL ENVIRONMENTAL

6 Socio-Cultural Environmental

6.1 Introduction

A Total of 106 surveys were conducted for the proposed Treasures of Trelawny Resort Development Project, Duncan Bay in the parish of Trelawny. The surveys were conducted in 16 surrounding Enumeration Districts (EDs) as outlined by the Statistical Institute of Jamaica, which were in relatively close proximity to the project site.

The survey population was devised based on a 5% sample of the Total Households in the area. The EDs surveyed are as follows:

Table 6-1: Enumeration Districts Surveyed

Enumeration District Code	Total Households	5 % Sample Value
Duncans	**611**	**31**
North 033	118	6
North 034	180	9
North 035	186	9
North 036	69	3
North 037	58	3
Albert Town	**1405**	**70**
North 029	329	16
North 030	329	16
North 031	25	1
North 032	238	12
North 038	41	2
North 039	110	6
North 051	164	8
North 053	103	5
North 054	66	3
Total	**2016**	**101**

The communities include Duncans, Kettering, Refuge, Carey Park, Samuel Prospect, Hyde Clarks Town, Duncans Hill, Stewart Castle, Rhodney Bottom, Spicy Hill Road, Carey Park, Samuel Prospect, Hyde Clarks Town, Duncans Hill, Stewart Castle, Rhodney Bottom, Spicy

Hill Road, Pound Hill, Rio Bueno Main Road, Crawle, Shawsmith Prospect and Windsor. Of the106 respondents 53 were females and 53 males.

The location of the respective EDs is shown below. Appendix III shows the Survey Instrument administered.

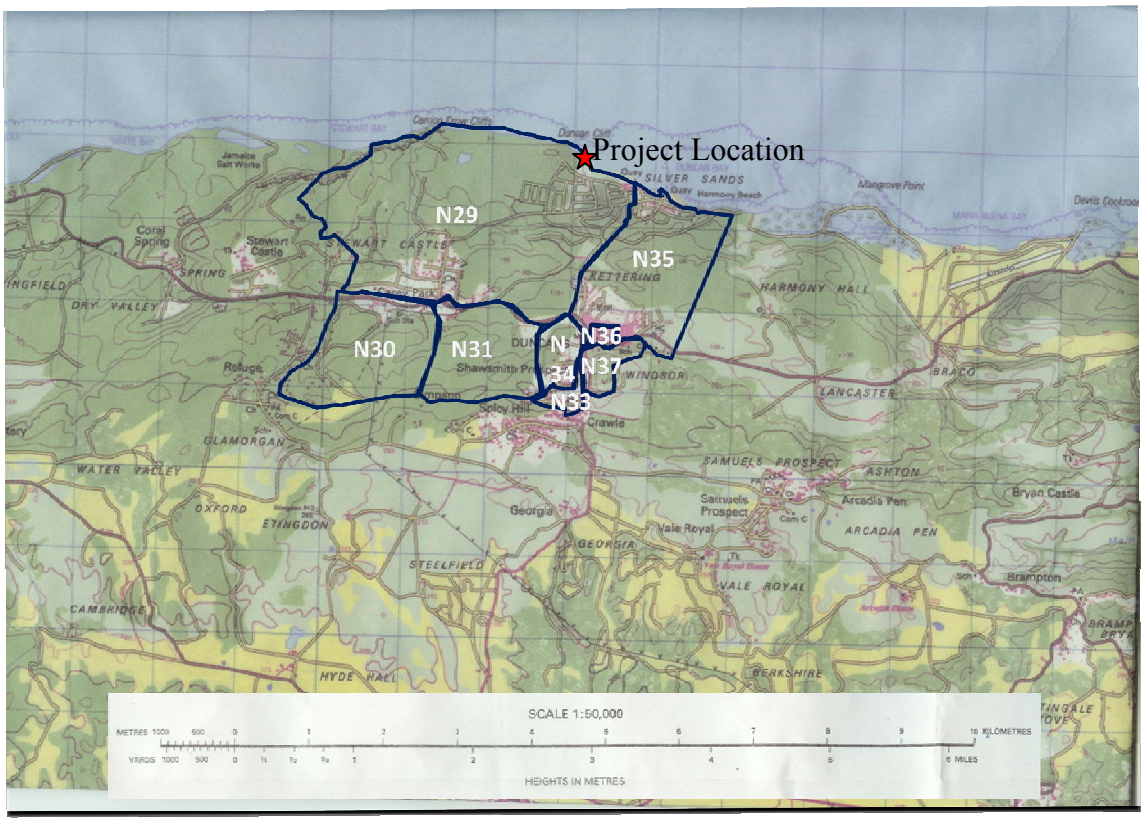


Figure 6-1: Map showing location of Enumeration Districts Surveyed

6.2 Survey Findings

6.2.1 *Demographics*

Detailed data on the personal characteristics of the respondents interviewed can be seen in the tables and charts below:

The survey shows that the Duncans community had the most representation of respondents within the age range of 20-39. The age range least represented throughout the 16 communities was 20 and under in Duncans, Kettering, Carey Park, Samuels Prospect,

Duncan Hill, Stewart Castle, Pound Hill, Rio Bueno Main Road, Shawsmith Prospect, and Windsor (Table 6-2).

Table 6-2: Gender of Respondents

Community ▶ / Parameter ▼	Duncans	Kettering	Refuge	Carey Park	Samuel Prospect	Hyde / Clarks Town	Duncans Hill	Stewart Castle	Rhodney Bottom	Spicy Hill Road	Pound Hill	Rio Bueno Main Road	Crawle	Shawsmith Prospect	Windsor	TOTAL
GENDER																
Male	15	2	5	5	2	4	1	8	1	1	1	1	1	5	1	**53**
Female	7	6	7	3	3	3	3	6	3	4	1	3		4		**53**
AGE RANGE																
Under 20	0	0	2	1	0	1	0	0	2	1	0	0	1	0	0	**8**
20-39	9	0	2	3	1	2	4	2	1	2	1	2	0	3	0	**32**
40-49	6	2	2	1	1	3		5	0	1	1	0	0	2	0	**24**
50-59	3	3	3	2	0	2	0	5	0	0	0	2	0	2	1	**23**
60-Over	4	3	0	1	3	0	0	3	1	1	0	0	0	1	0	**17**
NR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**
YEARS OF RESIDENCY																
0-5 Yrs	0	0	2	1	0	0	2	3	1	1	0	1	0	0	0	**11**
6-10 Yrs	0	1	4	0	0	1	0	2	0	1	1	1	0	0	0	**11**
11-20 Yrs	5	3	3	3	0	2	1	1	1	2	0	0	0	4	0	**25**
20+ Yrs	17	5	2	4	5	4	1	7	12	1	1	2	0	6	1	**68**
No Response	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	**1**

The number of persons who also live with respondents was asked to ascertain if the amount of individuals in the same household share the same socio-economic background.

The category was divided into male and female in addition to age range and employment status. The surveys show that more females than males live within the households of respondents in most communities. Ages 0-14 and 20-35 were significantly more prominent in the households of respondents in all communities. The Age range of 65 and over was the least represented category of individuals who live with respondents. The majority of persons

living with respondents were employed. The Charts and tables below show the characteristics of the persons living with respondents.

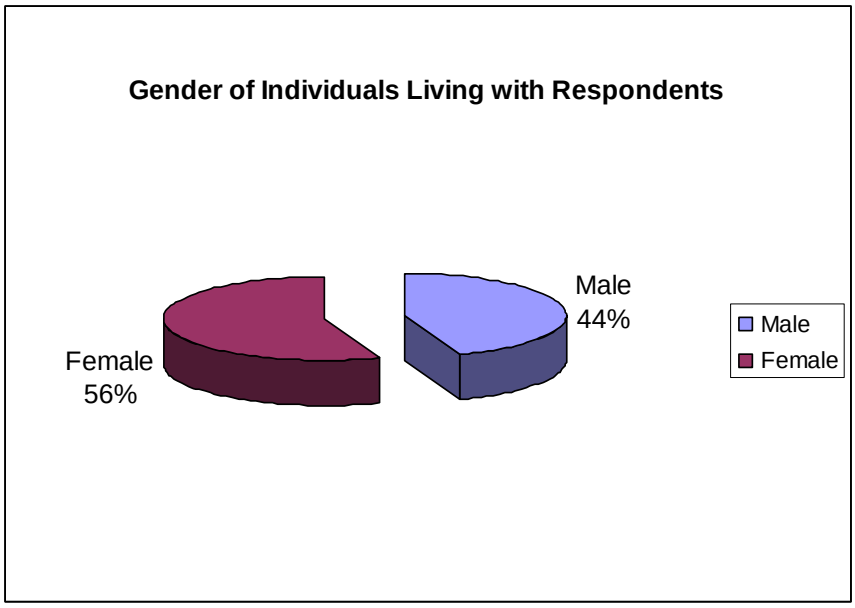


Figure 6-2: Gender of Individuals living with Respondents

The surveys showed that the Duncans community had the most representation of respondents within the age range of 20-39. The age range least represented throughout the 16 communities was 20 and under in Duncans, Kettering, Carey Park, Samuels Prospect, Duncan Hill, Stewart Castle, Pound Hill, Rio Bueno Main Road, Shawsmith Prospect and Windsor.

The category presenting the amount of years respondents have lived in the community spans from 0 years to 20 or more years. Respondents who have lived in their communities for more than 20 years were more prominent within this category across all 16 communities with 0-10 years being the lowest category.

6.2.2 *Social and Economic Findings*

6.2.2.1 Housing

The majority of respondents (76%) interviewed own a separate and detached house. Those owning semi-detached housing accounted for 8% of respondents interviewed (Table 6-3).

Table 6-3: Type of Housing Unit

Housing Type	Total
Separate House, detached	78
Semi-Detached	8
Part of a house(Apartment)	9
Part a commercial building	2
Other	6
Total	**103**

Seventy-five percent (75%) of those interviewed had houses made of block and steel. Most of the Houses of respondents were made of Block and Steel and Concrete. Five percent (5%) had accommodations made of wood, with 0.8% made of Wattle and Adobe.

Sixty-nine percent (69%) had toilet facilities with water closets linked to the sewer. Seven percent (7%) had toilets not linked to sewers. Respondents also have pit toilets which accounts for 24% of the survey population. For all types of toilet facilities including those linked to water closets and those not linked etc. 13% are shared.

According to respondents surveyed, 65% of the respondents use indoor pipes as their main water source. Twenty-one percent (21%) use outside private pipes and 14% use the public standpipe as their water source.

Respondents' kitchen facilities were mostly indoors (84% of those surveyed). The remaining 16% s had outside kitchen facilities.

The source of lighting of respondents varied between electricity and kerosene. Electricity accounted for 93% with 7% using Kerosene.

The ownership of houses by respondents is not uncommon as 72% owned their own shelter. Eighteen percent (18%) utilise rented space, while another 7% had rent free accommodation. Less than 1% of those surveyed admitted to living on squatter settlements while 2% utilised other housing arrangements not mentioned on survey.

6.2.2.2 Employment

The majority of Respondents are employed. This is seen equally across all communities (Table 6-4). When asked about the employment status of people in their household, it was revealed that 178 were in paid employment at the time. This compared to 122 who were said to be unemployed. Thirty seven percent (37%) voiced the opinion that unemployment was a major concern. This was reflected in sections 2, 3 and 4 of the survey instrument. The stated occupations of respondents included housewife, vendor, teachers, and farmers among others (Figure 6-3) With regards to the proposed development, 95% (101) of respondents were of the view they would be able to secure job opportunities. The majority of respondents (76%) have worked or knows someone in their family who has worked in the hotel industry. The main reasons for respondents anticipating the proposed development were:

1. job opportunity – 68%
2. increase in business activity – 11
3. improved infrastructure – 3%
4. crime and violence – 1%
5. investment – 3%

Table 6-4: Employment status of individuals living with respondents

	Duncans	Kettering	Refuge	Carey Park	Samuel Prospect	Hyde Clarks Town	Duncans Hill	Stewart Castle	Rhodney Bottom	Spicy Hill Road	Pound Hill	Rio Bueno Main Road	Crawle	Shawsmith Prospect	Windsor	**TOTAL**
Paid Employment	46	8	26	19	7	6	7	18	8	4	4	5	3	16	1	**178**
Unemployed	35	2	16	11	8	2	2	7	8	12	5	2	4	7	1	**122**

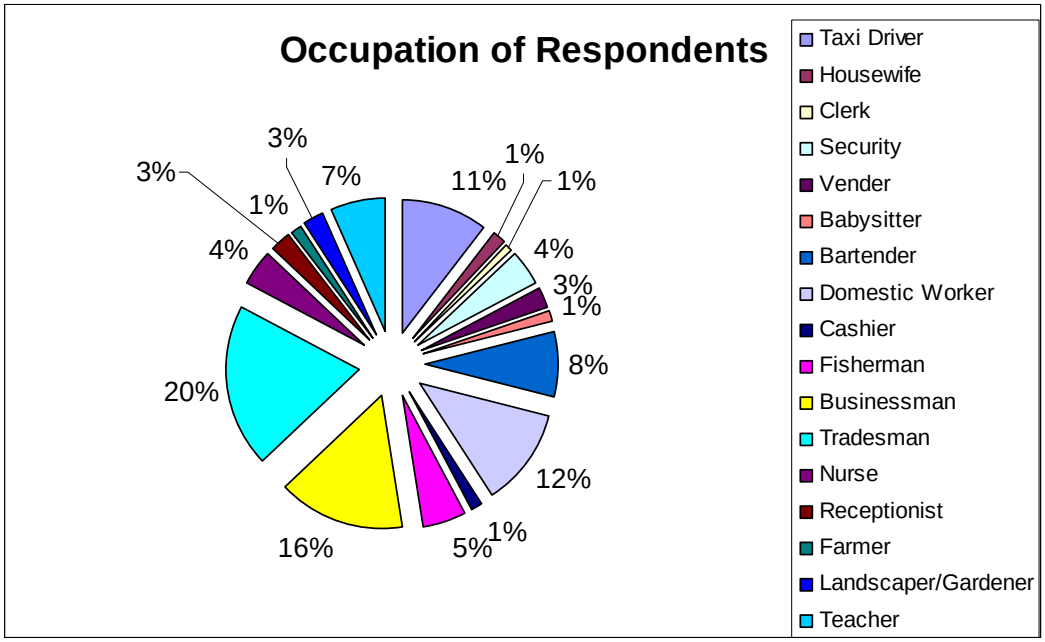


Figure 6-3: Occupation of Respondents

6.2.2.3 Community Views

When asked about their likes and dislikes of their respective communities, thirty two percent (32%) of respondents expressed their liking to the lack of crime and violence in their community, compared with 37% which found it a problem. Twenty-six percent (265) of Respondents also like quietness and friendliness of their communities. The dislikes varied widely, however unemployment was their most common dislike at 37%. Twenty-six percent (26%) disliked the poor roads in their communities and dirty environment was also a concern of 19% of the respondents.

At least one (1) individual expressed concern that persons from the communities will be treated unfairly to those from outside the region.

Ninety-seven percent (97%) of respondents are of the opinion that the area is in dire need of new development.

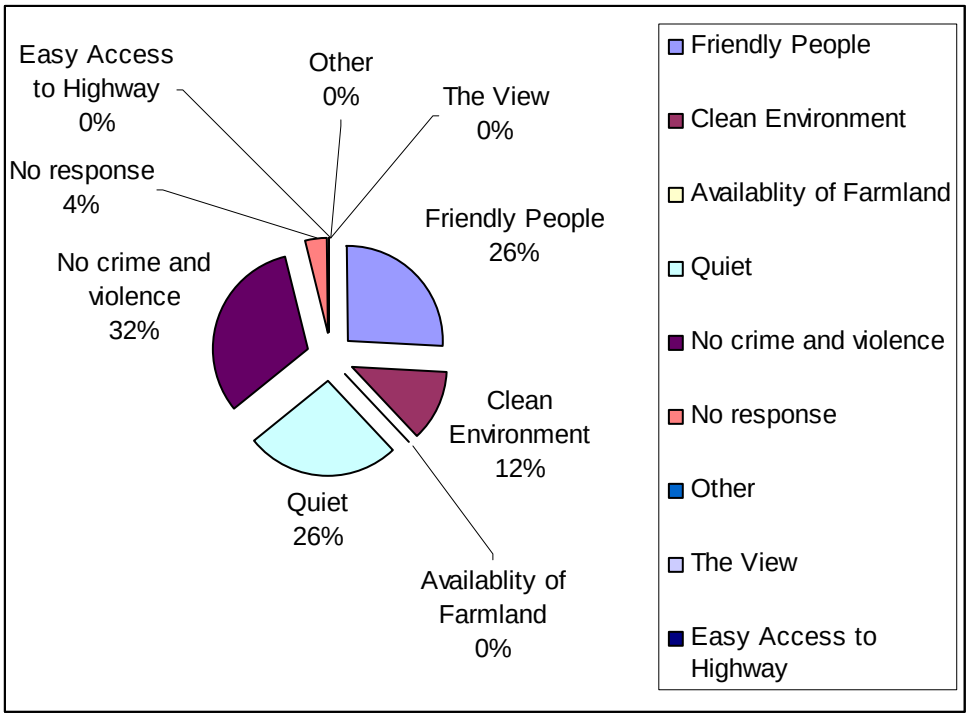


Figure 6-4: Characteristics Respondents Liked about their Community

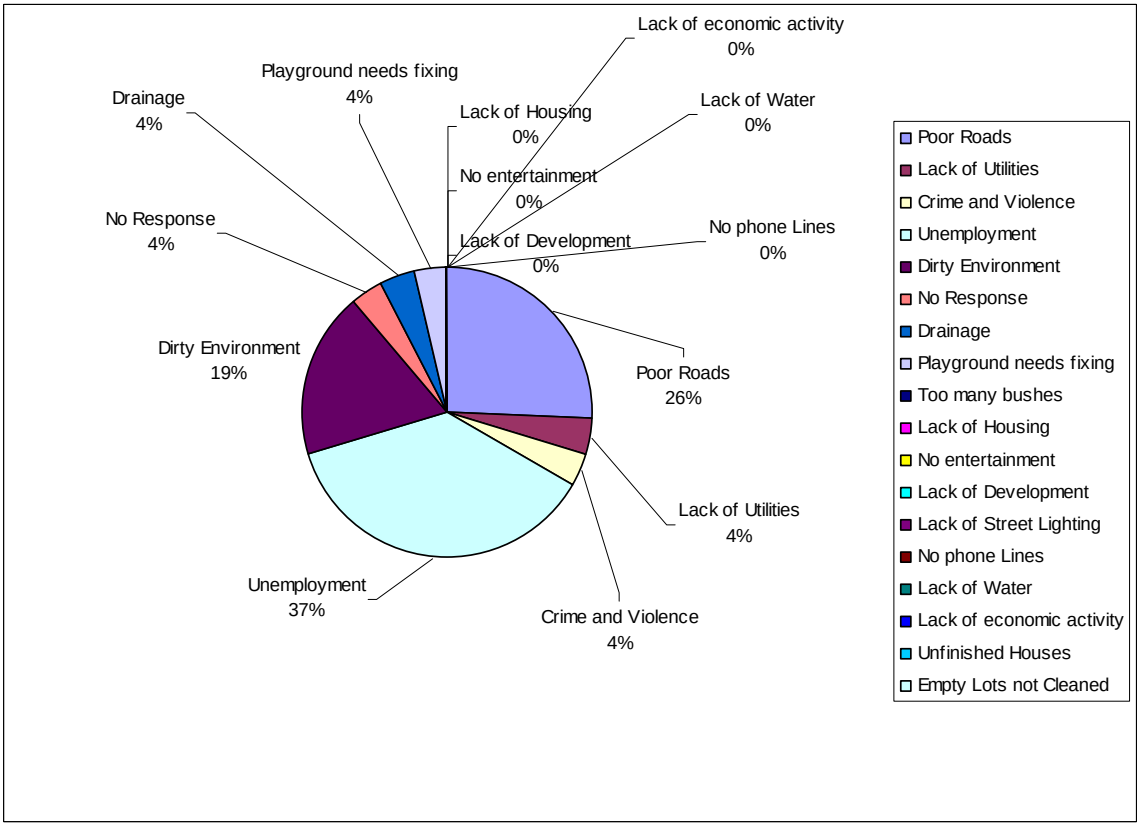


Figure 6-5: Characteristics Respondents disliked the most about their Community

6.2.2.4 Awareness of Project

A majority of respondents are aware of the proposed development. Eighty-eight percent (88%) of respondents were in high favour for this development and only 1% were strongly against the development. The respondents in favour of the development thought it would provide an opportunity to gain employment. The others disagreed out of concern of the free usage of the beach being terminated (Table 6-5).

Table 6-5: Respondents views and concerns on the proposed development

Respondents in favour of the development	Percentage	Respondents not in favour of the development	Percentage
More jobs	82%	The beach will no longer be accessible to poor people. You will have to pay for a day pass to get access to the beach.	2%
Progress for the Community	6%	Persons will move and block houses	2%
Parish will become popular	6%		
Tourist will become more attracted to the area	4%		
Reduce Crime	2%		

According to the surveys conducted, large scale development is beneficial to the community as 83% of respondents agreed with this notion and a significantly low percentage of 17% disagreed. The reasons given for agreeing and disagreeing that large scale development will be beneficial to the community are listed below (Table 6-6).

Table 6-6: Respondents views on large scale development in their community

Respondents who agreed	Percentage	Respondents who disagreed	Percentage
Job Opportunities	56%	Reduce Peacefulness	3%
Skills Development	26%	Negative Effect on Environment	<1%
Improve Utilities	10%	Other	<1%
Sense of Freedom	<1%	No Response	3%
Increase in Business Activity	<1%		

In terms of the effect of the proposed resort condominium development near Silver Sands on the community, 91% expressed a positive view of its economic value.

6.2.2.5 Environmental Views

Eighty-four respondents were of the view that the project would have a positive impact on the environment. At least one (1) individual expressed the view that they would lose access to the use of the beach while another expressed the view that the area would need to upgrade the existing water supply system.

The majority of respondents felt that the proposed development would have limited impact on their resources (natural and otherwise). Sixteen percent (16%) of respondents stated that their resources might be affected by the development. Eighty-three percent (83%) of respondents did not think the proposed development would affect resources.

Resources that may be affected	Percentage	Extent of Impact to Resources	Percentage
Water	54%	Lack of water through pipes and pumps	9%
Coral Reef	9%	Fish in Coral reef dying	9%
Electricity	36%		
Dust Pollution	9%		

A significant number of respondents use the general location for various social activities. The majority of these activities include swimming and fishing. Many respondents interviewed also refrain from using the site for any activity. The pie charts provided below show the aforementioned in more detail.

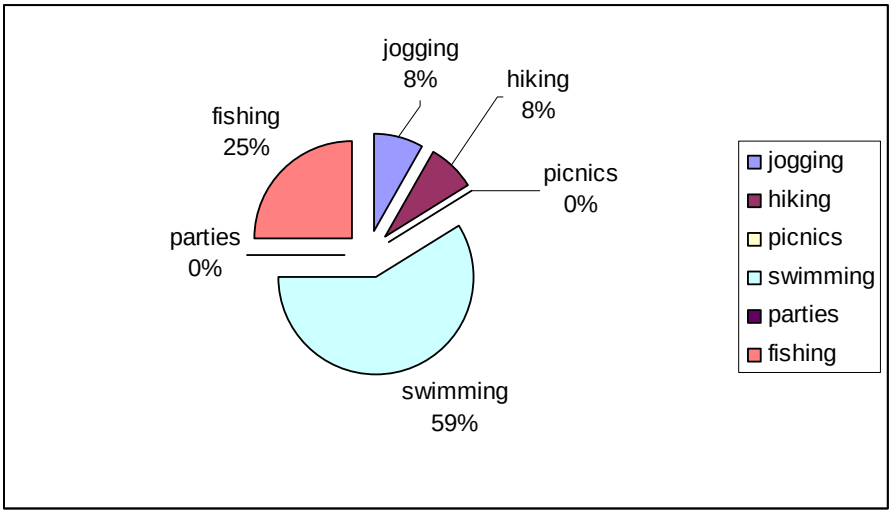


Figure 6-6: Percentage of Respondents using the general area for social activities

6.2.2.6 Cultural and/or Historical Information

Most respondents (72%) are not aware of any natural resources in the area where the proposed development will occur. Twenty-eight percent (28%) of respondents knew of natural resources in the area and identified them as such:

- Corals- 59%
- Slugs-3%
- Crabs- 6%
- Marine Flora & Fauna- 3%
- Mangrove- 3%
- Cave-3%
- Spring-3%
- Freshwater-3%
- Birds- 6%
- Snake- 9%

A large portion of respondents interviewed (68% of 87 answering this question) are not aware of any historical or cultural significance in their community. The respondents who knew of cultural and historical sites in their community were 32% of the 87 individuals. Those individuals, who knew of historical sites, identified them as:

- The Old Sugar Boiler,
- The Kettering Baptist Church,
- A Slaver House,
- The Old Plantation,

- Caves,
- Silver Sands, and
- Duncan Bay

DETERMINATION OF THE POTENTIAL IMPACTS OF THE PROPOSED PROJECT

7 Determination of the Potential Impacts of the Proposed Project

7.1 Introduction

This proposed resort development has the potential to create a variety of impacts if it is implemented. These potential impacts can be either positive or negative depending on the receptors involved and other parameters such as magnitude, duration, project management and monitoring. Since this report is geared primarily towards identification of environmental impacts those will be presented in greater detail later in this report, other impacts will be presented in less detail in this section.

In assessing the significance of potential impacts, various measures are used. These include the use of checklists/matrices, expert knowledge and a keen assessment of the project plans and details. Each parameter is evaluated according to the following:

- Potential impact - any change to the environment, whether adverse or beneficial, wholly or partially resulting from the proposed activities, products or services
- Activity – phase of development that action takes place in
- Environmental receptor - sensitive component of the ecosystem that reacts to or is influenced by environmental stressors
- Magnitude - A measure of how adverse or beneficial an effect may be
- Duration - the length of time needed to complete an activity
- Significance - A measure of importance of an effect
- Mitigation - Measures taken to reduce adverse impacts on the environment

Outlined below are the impacts on the various phases of the proposed development as they relate to key aspects of the project. Namely:

- Physical environment
- Biological environment
- Socio-economic environment
- Cumulative impact assessment

Mitigation measures are provided, where necessary, at the end of each subsection.

7.2 Sensitive Habitats, Flora and Fauna

Artificial Lighting: Sea turtles, especially hatchlings, are profoundly influenced by light. Baby sea turtles, freshly emerged from the nest, depend largely on a visual response to natural seaward light to guide them to the ocean. In zones of coastal development, sources of artificial light distract hatchlings so that they turn away from the sea and crawl landward. It is essential that artificial light sources be positioned so that the source of light is not directly visible from the beach and does not directly illuminate areas of the beach. Low pressure sodium lights should be used to the maximum extent possible. Low intensity, ground-level lighting is encouraged. Night time and security lighting should be mounted not more than 5 m above the ground and should not directly illuminate areas seaward of the line of permanent vegetation. Window shading is recommended.

Natural or artificial structures rising above the ground should be used to the maximum extent possible to prevent lighting from directly illuminating the beach and to buffer noise and conceal human activity from the beach. Planting native or ornamental vegetation, or using hedges and/or privacy fences is recommended.

Beach stabilization structures: The construction of seawalls and jetties, and lights shining on the beach at night should be prohibited or closely evaluated in light of the ecological requirements of endangered turtles.

Physical destruction of coral and sea grass: Anchoring should not occur in reef or sea grass areas. Divers, especially tourists, should be thoroughly coached on diving etiquette so as to preclude trampling, collecting, and touching living coral.

Impacts to Mangrove/Salina: The area of mangrove habitat represents less than one (1) percent of the site. This stand is small and is also separate and apart from any other mangrove area on the North Coast, thus not a contiguous stand. This area is being incorporated into the design of the facility; any minor infraction will not have a significant ecological impact on the mangrove system.

Whilst no significant direct impacts are anticipated, there is the potential for indirect impacts unless appropriate mitigation measures are implemented, particularly during any construction works. Such mitigation measures mainly relate to controlling the potential for impacts to water quality. As with all other projects occurring at the land-water interface, the control of erosion, sedimentation and other water quality impacts is a key issue. However, given the existing disturbance in the vicinity of the affected area and the fact that any works associated with the development would incorporate implementation of appropriate environmental management and impact mitigation measures, the potential impacts are unlikely to be substantial or significant with regard to aquatic communities.

Mangroves can be replanted through seedlings. In order to overcome the deficiencies in existing replanting techniques, Encased Replanting is suggested as the mitigation method, a more productive and adaptable alternative to current techniques. The method focuses on isolating the seedling into a controlled environment at the actual replanting site. The encasement artificially creates an environment favourable to the seedling's initial development while protecting the plant long enough to become well established. The isolation physically separates the seedling from surrounding conditions that are unfavourable to early development of the tree. Seedlings of each affected type should be harvested as much as possible from the affected site.

Areas in which 5 percent or more of mangrove trees have been trimmed below 4 feet in height, destroyed, defoliated, or removed as a result of construction activities will be restored or mitigated. Restoration will be accomplished by replanting mangroves, in the same location and of the same species as each mangrove destroyed, defoliated, removed, or trimmed, to achieve within 5 years a canopy area equivalent to the area destroyed, removed, defoliated, or trimmed on a mitigation ratio of 3:1 to the affected area.

Mitigation will be accomplished by replanting offsite where necessary, in areas suitable for mangrove growth, mangroves to achieve within 5 years a canopy area equivalent to the area destroyed, removed, defoliated, or trimmed. Where all or a portion of the restoration or mitigation is not practicable, the impacts resulting from the destruction, defoliation, removal, or trimming of the mangroves will be offset by donating a sufficient amount of money to offset the impacts, which must be used for the restoration, enhancement, creation, or preservation of mangrove wetlands within a restoration, enhancement, creation, or preservation project approved by NEPA at a mitigation ratio of 3:1 to affected area. The donation will be equivalent to the cost, as verified by NEPA of creating mangrove wetlands at a 3:1, created versus affected ratio, based on canopy area.

Monitoring of physical water quality parameters (both salina and within mangroves for a minimum period of 2 weeks) such as sediment, turbidity and nutrients would determine whether the safeguards are adequate. Monitoring is particularly important during and after rainfall events.

Impacts to Seagrass: Conservation of existing seagrass beds has proven to be a much more cost-effective management technique and that will be applied here as much as possible. However should it be necessary, based on current techniques and with proper monitoring the impacts should be minimal. Under the appropriate conditions of water depth, sediment type, and wave and current conditions, with small projects of under 0.8 ha (2 acres), the transplantation of seagrasses using manual techniques of sods, cores, and bare roots will probably be effective.

In cases where planting is necessary, however, a set of helpful guidelines has been developed by the National Oceanic and Atmospheric Administration (Fonseca et al. 1998). Those guidelines include the following steps:

- Planning
- Obtaining Transplant Stock
- Planting
- Monitoring and Evaluating Success

7.3 Physical Environment

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.3.1 *Aesthetics*							
Pre-Construction, Construction & Operation	Humans, Flora & Fauna	Negative	**Item A1 –** The clearance and removal of vegetation from the site will result in a visually negative impact as it represents a change from what is customary. Similarly the construction site. All activities on the site will be carefully examined to ensure as little impact on the surrounding community as possible. Landscaping of the site during the latter part of construction and through operation will greatly improve on the aesthetics of the area.	Proper upkeep and maintenance of the site will be done. Vegetation cover will be maintained at the periphery to reduce the visual impact. Where necessary, hoarding of not less than 2.4 m above ground level should be provided along the entire length of that portion of the site boundary except for any site entrances or exits. Other measures include: minimising height of temporary structures, replanting of disturbed vegetation, and the re-use of topsoil stripped during site clearance.	Short Term	Minor Negative	Moderate
			Item A2 – On completion of the proposed project, the salina and mangrove area will be enhanced to perform their key role in nature. The wetland flora and fauna will remain as a developmental feature to the area and the development	During construction all steps will be taken to ensure the mangrove and salina areas are not littered or otherwise damaged. Silt screens will be used, as necessary, to reduce any potential siltation within these areas. Proper upkeep and maintenance will be required so that the salina/mangrove area can remain functional	Long Term	Major Positive	High
			Item A3 – The completed development will be aesthetically pleasing and through landscaping and the enhancement of the salina/mangrove area will offer a relaxing, beautiful residential and recreation area for the people of Duncan Bay to enjoy.	A management and operational plan must be implemented so that the development can be properly maintained. Effective landscaping and solid waste storage and disposal must be put in place so that the cleanliness of the area is maintained.	Long Term	Positive	High
7.3.2 *Geological & Geo-Technical*							
Pre-Construction, Construction & Operation	Humans, Flora & Fauna	Positive	**Item GG1 –** The inclusion of any existing drains (which will be upgraded) into the project's drainage design will allow for better control and management of stormwater which will reduce or eliminate erosion and limit associated impacts of silting and sedimentation. This is a long term, beneficial impact.	The inclusion of any exiting drainage features (which will be upgraded) into the projects' drainage design will allow for better control and management of stormwater which will reduce or eliminate erosion and limit impacts of silting and sedimentation.	Long Term	Major Positive	High
7.3.3 *Water Quality/Surface Water Hydrology and Groundwater*							
Construction			**Item WQ1 –** The potential impacts on water quality	The water quality of these systems can be evaluated on a periodic or event basis	Long	Minor	Low

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
& Operation			are confined to groundwater and marine area. The impacts on groundwater of this project will be negligible as there are no chemicals, waste streams or disposal activities associated with the development that stands to affect groundwater. The salina/mangrove and marine areas can be impacted negatively by siltation and sedimentation if a problem with soil erosion is realised, which is unlikely.	to determine if negative impacts are being realised. The project monitoring phase will play a major role in this activity. The salina/mangrove area will provide a natural filtering system, and will enhance any measures put in place by the developers such as silt/sediment screens and landscaping to offset the possibility, primarily during construction.	Term	Negative	
7.3.4 *Air Quality*							
Pre-Construction, Construction & Operation	Humans, Flora and Fauna	Negative	**Item AQ1 –** During site clearance and construction activities, there is a possibility that stockpiles of various materials associated with the proposed project may have to be maintained in the project area. These stockpiles, without proper management and monitoring can dry out and result in fugitive dust formation which can be dispersed in the wind affecting air quality. This is a short term, reversible and mitigable impact.	All stockpiles of construction material should be kept onsite for a minimum amount of time. This will limit the potential for stockpiles drying out and becoming airborne. If unavoidable, the stockpiles may have to be sprinkled or in the worst case covered to limit dispersion of dust particles.	Short Term	Minor Negative	Medium
			Item AQ2 – Various mechanical equipment and vehicles are expected to be used at the project site. The heavy duty vehicles are expected to be primarily diesel fuel vehicles. When properly maintained heavy duty vehicles can operate without causing significant decrease in air quality. However, if maintenance is poor, excessive fugitive emissions may result.	Heavy duty equipment and vehicles using diesel fuel must be properly maintained and inspected at regular intervals. All vehicular maintenance should be done at an approved off-site maintenance location such as a garage. Vehicle causing excessive fugitive emissions should be removed from service.	Short Term	Minor Negative	Low
			Item AQ3 – The removal of vegetation during site clearance activities may increase the potential for particulate matter to get into the atmosphere. This is as a result of exposed soil that may dry out.	After the removal of vegetation from the site during site clearance activities, the area must be monitored and dust suppression techniques put in place as needed.	Short Term	Minor Negative	Low
7.3.5 *Noise & Vibration*							
Pre-Construction, Construction, & Operation	Humans and Fauna	Negative	**Item N1 –** Various mechanical equipments, vehicles and site activities can generate noise that may exceed acceptable levels.	Silencers or mufflers on construction equipment should be properly fitted and maintained. If site activities are known to be noisy, they should be scheduled at times least likely to impact those in hearing distance.	Short Term	Minor Negative	Low

7.4 Biological Environment

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.4.1 *Aquatic Fauna*							
Construction and Operation	Fauna	Negative	**Item AF1** – The aquatic community may be affected mainly during the pre-construction and construction phases due to the possibility for increases in turbidity through increased sedimentation and/or siltation within the drainage corridor. This potential impact is particularly in the form of a loss of biodiversity. Any biological specimens inhabiting these natural channels during the wet season will re-colonize the area soon after the project is operational because the channels will be incorporated into the drainage regime for storm water from the proposed development.	Conditions that can lead to soil erosion should be avoided. Drainage channels with silt screens where they terminate in the salina/mangrove area will allow for entrained sediments to be removed. It is not envisioned that the project will have a negative impact on Duncan Bay if these mitigation measures are implemented.	Short Term	Minor Negative	Low
7.4.2 *Wildlife Resources*							
Construction & Operation	Fauna	Negative	**Item WR1 -** There exists a potential loss of wildlife resources within the immediate area. This loss is temporary since any resident wildlife will temporarily relocate to surrounding areas that are not affected. No region-specific wildlife resource occupies the area that will be critically endangered should this project go ahead. The improvements to the salina/mangrove area will improve the conditions for the existing wildlife resources, particularly the avifauna.	The removal of wildlife resources and their ecological habitats is unavoidable notwithstanding the fact that the area is disturbed through various activities such as illegal dumping. Wildlife is mobile in nature and will more than likely relocate to other areas in the vicinity where they are less likely to be in danger.	Long Term	Negative	Low
7.4.3 *Vegetation Resources*							
Construction & Operation	Fauna	Negative	**ItemVR1 -** In order to construct this development the area must be cleared of all existing vegetation. This presents a loss of biodiversity within the immediate area. Established ecosystems will be lost. No region-specific endemic plant species were found in the area. The proposed site is degraded with anthropogenic impacts primarily through illegal dumping which extends to the mangrove area.	The removal of vegetation and ecological habitats is unavoidable and is the main trade-off to be made against the benefits to be derived from project implementation. Landscaping measures to be put in place will as much as possible, incorporate plants that are typical of the region.	Long Term	Negative	Low

7.5 Socio-Cultural and Socio-Economic Environment

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
7.5.1 *Employment & Socio-Economic Impacts*							
Operation	Humans	Positive	**Item E1** – This project will provide a limited amount of new employment opportunities during construction of the proposed development. Additionally, Treasures of Trelawny will utilise its existing contractors and engineers who may seek to employ residents of the surrounding communities due to their proximity to the project site, and their knowledge of the area and operations there.	Positive impact. **NO MITIGATION is REQUIRED**	Long Term	Major Positive	Moderate
7.5.2 *Recreation and Beach Access*							
Construction	Humans	Positive	**Item RBA1** – This project will not infringe on the prescriptive rights to beach access during any phase.	Positive impact. **NO MITIGATION is REQUIRED**	Long Term	Major Positive	Moderate
7.5.3 *Cultural Heritage*							
Construction	Humans	Positive	**Item CH1** – The Duncan Bay area is known to be close to other heritage sites, such as the Kettering Free Village and the Kettering Baptist Church. Any cultural heritage found on the site or near that have not been investigated or adequately studied previously, would be affected. No heritage sites are known to be on the site or in close proximity to the site that would be affected by this development.	Secure any identified cultural heritage resources through the Jamaica National Heritage Trust.	Long term	Major Positive	Low
7.5.4 *Traffic*							
Pre-Construction, Construction & Operation	Humans	Negative	**Item T1 –** The existing main roads will be used to deliver equipment and remove debris from the proposed site location. The added vehicles and the frequency of their movement and the movement of workers have the potential to result in congestion on the roads. Also, the potential for hazards to the commuting public is increased.	The potential increase in traffic is not anticipated to be significant as a result of improvements to roadways in the area, most notably the North coast Highway, and the overall planned development of the general area as a resort area. If the facility owns vehicles, they will ensure that they are properly maintained at all times. Offending contract vehicles will be prohibited from the property.	Long Term	Minor Negative	Moderate
7.5.5 *Solid Waste*							
Construction & Operation	Humans	Negative	**Item SW1** – Site clearance activities during the pre-construction phase and other waste from packaging	All solid waste generated during all phase will be collected, handled and disposed of appropriately. Centralised storage areas (dumpsters, compacters	Long Term	Minor Negative	Low

Activity	Environmental receptor	Type of Impact	Potential Impact	Mitigation	Duration	Significance Level	Likelihood
			materials in the other phases will generate solid waste. If these waste streams are not properly managed then the potential exist for a negative impact. A properly implemented and executed solid waste management plan can remove this negative potential.	etc.) will be located within the development for proper solid waste handling and storage. Solid waste removal will be facilitated by the existing authority.			
7.5.6 *Sewage Waste*							
Construction & Operation	Humans	Negative	**Item SeW1** – The potential for sewage waste pollution during site clearance and construction activities exist though remote. The use of regularly serviced portable chemical toilets will negate this potential negative impact. Sewage handling and disposal will be effectively and carefully managed as part of the project management and monitoring plans.	**NO MITIGATION is REQUIRED**	Short Term	Positive	Low
Construction & Operation	Humans	Negative	**Item SeW2** – As part of the proposed development, a sewage treatment facility will be constructed. This facility is designed to treat to the tertiary level and will be complemented by an improved salina/mangrove area. Treated effluent is expected to consistently meet or exceed regulatory standards.	**NO MITIGATION is REQUIRED**	Short Term	Positive	Low
7.5.7 *Utilities Demand*							
Construction & Operation	Humans	Negative	**Item UD1** – Treasures of Trelawny will work with NWC and JPSCo to develop independent/reliable source of each utility for the resort. Initiate water and energy conservation and minimisation strategies. Utilise treated wastewater for irrigation.	**NO MITIGATION is REQUIRED**	Long Term	Minor Negative	Low

7.6 Cumulative Impact Assessment

The potential cumulative impacts as a result of this development are as follows:

- Impacts to Biological Resources
- Impacts to Physical Resources
- Impacts on Socio-Economic and Socio-Cultural Resources

7.6.1 *Impacts to Biological Resources*

Impacts to the biological resources of the area are at a minimum. Any discharge from the proposed development will be treated to tertiary level and be subjected to monitoring prior to any of it entering the salina/mangrove area. Though run-off will be increased, the salina/mangrove area provides the necessary buffer zone to prevent any flooding of the area. If properly implemented and managed, discharges from the development (storm water and treated effluent) will be not affect the receiving environment.

The loss of vegetated land is not a major impact for two reasons:

- this area was previously disturbed when the lots were prepared, and
- the small size (2 hectares)

7.6.2 *Impacts to Physical Resources*

The surrounding economic zone comprises other developed resorts and future/planned developments, and residential communities.

Water demands for the proposed development have been considered and will be met by the improved water system put in place in 2006. This system was designed to accommodate the Harmony Cove and other developments in the region. The cumulative impact of water supply to the development would not be to the detriment of other users presently being supplied.

Sewerage demands for the proposed development have been considered. No central sewerage system exists in the region. As a result, a tertiary level sewage treatment facility is being proposed to process all sewage that will be generated from this development. The treated

effluent will additionally be used to irrigate the development to reduce demand on existing water systems.

The proposed project area is not known to be prone to land slippage and coastal erosion. Neither is the area known for agricultural purposes. The development will add to the existing land-use pattern of residential and/or resort development for the general region.

7.6.3 *Impacts on Socio-Economic and Socio-Cultural Resources*

No cumulative impact is expected on the socio-economic and socio-cultural resources of the area. The development will increase economic opportunities through job creation. Additionally, the country will benefit from the increase in rooms for the tourism sector. The commercial benefits to the parish of Falmouth will also increase as it positions itself to be among Jamaica's top hotel/resort destinations.

Cultural resources in the region may receive a positive spin-off from this and other developments through visitations etc. The region will also be well positioned to benefit from improved services (utilities etc.) through this and other developments.

7.7 Impact Matrices

Table 7-1: Impact Identification of the Proposed Development

	EIA Activities																
	Site Preparation				Construction								Operation				
	Site Surveying	Site Clearance	Site Access	Solid Waste Disposal	Materials Sourcing	Materials Transport	Construction Camp/Materials Storage	Construction Works	Solid Waste Disposal	Sewage Treatment	Surfacing/Paving	Landscaping	Traffic	Solid Waste Disposal	Water Supply	Electricity Generation	Increased Migration
Physical Parameters																	
TOPOGRAPHY																	
GEOLOGY & GEOTECHNICAL																	
AMBIENT NOISE & VIBRATION																	
WINDS																	
RAINFALL																	
NOISE AND DUST																	
DRAINAGE																	
TEMPERATURE																	
NATURAL HAZARD VULNERABILITY																	
Ecological Parameters:-																	
TERRESTRIAL ECOSYSTEMS																	
VEGETATION																	
AVIFAUNA																	
OTHER FAUNA																	
AQUATIC & MARINE ECOSYSTEMS																	
VEGETATION																	
FAUNA																	
SENSITIVE HABITATS																	
Socio-Economic Parameters:-																	
AESTHETICS																	
LAND USE COMPATIBILITY																	
EMPLOYMENT																	
STRUCTURES/ROADS																	
WASTE MANAGEMENT																	
TRAFFIC ON THE ACCESS ROAD																	
INCREASED CRIME POTENTIAL																	

	EIA Activities																
	Site Preparation				Construction								Operation				
	Site Surveying	Site Clearance	Site Access	Solid Waste Disposal	Materials Sourcing	Materials Transport	Construction Camp/Materials Storage	Construction Works	Solid Waste Disposal	Sewage Treatment	Surfacing/Paving	Landscaping	Traffic	Solid Waste Disposal	Water Supply	Electricity Generation	Increased Migration
HAZARD VULNERABILITY																	
SOLID WASTE DISPOSAL																	
SEWAGE DISPOSAL																	
OCCUPATIONAL HEALTH & SAFETY																	

Key	
No Impact	
Minor Negative	
Major Negative	
Minor Positive	
Major Positive	

Table 7-2: Impact Mitigation Matrix (Pre-Construction Phase)

	Proposed Mitigative Measures													
	Detailed Topographic Surveys	Effective Site Management	Scheduling of Construction Activities	Waste Management Plan	Regular Solid waste collection	Placing of Solid waste Receptacles	Road Paving and Surfacing	Dust Management Techniques	Proper Vehicle Maintenance	Installation of Sediment Traps	Security & Fencing	Positive Impact No Mitigation	Community Relations	Flora & Fauna Relocation
Impacts - Preconstruction Phase														
Clearing of Site Vegetation														
Levelling of Site														
Transportation of Construction Material														
Increase in Noise														
Increase in Dust														
Disturbance of flora and fauna														
Aesthetics														
Increased Traffic														
Increased Employment														
Road Wear														
Increased Sedimentation of Coastal Waters														
Change in the Natural Drainage														
Solid Waste Generation														
Disturbance of Wetland Communities														
Increased Earning Potential for Community														
Traffic Inconveniences														

Key	
No Impact	
Minor Negative	
Major Negative	
Minor Positive	
Major Positive	

Table 7-3: Impact Mitigation Matrix (Construction Phase)

	Proposed Mitigative Measures														
	Detailed Topographic Surveys	Phasing of Building Plans	Scheduling of Construction Activities	Waste Management Plan	Regular Solid waste collection	Placing of Solid waste Receptacles	Road Paving and Surfacing	Dust Management Techniques	Proper Vehicle Maintenance	Landscaping Measures	Effective Site Management	Security & Fencing	Installation of Sediment Traps	Scheduling of Heavy Vehicles	Positive Impact No Mitigation	Community Relations
Impacts - Construction Phase																
Increased Employment																
Levelling of Site																
Transportation of Construction Material																
Increase in Noise																
Increase in Dust																
Occupational Health & Safety Concerns																
Aesthetics																
Increased Earning Potential for Community																
Increased Traffic																
Road Wear																
Increased Sedimentation of Coastal Waters																
Change in the Natural Drainage Patterns																
Solid Waste Generation																
Sewage Disposal																
Disturbance of Wetland Communities																

Key	
No Impact	
Minor Negative	
Major Negative	
Minor Positive	
Major Positive	

Table 7-4: Impact Mitigation Matrix (Operation Phase)

	Proposed Mitigative Measures								
	Community Wide Plan	Operation & Maintenance Plan	Regulatory Monitoring	Waste Management Plan	Regular Solid waste collection	Placing of Solid waste Receptacles	Security & Fencing	Landscaping Measures	Positive Impact No Mitigation
Impacts - Occupational Phase									
Increased Employment opportunities									
Sewage Treatment System Management									
Drainage Patterns									
Solid Waste Management									
Water Conservation									
Energy Conservation									
Aesthetics									
Regulatory Compliance									
Fugitive Dust									
Increased Earning Potential for Community									

Key	
No Impact	
Minor Negative	
Major Negative	
Minor Positive	
Major Positive	

ENVIRONMENTAL MONITORING AND MANAGEMENT PLAN

8 Environmental Monitoring and Management Plan

8.1 Monitoring Plan

The Monitoring Plan to be devised for the development should be implemented during the pre-construction and construction phases of the project. Monitoring involves the observation, review and assessment of onsite activities to ensure adherence to regulatory standards and the recommendations made to reduce negative impacts. The Plan must be comprehensive and address relevant issues, with a reporting component that will be made available to the regulatory agencies based on a mutually agreed frequency. It is recommended that a minimum monthly monitoring report be submitted to NEPA.

The monitoring report will include at a minimum:

- Raw data collected
- Tables/graphs (where appropriate)
- Discussion of results with respect to the development in progress, highlighting parameters which exceed standards
- Recommendations
- Appendices with photos/data, etc.

At a minimum, the following activities will be monitored in the various phases:

8.1.1 *Pre-Construction Phase Monitoring*

- During site clearing activities, those trees that will be saved and incorporated into the development must be identified and protected. The plants to be retained should be flagged, and if necessary fenced. It is suggested that the developers assess a monetary value to be placed on each plant, for which the contractor will be made liable. Should the contractor damage or remove a flagged tree, the penalty should be assessed. An inventory and map (if applicable) of all trees to be retained must be developed. (Weekly Monitoring)
- Where identified, endemic and rare species should be preserved in place or collected for transplanting (As Observed)

- Stockpiles of soil and vegetative debris generated during site clearing activities should be monitored and maintained to eliminate generation of fugitive dust. (Daily Monitoring)
- Noise levels along the perimeters of the project area should be monitored and recorded to ensure that activities at the site are not exceeding standards. (Daily Monitoring)

8.1.2 *Construction Phase Monitoring*

- Sewage - Ensure that temporary portable chemical toilets are available for construction personnel and that the contents are disposed by an approved waste hauler in an appropriate waste disposal facility. (Weekly Monitoring)
- Sand/Marl/Aggregate Supply - Routinely monitor sourcing of quarry materials to ensure supplier is obtaining supplies from licensed operations. (Monthly Monitoring)
- Solid Waste Management - Ensure that solid waste management plan is prepared, and that workers are aware that no solid waste material should be scattered around the site. Monitor availability and location of skips/dumpsters. (Weekly Monitoring)
- Monitor the disposal of refuse to ensure that skips/dumpsters are not overfilled. (Weekly Monitoring)
- Routine collection of solid waste for disposal must be implemented, and disposal monitored to ensure use of approved disposal facilities. (Weekly Monitoring)
- Exposed soil areas must be monitored to determine potential for erosion, silting and sedimentation particularly during storm events. (Weekly Monitoring)
- If erosion, silting or sedimentation is a potential or occurs, immediate steps must be taken to negate the impact on the coastal waters and other receptors where applicable. (As Needed)
- Equipment staging and parking areas must be monitored for releases and potential impacts. (Weekly Monitoring)
- If any cultural heritage resources are unearthed during construction, activities should be stopped and an Archaeological Retrieval Plan implemented. (As Needed)

- Noise levels along the perimeters of the project area should be monitored and recorded to ensure that activities at the site are not exceeding standards. (Daily Monitoring)

8.1.3 *Operation Phase*

- Sewage - Monitor effluent quality periodically to determine compliance with regulatory standards and appropriateness for use as irrigation water and or flushing to the salina/mangrove swamp. (Monthly Monitoring or as determined by regulatory standards)
- Solid Waste - Monitor solid waste skips/dumpsters and removal contractor to ensure proper waste handling and disposal. (Weekly Monitoring)
- Drainage - Regular inspections of drainage systems should be performed to ensure that the drains remain clear of blockages to safeguard against flooding or damage to salina/swamp/marine environment. (Monthly Monitoring).

8.2 Management Plan

An Environmental Management Plan (EMP) is necessary for this project, particularly during the operational phase of the project. The primary objective of the EMP is to ensure that the project complies with the terms and conditions of the National Environment and Planning Agency and other applicable and relevant Authorities. The plan will provide guidance in the following areas:

Training of managers and staff

1. Solid waste handling and disposal
2. Hazardous material storage and disposal
3. Sewage treatment and disposal
4. Natural Hazards Management

As required or as necessary, active environmental monitoring will be undertaken to provide quantitative information on the state of the environment as it relates to the phases of the project.

Areas of concern are:

- Water quality
- Air quality
- Loud noise
- Land rehabilitation
- Creative conservation

8.2.1 *Natural Hazard Management Plan*

It is necessary to develop a hazard response plan to offset the worst effects of hurricanes on the project area. This plan will be prepared as a separate document on the advice from the Office of Disaster Preparedness and Emergency Management (ODPEM).

Losses due to hurricanes can be reduced through an effective response plan. The principal features of such a plan are:

- Comprehensive risk assessment based on historical precedent and vulnerability of the site. Distribution of occurrences, frequencies of wind strengths and direction, and frequencies of storm surges.
- Appropriate preventative design and engineering (e.g. structures built to withstand hurricane force winds etc.)
- Public awareness and staff training in disaster response
- An effective national warning system

8.2.2 *Operational Hazard Management & Safety Plan*

A clearly defined emergency response and preparedness policy will be developed and brought to the proposed project. An effective response is seen as the direct outcome of quality environmental management and comprehensive training and awareness of safety procedures. The principal objective of emergency preparedness is to localize accidents, and if possible contain and minimize them.

8.2.2.1 Response Plan

Taken into consideration that the pier is to be rehabilitated, this report can only provide systems and general procedures necessary to effectively respond to emergencies.

The proposed development will have an Emergency Response Plan, which will provide guidelines to allow for flexible response to a range of potential circumstances. The plan would include:

- Chain of command and coordination procedures
- Lines of communication
- Means of obtaining needed information and assistance

Copies of the plan or relevant portions will be strategically located at vantage points across the property to allow for immediate access.

All employees will receive safety and emergency response training as a part of the initiation process.

8.2.2.2 Fire Safety

All water stored on site for both domestic and potable use will be piped into a fire response system. This will involve connections to fire hydrants and fire hoses, which will be distributed across the project area to assist in the event of a fire emergency.

Specialized fire fighting equipment will be provided as necessary.

REFERENCES

9 References

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APPENDIX

APPENDIX I: APPROVED TERMS OF REFERENCE

Appendix I: Approved Terms of Reference

DRAFT TERMS OF REFERENCE - EIA TREASURES OF TRELAWNY

Introduction

PURPOSE

Treasures of Trelawny Limited proposes to construct a 112 room hotel on 2 hectares (5 acres) of land at Duncan Bay in the parish of Trelawny, in compliance with the Trelawny Parish Development Order, the Town and Country Planning Act and the NRCA Act of 1991 and other relevant policies, legislation, regulations and standards.

Conrad Douglas and Associates (CD&A) will work closely with our clients, Treasures of Trelawny Limited and their engineering design and construction partners, to complete a high quality EIA report that addresses all environmental and engineering concerns that may be associated with this project.

BACKGROUND

Tourism is one of the major foreign exchange earning sectors in Jamaican economy. The natural, socio-economic and cultural environments are important resources for tourism but these features are sensitive to disturbance by human activities. Therefore, negative impacts resulting from inadequately planned and uncontrolled tourism developments can adversely affect the environments on which their success depends. The magnitude of these impacts is largely dependent on the scale, type and operational nature of developments proposed relative to the fragility of the environment.

The proposed development is located just west of the Silver Sands resort community, north of the town of Duncans and east of the Amaterra Resort Development at Stewart Castle.

The Environmental Impact Assessment should:

1. Provide a complete description of the existing site proposed for development. Detail the elements of the development, highlighting areas to be reserved for construction 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 which should include social, cultural and heritage considerations. Assess public perception of the proposed development.
3. Outline the Legislations and Regulations relevant to the project.
4. 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 costs.
6. Identify mitigation action to be taken and quantify associated costs.
7. Design a Monitoring Plan which should ensure that the mitigation plan is adhered to.
8. Describe the alternatives to the project that could be considered at that site.

To ensure that a thorough Environmental Impact Assessment is carried out, 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 reserved for construction and landscaping, 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 pre-construction, construction, and post construction 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.

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

iii) Socio-economic, cultural and heritage constraints.

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 **geology** and **hydrology.** Special emphasis should be placed on storm water run-off, drainage patterns, effect on groundwater and availability of potable water. Any slope stability issues that could arise should be thoroughly explored.

ii) **Water quality** of any existing wells, rivers, ponds, streams or coastal waters in the vicinity of the development. Quality Indicators should include but not necessarily be limited to nitrates, phosphates, faecal coliform, and suspended solids.

iii) Climatic conditions and air quality in the area of influence including particulate emissions from stationary or mobile sources, wind speed and direction, precipitation, relative humidity and ambient temperatures relevant to the site,

iv) Noise levels of undeveloped site and the ambient noise in the area of influence

v) Obvious sources of pollution existing and extent of contamination.

vi) Availability of solid waste management facilities

vii) Natural Hazard vulnerability

(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, wild endemic crop plants, and invasive species, if found, should also be considered. There may be the need to incorporate micro-organisms to obtain an accurate baseline assessment. Generally, species dependence, niche specificity, community structure and diversity ought to be considered. Species will be identified in the form of a species list using applicable means such as direct observation, observation of general surroundings or indicating agents / indicators, etc.

(C) Socio-economic & cultural

Present and projected population; present and proposed land use; planned development activities,

issues relating to squatting and relocation, community structure, employment, distribution of income, goods and services; recreation; public health and safety; cultural peculiarities, aspirations and attitudes should be explored. The historical and heritage value and importance of the area should also be evaluated and all existing features and elements surveyed into the baseline maps. While this analysis is being conducted, it is expected that an assessment of public perception of the proposed development be conducted. This assessment may vary with community structure and may take multiple forms such as public meetings or questionnaires. Include the concerns and recommendations of the neighbouring communities, groups and agencies such as the Parish council, Jamaica National Heritage Trust, and NWA, as well as information on available institutions to support development.

Task #3 - Legislative and Regulatory Considerations

Outline the pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels. The examination of the legislation should include at minimum, legislation such as the NRCA Act, the Wildlife Protection Act, the Town and Country Planning Act, legislation and policies from the Forestry Department, Building Codes and Standards, Development Orders and Plans, the Jamaica National Heritage Trust Act, and the appropriate international convention/protocol/treaty where applicable

Task #4 - Determination of Potential Impacts

Identify the major environmental and public health issues of concern and indicate their relative importance to the design of the subdivision. Identify potential impacts as they relate to, (but are not restricted by) the following:

- change in drainage pattern
- flooding potential
- landscape impacts of excavation and construction
- loss of natural features, habitats and species by construction and operation
- pollution of potable, coastal, surface and ground water
- air pollution
- spill and leaching of chemicals

- impacts on the archaeological, historical and built heritage of excavation and construction
- capacity and design parameters of proposed sewage treatment facility
- socio-economic and cultural impacts
- risk assessment
- noise

Issues such as Coastline stability, coral reef, mangrove and wetland, seagrass impacts, unique coastal environments, nutrient loading in coastal waters and impact on coastal commercial fishing should be examined.

Distinguish between significant positive and negative impacts, direct and indirect, long term and immediate impacts. Identify avoidable as well as irreversible impacts. Characterize the extent and quality of the available data, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. Project activities and impacts should be represented in matrix form with separate matrices for pre and post mitigation scenarios.

Task #5 –Mitigation

Prepare a sequence of guidelines / alternatives to avoid or reduce as best as possible, any adverse impacts due to proposed usage of the site and utilising of existing environmental attributes for optimum development (for example, Wise Practice Construction Techniques) Where possible, quantify and assign financial and economic values to impacts and mitigation methods.

Task #6 - Monitoring

Design a plan to monitor implementation of mitigatory or compensatory measures and project impacts during construction and operation of the facility. An Environmental Management Plan for the long term operations of the site should also be prepared.

An outline monitoring programme should be included in the EIA, 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 in given time periods.
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored. These may in instances, be pre-determined by the local authority 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.

Task #7 - Project Alternatives

Examine alternatives to the project including the no-action alternative. This examination of project alternatives should incorporate the use history of the overall area in which the site is located and previous uses of the site itself. Refer to NEPA guidelines for EIA preparation.

All Findings must be presented in the **EIA report** and must reflect the headings in the body of the TORs, 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.

APPENDIX II: PROJECT TEAM

Appendix II: Project Team

Dr. Conrad Douglas
Mr. Paul Thompson
Mr. Orville Grey Jr.
Mr. Wayne Morris
Mr. Marco Campbell
Ms. Stephanie McIntyre
Mr. Damion Whyte
Mr. Burklyn Rhoden
Mr. Peter Wilson-Kelly
Prof. Ted Robinson

APPENDIX III: SOCIO-ECONOMIC SURVEY INSTRUMENT

Appendix III: Socio-Economic Survey Instrument

SURVEY INSTRUMENT
Conrad Douglas & Associates Limited

ENVIRONMENTAL IMPACT ASSESSMENT
For
Treasures of Trelawny Resort Development, Duncans, Trelawny

Social Impact Assessment

Community Name _____ Community Code **(ED)** | | | | | |

SECTION 1: PERSONAL CHARACTERISTICS

1) Gender
   1. Male
   2. Female

2) Age Range
   1. Under 20
   2. 20 – 39
   3. 40 – 49
   4. 50 – 59
   5. 60 – over
   6. Not Stated/No Response

3) How many years have you been living in the community?
   1. 0 – 5 Years
   2. 6 – 10 Years
   3. 11 – 20 Years
   4. more than 20 Years
   5. Not Stated/No Response

4) How many people live in this household? M ☐ F ☐ Total ☐

5a. How old are they?

Age Range	#
0-14	
15-19	
20-35	
36-45	
46-55	
56-64	
65 and over	

5b. How many persons are in paid employment?

5c. How many persons are unemployed?
6. Are you in paid employment?

7. If Yes, what is your occupation?

SECTION 2: OPINIONS ON THE COMMUNITY

8. What do you like most about the community? (***ASK & WAIT FOR RESPONSE)***
    1. Friendly people
    2. Clean environment:
    3. Availability of farmland
    4. Quiet
    5. No crime & violence
    6. Other, (specify)_____
    7. Not Stated/No Response

9. What don't you like about the community? (***ASK & WAIT FOR RESPONSE)***
    1. Poor roads
    2. Lack of Utilities
    3. Crime & violence
    4. Unemployment
    5. Dirty environment
    6. Other, (specify)_____
    7. Not Stated/No Response

10. "Large scale development is beneficial to this community" (e.g. construction activities, housing) Do you agree?
    1. Yes
    2. No
    3. Not Stated/No Response

11. Why do you think so?
    1. Job opportunities
    2. It will reduce the peacefulness of the area
    3. Offers skills development
    4. Improves utilities
    5. It will affect environmental quality in a negative way
    6. Other (specify)
    7. Not Stated/No Response

SECTION 3: KNOWLEDGE AND VIEWS ON RESORT CONDOMINIUM DEVELOPMENT PLANS

Public Awareness

12. Are you aware of the proposal to set-up a 112 room resort development on a five acres beachside property in Duncans in Trelawny close to the Silver Sands Resort Community?

    1. Yes
    2. No

13. If yes, are you:

    1. Strongly in favour
    2. In favour
    3. Neither in favour or against
    4. Against
    5. Strongly against

What are your reasons?

_____

_____

_____

_____

_____

_____

14. What effect do you think the proposed resort condominium development near Silver Sands will have on the following:

    a. Economic value of the community ***(READ & WAIT FOR RESPONSE)***

    1. Positive
    2. Negative
    3. No Change
    4. Don't Know
    5. Not Stated/No Response

    b. Job Opportunities ***(READ & WAIT FOR RESPONSE)***

    1. Positive
    2. Negative
    3. No Change
    4. Don't Know
    5. Not Stated/No Response

    c. Environment ***(READ & WAIT FOR RESPONSE)***

    1. Positive
    2. Negative
    3. No Change

4. Don't Know
5. Not Stated/No Response

15. Do you think the proposed development will affect you personally?

1. Yes
2. No
3. Don't Know/Not Sure
4. Not Stated/No Response

16. What are your reasons?

SECTION 4

17. Have you or any member of your household ever worked in the hotel or resort industry?

1. Yes
2. No
3. Don't Know/Unsure
4. Not Stated/No Response

Social Attitude

18. Do you look forward to this development?

1. Yes
2. No

19. If yes, why?

20. If no, why not?

21. Do you think that the construction and operation of the proposed development will affect the availability of any of your resources (e.g. water, light, aesthetics etc)
    1. Yes
    2. No

22. If Yes, please state which of the resource(s) you suspect will be affected?

23. For each affected resource, describe briefly, the nature/extent of the effect

Resource	Nature/ extent of effect

24. Do you use the proposed site for any activity?
    1. Yes
    2. No

25. If Yes, what do use the proposed site for?

26. Are there any natural resources on the site that you know of?

1. Yes
2. No

27. If Yes, what are these?

28. What impacts do you think the proposed resort development will have on this community?

29. Is the site of any cultural/historical interest?

1. Yes
2. No

30. If Yes, what/where?

31. Do you have any involvement in the proposed development?

1. Yes
2. No

32. If Yes, how are you involved?

33. `Do you think that the area needs any new development?

1. Yes
2. No

HOUSING CONDITIONS

(Surveyor can ask these questions if he/she cannot ascertain the answers from observation)

34. Type Of Dwelling

Separate house, detached ☐

Semi-detached ☐

Part of a house (Apartment) ☐

Part of a commercial building ☐

Other ☐

35. Construction Material

Block and Steel ☐

Wood ☐

Concrete ☐

Stone/Brick ☐

Wattle and Daub ☐

Other ☐

AMENITIES

36. Toilet Facilities

Type:

WC linked to sewer ☐

WC not linked to sewer ☐

Pit ☐

Other ☐

None ☐

37. Shared

1. Yes
2. No

47. SOURCE OF WATER

Indoor tap/pipe ☐

Outside Private tap/pipe ☐

Public stand pipe ☐

River/Pond/Well ☐

Rainwater (tank) ☐

48. KITCHEN (OUTDOOR)

Yes ☐

No ☐

38. SOURCE OF LIGHTING

Electricity ☐

Kerosene ☐

Other ☐

None ☐

39. TENURE

Owner ☐

Rent-free ☐

Rented ☐

Squatter-occupied ☐

Other ☐

All the completed survey instruments are available for review at your discretion.

Name of Interviewer:
Date of Interview:

APPENDIX IV: FLORA AND FAUNA SPECIES LIST

Appendix IV: Flora & Fauna Species List

Table 9-1: Floral Species List

Scientific Name	Common Name
Abrus precatorius	Red Bead Vine, Crab's Eyes
Acacia sp.	
Agave sp.	
Amaranthus spinosus	Prickly Calalu
Amyris elemifera	Torchwood
Andropogon sp.	Corralita
Ateramnus lucidus	Crab Wood
Avicennia germinans	Black Mangrove
Batis maritima	Jamaican Samphire
Bidens pilosa	Spanish needle
Blighia sapida	Ackee
Bourreria sp.	
*Brassavola cordata**	White orchid
Bromelia pinguin	Pinguin, Ping Wing
Bromeliaceae (Family)	Tank Bromeliad
Brosimum allicastrum	Breadnut
*Broughtonia sanguinea**	Pink Orchid
Browallia americana	Forget-me-not
Brya ebenus	West Indian Ebony
Bryophyllum pinnatum	Leaf-of-Life
Bursera simaruba	Red Birch
Caesalpinia bonduc	Grey Nickal/Nicker
Canella winterana	Wild Cinnamon, Canella
Capparis flexuosa	Limber caper
Carica papaya	Papaya
Cenchrus sp.	
Centrosema virginianum	
Cephalocereus swartzii	
Cleome spinosa	
Clusia flava	Card Gum, Tar Pot
Coccoloba uvifera	Seaside Grape
Colubrina asiatica	Hoop With
Commelina diffusa	Water grass
Commelina erecta	

Scientific Name	Common Name
Conocarpus erectus	Button Mangrove
Crescentia cujete	Calabash Tree
Crotalaria retusa	Rattleweed
Crotalaria verrucosa	Blue Rattleweed
Croton humilis	Pepper Rod
Croton linearis	Rosemary
Cyperus odoratus	
Cyperus sp.	
Dalbergia brownei	
Desmanthus sp.	
Desmodium canum	Sweetheart
Distichlis spicata	Salt grass
Eugenia sp.	
Eupatorium odoratum	Jack-in-the-bush, Christmas Bush
Euphorbia hirta	
Ficus aurea	Strangler fig
Haematoxylum campechianum	Logwood
Helicteres jamaicensis	Screw Tree
Heliotropium indicum	Scorpion Weed
*Hylocereus triangularis**	God Okra, Prickle Withe
Hyptis capitata	Ironwort, Wild Caesar Obeah
Ipomoea pes-caprae	Beach Morning Glory
Ipomoea sp.	
Jatropha gossypifolia	Belly-ache-bush
Laguncularia racemosa	White Mangrove
Leucaena leucocephala	Lead Tree
Mallotonia gnaphalodes	Seaside Lavender
Malpighia sp.	Cherry
Melicoccus bijugatus	Guinep
Merremia umbellata	
Metopium brownii	Burnwood
Mikania micrantha.	
Mimosa pudica	Shame weed
Momordica charantia	Cerasse
Morinda citrifolia	Noni
Morinda royoc	Red Gal, Strongback
Mucuna pruriens	Cowitch

Scientific Name	Common Name
Nectandra sp.	
*Oncidium tetrapetalum**	Pimento Orchid
Opuntia dillenii	Seaside Tuna
Peperomia sp.	
Phyllanthus angustifolius	Seaside Laurel
Pimenta dioica	
Pimenta sp.	Wild Pimento
Pinus caribaea	Caribbean Pine
Piper amalago	Black Jointer
Piscidia piscipula	Dogwood
Pisonia aculeata	Cockspur
Plumeria obtusa	Wild Frangipani
Portlandia sp.	
Psychotria sp.	
Rhizophora mangle	Red Mangrove
Rhoeo discolor	
Ricinus communis	Castor bean
Ruellia tuberosa	Duppy Gun, Menow Weed
Samanea saman	Guango
Schaefferia frutescens	
Selenicereus grandiflorus	Queen-of-the-night
*Senecio discolor**	Whiteback
Sesuvium portulacastrum	Seaside Purslane
Sida acuta	
Sida procumbens	
Sida sp.	
Sonchus oleraceus	Sow-thistle
Spartina sp.	
Sporobolus virginicus	
Stachytarpheta jamaicensis	Vervine
Suriana maritima	Bay Cedar
Tabernaemontana laurifolia	
Tabernaemontana sp.	
Tecoma stans	
Terminalla catappa	Almond
Thespesia populnea	Seaside Mahoe
Tillandsia recurvata	Old Man's Beard

Scientific Name	Common Name
Tillandsia sp.	
Tournefortia hirsutissima	Cold With
Tournefortia volubilis	Chigger Nut (Jigger Nit)
Turnera ulmifolia	Ram-goat Dashalong
Turnera ulmifolia.	
Urechites lutea	Deadly Nightshade
Waltheria indica	Raichie
Wedelia trilobata	Creeping Ox-eye, Marigold
Ziziphus sp.	Bastard Lignum Vitae
** Endemic*	

Avifaunal Composition

Table 9-2: Wetland and shore birds seen in the survey of the Duncan's property (Salina & Coast)

PROPER NAME	CODE USED	SCIENTIFIC NAME	STATUS	DAFOR
Black-necked Stilt	**BNST**	*Himantopus mexicanus*	Resident	**D**
Brown Pelican	**BRPE**	*Pelecanus occidentalis*	Resident	**R**
Cattle Egret	**CAEG**	*Bubulcus ibis*	Resident	**F**
Common Moorhen	**COMO**	*Gallinula chloropus*	Resident	**R**
Glossy Ibis	**GLIB**	*Plegadis falcinellus*	Resident	**O**
Great Blue Heron	**GBHE**	*Ardea herodias*	Migrant	**R**
Great Egret	**GREG**	*Casmerodius albus*	Resident / Migrant	**R**
Kildeer	**KIER**	*Charadrius vociferous*	Resident	**F**
Little Blue Heron	**LBHE**	*Egretta caerulea*	Resident / Migrant	**R**
Magnificent Frigatebird	**MAFB**	*Fregata magnificens*	Resident	**O**
Piping Plover	**PIPL**	*Charadrius melodus*	Migrant	**O**
Royal Tern	**ROTE**	*Sterna maxima*	Resident	**O**
Ruddy Turnstone	**RUTU**	*Arenaria interpes*	Resident	**O**
Sanderling	**SAND**	*Calidris alba*	Migrant	**R**

Table 9-3: Terrestrial birds observed using transects and points counts

PROPER NAME	CODE USED	SCIENTIFIC NAME	STATUS	DAFOR
American Kestrel	**MAKE**	*Falco sparverius*	Resident	O
Bananaquit	**BANA**	*Coereba flaveola*	Resident	A
Black-faced Grassquit	**BFGR**	*Tiaris bicolor*	Resident	R
Black-whiskered Vireo	**BWVI**	*Vireo altiloquus*	Migrant	R
Caribbean Dove	**CADO**	*Leptotila jamaicensis*	Resident	O
Cave Swallow	**CASW**	*Hirundo fulva*	Resident	O
Common Barn Owl	**COWO**	*Tytl alba*	Resident	R
Common Ground Dove	**COGD**	*Columbina passerine*	Resident	F
Common Yellowthroat	**COYT**	*Geothlypis trichas*	Migrant	R
Gray Kingbird	**GRKI**	*Tyrannus dominicensis*	Resident	A
Great Antillean Grackle	**GRAG**	*Quiscalus niger*	Resident	D
Jamaican Euphonia	**JAEU**	*Euphonia Jamaica*	Endemic	F
Jamaican Oriole	**JAOR**	*Icterus leucopteryx*	Endemic	O
Jamaican Vireo	**JAVI**	*Vireo modestus*	Endemic	R
Jamaican Woodpecker	**JAWO**	*Melanerpes radiolatus*	Endemic	R
Loggerhead Kingbird	**LOKI**	*Tyrannus caudifasciatus*	Resident	F
Northern Mockingbird	**NOMO**	*Mimus polyglottos*	Resident	D

PROPER NAME	CODE USED	SCIENTIFIC NAME	STATUS	DAFOR
Olive-throated Parakeet	**OTPA**	*Aratinga nana*	Resident	O
Prairie Warbler	**PRAW**	*Dendroica discolor*	Migrant	R
Red-billed Streamertail	**RBST**	*Trochilus polytmus*	Endemic	O
Sad Flycatcher	**SAFL**	*Myiarchus barbirostris*	Endemic	R
Saffron Finch	**SAFI**	*Sicalis flaveola*	Resident	F
Smooth-billed Ani	**SMBA**	*Crotophaga ani*	Resident	O
Stolid Flycatcher	**STFL**	*Myiarchus stolidus*	Endemic/ subspecies	R
Turkey Vulture	**TUVU**	*Carthartes aura*	Resident	F
Vervain Hummingbird	**VEHU**	*Mellisuga minima*	Resident	O
White-crowned Pigeon	**WCPI**	*Columba leucocephala*	Resident	F
White-collared Swift	**WCSW**	*Streptoprocene zonaris*	Resident	O
White-winged Dove	**WWDO**	*Zenaida asiatica*	Resident	A
Yellow Warbler	**YEWA**	*Dendroica petechia*	Resident	O
Yellow-faced Grassquit	**YEFC**	*Tiaris olivacea*	Resident	F
Zenaida Dove	**ZEDO**	*Zenaida asiatica*	Resident	F

Yellow-crowned Night Heron and the Barn Owl were the only nocturnal birds seen during the night survey.

Table 9-4: Endemic birds observed during the two days of birds survey in Duncan Bay

PROPER NAME	CODE USED	STATUS	DAFOR	FOREST DEPENDENT Y/N
Jamaican Euphonia	JAEU	Endemic	F	N
Jamaican Oriole	JAOR	Endemic	O	N
Jamaican Vireo	JAVI	Endemic	R	N
Jamaican Woodpecker	JAWO	Endemic	R	N
Red-billed Streamertail	RBST	Endemic	O	N
Sad Flycatcher	SAFL	Endemic	R	Y
Stolid Flycatcher	STFL	Endemic/ subspecies	R	N

Note: only one of the endemics observed are forest dependent species. Only 6 of the endemic birds on the island were observed on the property.

Table 9-5: Recommended Plant list for landscaping property

Common Name	Scientific Name	Life form
Christmas Palm	*Fitches merrilli*	Tree
Traveller Palm	*Ravenala madagasscariensis*	Tree
Royal palm	*Roystonia princes*	Tree
Black olive	*Bucida buceras*	Tree

Common Name	Scientific Name	Life form
Poor man's Orchid	*Bauhinia purpurea / Bauhinia variegata*	Tree
Lignum vitae	*Guaiacum officinale*	Shrub / Low growing plants
Oleander	*Nerium oleander*	Shrub / Low growing plants
Bougainvillea	*Bougainvillea. sp*	Shrub / Low growing plants
Ixoras	*Ixora coccinea*	Shrub / Low growing plants
Hibiscus	*Hibiscus rosa-sinensis*	Shrub / Low growing plants
Lanatana	*Lantana camera*	Shrub / Low growing plants
Plumbago	*Plumbago auriculata*	Shrub / Low growing plants
Mini Ixorias	*Ixora. sp*	Shrub / Low growing plants
Mini Bougainvillea	*Bougainvillea. sp*	Shrub / Low growing plants
Mini Oleander	*Nerium. sp*	Shrub / Low growing plants

APPENDIX V: PHOTO-INVENTORY

Appendix V: Photo-Inventory

TERRESTRIAL ENVIRONMENT

Plate 9-1: Patch of Rheo plants

Plate 9-2: Agave Patch

Plate 9-3: Common Red Orchid (*Broughtonia sanguinea*)

Plate 9-4: Fruiting Agave Patch

Plate 9-5: Climbing cacti (*Hylocereus trinagularis*)

Plate 9-7: leaf litter in drainage channel in forested area

Plate 9-6: Dry Limestone Forest near Duncan Cliff

Plate 9-8: Vegetation characteristic to the immediate west of Salina

Plate 9-9: Pimento, Red birch and other plants on the limestone hill on property

ate 9-10: Rocky outcropping common to site

Plate 9-11: Beginning of Duncan Cliff at edge of roperty

Plate 9-12: Cliff [Note obvious ancient sea notch]

Plate 9-13: cliff vegetation comprising mainly tank bromeliads, sea grape and ficus spp.

Plate 9-14: Bromeliad patch

Plate 9-15: Tank bromeliad found on top of cliff face

Plate 9-16: Common dry limestone orchid (*Oncidium* sp.)

Plate 9-17: Illegal garbage dump at landward entrance to the site

Plate 9-18: Dumping of construction waste in close proximity to site location

Plate 9-19: View from site looking south

SALINA

Plate 9-20: View of Salina from the East

Plate 9-21: View from Salina towards the sea (North)

Plate 9-22: Looking south (Landwards)

Plate 9-23: Salina [View from East]

Plate 9-24: Back of sand dune showing red sand (Possibly left over from construction in the area)

Plate 9-25: Salina looking southwest

Plate 9-26: Shorebirds utilising Salina

MANGROVE

Plate 9-27: View from Mangrove area looking Seaward [Note coloured water due to leaching from Red Mangrove Roots]

Plate 9-28: Area Bordered by Red and Black Mangroves

Plate 9-29: Red Mangrove in Bloom

Plate 9-30: View of Black Mangrove Stand from the East

Plate 9-31: Mangroves and Reeds [North -west of salina]

BEACH

Plate 9-32: View of Vegetated beachface from the east [Note – tracks made by cars at the top of dune face]

Plate 9-33: Note vegetated state of beachface (Salina in background]

Plate 9-34: Runner such as Ipomea on beach at Western end of property

Plate 9-35: Beach tip north of property [note - the height of the beach face and the Falmouth formation in front]

Plate 9-36: White fine textured coralline beach sand

ROCKY FORESHORE

Plate 9-37: Dead juvenile octopus and algae found in rocky pool

Plate 9-38: Green algae

Plate 9-39: Various marine snails

Plate 9-40: Turtle grass in rocky pool at low tide

Plate 9-41: Sand Dollar

Plate 9-42: *Batis maritima*

Plate 9-43: Red Mangrove seedling found on Rocky shore west of mangrove stand

Plate 9-44: High ancient sea ridge found to the northeast of site

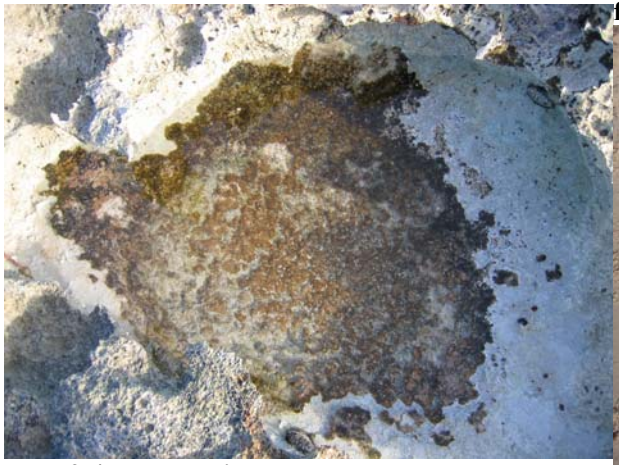

Plate 9-45: Encrusting red algae

Plate 9-46: Chiton (*Acanthopleaura granulate*)

Plate 9-47: Green sea urchin (*Lytechinus variegates*) found stranded on beach at dawn

Plate 9-48: Possible evidence of sea turtle landing [Note - no nest was found]