

# ENVIRONMENTAL IMPACT ASSESSMENT

## FOR THE PROPOSED DEVELOPMENT OF A HOTEL RESORT AT, CORAL SPRINGS TRELAWNY, JAMAICA

October 2016



**Felicitas Limited**

2 floor, 53 Knutsford Boulevard

Kingston 5, Jamaica

Tel: (876) 969-9153; Fax: (876) 925-3163

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*Prepared for:*

**FELICITAS LIMITED**

2nd Floor, 53 Knutsford Boulevard  
Kingston 5

*Prepared by:*

**ENVIROPLANNERS LTD.**

17 Munroe Road  
Kingston 6

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# 1 Executive Summary

## 1.1 Introduction

Felicitas Limited is a locally registered company with registered office at 53 Knutsford Blvd, Kingston 5. The company purchased a property at Coral Spring in Trelawny in 2007, comprising approximately 25.33 hectares (62.58 acres) for the development of a resort. It is situated approximately 8.4km east of the capital town centre of Falmouth and 4.3km south west of the town of Duncans in north eastern Trelawny.

Felicitas Limited has since then established a joint venture partnership with the H10 Hotels group for the development of a hotel resort on the property under the H10 brand.

The resort is proposed to be erected in three phases, the phases are:

### **Phase 1/Hotel 1**

Phase one hotel will be a family hotel with its own design features, but will have similar defining aesthetic elements as the other phases. Phase 1-hotel will have 400 junior suites, 28 master suites. Construction for phase 1 will commence in June 2017.

### **Phase 2/Hotel 2**

Phase two hotel will be an adult facility with its own character, but like hotel one, it will have similar defining aesthetic features. Phase 2-hotel will have 353 junior suites, 19 master suites and private amenities spaces.

### **Phase 3/Villas**

Phase 3 villas will be built in four modules with two bedrooms, living room and dining room, two bathrooms and a pool. The villas will be operated by an independent company/Hotel. Villas will have a checking area, club, exclusive restaurant and a common swimming pool. The villas will have 37 suites and 222 habitable rooms.

Each hotel has its own separate formal and functional identity, without losing sight of the unified image of the Hotel Complex.

The first phase, **HOTEL 1**, has a slightly larger built area per room impact than the rest of the phases given that it covers most of the common entertainment and administration areas. It has a surface parking for 192 vehicles.

The entrance to the lobby (reception, lobby-bar, business centre, ...) is on level +10.00, from where we can access level +5.15, which is the restaurant area housing the main buffet restaurant and several themed restaurants, all with spacious terraces looking out towards the north-east and the pool, open air and entertainment areas.

Between both hotels, on level +10.00, there is transition area with equipment that, although located in **HOTEL 1**, it constitutes shared services with other phases (**HOTEL 2 and VILLAS**). These unique buildings distributed around a square correspond to the entertainment area (casino, theatre, sports bar, etc.), as well as some administrative areas. Further east, and also shared between phases, is the Convention Centre and sports area.

While guests of **HOTEL 2** have access to the shared services described above for **HOTEL 1**, its common areas are exclusive to this hotel, intended for adults only. It is close to the surface parking for 78 vehicles. As happens with the counterpart building, from level +10.00, we access the lobby - reception. The restaurants are located on the lower level, +5.15, and have terraces looking out towards the north and the pool, open air and entertainment areas.

Both hotels will have an independent **PRIVILEGE** area located on first line beach with an exclusive lounge area and reception.

The **VILLAS** will also have their own reception, club, exclusive restaurant and pool with a sun terrace located on the highest area of the plot, next to a surface parking for 65 vehicles.

## 1.2 Topography and Physiography

The project area is a 'greenfield' site located along the northern coastline and forms part of Stewart Bay coastal area in Trelawny (Figure 4.2.1). The property is bounded by the Caribbean Sea in the north, cuts into the hills in the south (with no clearly defined boundary) and a stone wall in the east that passes through the centre of a wetland/pond



area. The western boundary is partly defined by the outer boundary of a narrow, unpaved access road to the site.

The Coral Spring hotel site consists of a flat to gentle sloping low-lying area on the northern section and upland or hilly area on the southern section of the property (Figure 2.2). Slope gradient on the northern low lying area does not exceed 5 degrees while in the upland area slopes are moderate to steep ranging from 15 degrees (37percent slope) to a little over 26 degrees (50 percent slope). The hill steepens gradually from the south west to the south east.

### **1.3 Geology**

The geology of the Coral Spring hotel site and surrounding areas is largely made up of limestone consisting of three different types: the Montpelier Limestone Formation (Mm), the older coastal limestone reefs and marls (Mp) and the younger Coastal Limestone known as the Falmouth Formation (Figure 4.2.1). Additionally, there are surficial deposits on the northern coastline. There are a number of distinct geomorphic features. These are: The marine coastline features, the wetland area, a low-lying limestone platform, distinct upland region referred to as an escarpment, and low karst landform.

The limestone escarpment consists of a steep scarp slope on the north facing slope and a gentler slope which decreases gradually south of the site. The scarp slope of the escarpment forms the hilly, upland terrain on the project site, while the southern slope of the escarpment forms poorly developed karst features consisting of low, semi conical hills and limestone depressions.

The steep-sided slope of the escarpment takes up approximately 40% of the hotel property on its southern section. The land rises from an elevation of 5m to 83m at its highest elevation. There are two NE-SW linear ridges separated by a narrow valley that forms the limestone hills on the site. The smaller ridge dies out before it reaches the shoreline, while the larger and more southerly ridge continues and terminates at the coastline where it forms the Carrion Crow Cliff on the Stewart Bay coastline as it juts out into the sea.

## 1.4 Soil

Soils are thin to non-existent on the site, with the exception of the coastline area. The back beach on the coastline has an estimated maximum thickness of 1m and the storm bank an estimated 50cm-80cm thick. The elevated platform and the limestone hills in the south have little or no soil cover. The hilly terrain is covered with occasional thin soils, cobblestones and boulder size material.

Based on the Soil Map of Jamaica (Figure 4.1) produced by the Rural & Physical Planning Division, the Bonny Gate Stony Loam is the dominant soil type within the proposed site. The Bonny Gate soil type is characterized by its sandy loam texture with high erodibility, very low moisture content and very rapid internal drainage.

## 1.5 Drainage

The site is located in the watershed drained by the Martha Brae River. There is no surface water/river close to the site. The presence of the coastal limestone has resulted in much of the overland flows being swiftly diverted into groundwater and overland flow to sea is minimized. The site is located within the North Eastern Subdivision (Duncans) Sub-Watershed Management Unit of the Martha Brae Watershed Management Unit and Hydrological Basin (Water Resources Authority Hydrological Database: <http://webmapjam.dyndns.pro/>). Site assessments along with topographical maps reviewed have shown that there is no significant feature traversing the site. A depression/pond is observed at the north eastern section of the site. Overlying soils are very thin and in some areas nonexistent within the depressed/pond area.

## 1.6 Hydrogeology

The site lies atop the Coastal and Falmouth Formations classified as Limestone Aquiclude Hydrostratigraphic Units (Water Resources Authority Hydrological Database: <http://webmapjam.dyndns.pro/>), comprising a series of elevated reefs (Figure 4.4). The Montpelier Formation lies along the southern fringe of the project site as well as to the south and east of the site. This geological formation is impermeable and acts as barriers to groundwater flows. The Coastal Limestone and Falmouth Formations however, are even bedded limestones with faults and fractures resulting in high permeability and lower

runoff potential. Faulting may create zones of increased permeability which could yield water to wells and springs.

## **1.7 Climate**

The climate of the general Falmouth area, like the rest of Jamaica, is subtropical with northeasterly prevailing winds and land-sea breezes. Average daily temperatures vary from 23 oC in January to about 28 oC in July. Humidity ranges from 66% to 87% with a significant diurnal variation resulting in high morning humidity dropping off significantly in the afternoon.

Long term (1951-1980) mean annual parish rainfall for Trelawny is just over 1600 mm. The 30-year monthly mean rainfall ranges between 69 mm (minimum) to 222 mm (maximum). In the dry season December to March long term average rarely exceeds 130 mm. There are two rainy seasons: October to January and during May.

## **1.8 Water Quality**

Baseline water quality samplings were conducted on June 1 and June 12, 2016 at four sites within the pond for this project. Two samples were collected on the 8<sup>th</sup> of June 2016 at JAD 2001 coordinate points 689702.891E 704204.47N and 689 784.353 E 704219.626N. The other samples were collected on June 18, 2016 at JAD 2001 coordinate points 689751.2E 704227.204N and 689 744.569E 704141.953N

The water quality within the pond indicates that it is influenced by sea water intrusion through tidal activities. The average concentrations of the major dissolved elements or ions are similar to those expected within seawater. The two primary indicators for marine water quality are chloride and sodium. The chloride concentration in the pond ranged from 26,400 to 66,000 mg/L and sodium ranged from 13,500 to 41,500 mg/L. The general composition of sea water is expected to be 19,000mg/L for chloride and sodium 10,500 mg/L. The BOD is due to the stagnation of the water and the activities of birds and others wildlife within the pond. The faecal and total coliform levels are very low within the pond.

## 1.9 Hydrological Assessment

The pre-development conditions were assessed by visiting the site and reviewing Google Earth images and the 1:12,500 topographic maps of the area. No significant waterways were observed either on the map or during the site visit. This suggests that storm water sheet flows over the land surface.

The south of the property is characterized by a steep escarpment which forms a ridge line running in a north-east to south-west direction. On the northern side of the ridge where the property is located the land slopes generally to the north and north-west. On the southern side, the land slopes generally to the south-east conveying storm runoff away from the property. This ridge acts as a buffer from storm runoff from the south of the property and reduces its vulnerability to flooding.

## 1.10 Ecology

### Flora

Vegetation on the flat terrain near the coastline changes progressively inland, from sparse grass to low shrubs, to dense high shrub land and small trees further inland at an estimated distance of 35m-40m south from the shoreline (Plate 2.7). Further south, the land rises into a hilly terrain in which the vegetation can be described as having dense woodland, typical of dry limestone forest.

The characteristic flora within the vegetation assemblages found surrounding the proposed development site lead to the characterization of the property into three distinct zones, namely:

1. Tall, Open, Dry Forest occupying limestone elevated areas ~ 25 hectares
2. Beach/beach hinterland vegetation on marine deposits on land ~ 3.9 hectares
3. Wetland vegetation on clayey soil types ~ 0.3 hectare
4. Standing water ~ 1 hectare

Over 80% of the site contained vegetation typical of dry limestone forest. The species found were characterized as trees, shrubs, vines, bromeliads, herbs and grasses.

## Fauna

Birds, pollinating insects (Butterflies and Bees), Lizards, Gastropods and Crustaceans were the predominant faunal types observed within/above the study site. Twenty varieties and a total 82 birds were observed in the study area surveyed. Other faunal species observed included Bats, Termites, Wasps, Lampyrid Fireflies and the Indian Mongoose.

### **1.11 Natural Hazards**

Like the rest of Jamaica the site is vulnerable to a number of natural disasters such as flooding, hurricanes and earthquakes. Flooding is not expected to pose any problems as the contour of the site facilitate very good natural drainage. Hurricanes that affect this section of the island will be expected to impact the development particularly winds and heavy rains. The impact of storm surge activity could also affect the site due its close proximity to the coastline as well as flat topography in the lower (northern) section of the site. The site is located in a region of Modified Mercalli Intensity of VI which means moderate earthquakes of minimal damage. However, the level of damage will also be dependent on the integrity of the structures. A well-built structure would be expected to suffer minimal damages.

### **1.12 Cultural**

A rapid assessment of the cultural and archaeological value of the Coral Spring property was conducted to ascertain evidence of any significant cultural value/assets. Historically the site was part of the Stewart Castle Estate indicating that it may have been primarily a sugar producing plantation, although cattle rearing was another primary plantation activity in this part of the Jamaica coast.

### **1.13 Socioeconomic**

The project is to be sited in the Coral Spring area of Trelawny along the coast and is reasonable distance away from the community within the zone of influence. The closest being approximately 1 km away. The communities within the sphere of influence are; Coral Spring, Stewart Castle and Carey Park. These varies from informal low income to upscale high end.

There were no significant issue or concerns identified during the survey done in the communities. The primary areas of concern were:

- Dust, during the construction
- Increase in criminal activities
- Squatting

The project was seen as being very beneficial primarily for the job opportunities it would create, and had 78% support from respondents.

### **1.14 Main Impacts**

During construction the development can be expected to produce the impacts which are normally associated with construction activities, these are summarized below.

#### Ecological

During site clearing to accommodate the development it will be inevitable that significant portions of the existing vegetation will be removed. Approximately 15 hectares or 60% of the 25 hectare property is expected to be impacted. However, since the construction will be in three phases the impact will be lessened as revegetation will be done in one phase before moving to the next. Where possible large trees should be preserved.

#### Topography

The hotel has been designed to fit into the existing topography of the site, however a pond with a surface area of 1.2 hectares (12,000 m<sup>2</sup>) is located in the north eastern corner of the site. To accommodate the development this pond must be filled to a height of 1.0 m – 1.5 m.

#### Air Quality

Site preparation and construction activities (such as site clearing, rock crushing, open surfaces and earthmoving operations) have the potential to generate fugitive dust which typically can directly impact areas that are less than a half a kilometer from the site. This impact is not expected to affect any of the neighbouring communities as the closest ones Coral Spring and Stewart Castle are at least 1 km from the site.

The project is to be executed in 3 phases to run concurrently and this will reduce the size of the exposed area and hence the level of the impact. Wetting of exposed surfaces during dry periods should be implemented as part of the site activities during construction. Persons on the site will be impacted by the fugitive dusts and should be mandated to wear the appropriate (Personal Protective Equipment (PPE)

#### Drainage

Lack of erosion and sediment control measures could result in increased storm water run-off during periods of heavy rainfall. With the inevitable removal of significant portions of the vegetation during site clearing sediments can be transported to the sea causing siltation and a negative impact on aquatic life. Siltation dams, buffer zones and drainage barriers should be implemented to minimize this impact.

#### Waste Water/Sewage

Lack of proper sanitary facilities during the construction has the potential to impact the marine environment and groundwater quality if not properly contained and disposed. Workers welfare areas must be adequately equipped with portable chemical toilets which should be provided, maintained and removed by a certified contractor.

#### Cultural and Archaeological

The site has been deemed by JNHT to be archaeologically sensitive although no feature of significance was observed during the traverse. It is also to be note that the densely forested southern section with very steep topography is very difficult to access. Either a fuller exploration needs to be done prior to the commencement of the project, or during site clearance activities the JNHT should be on site to observe if there are any structures/artifact of importance.

#### Socio-economic

- Employment for significant number of persons will be created both during construction and operation. The developer's policy is to employ persons who are resident within close proximity to the site and hence community within the zone of influence will be given first option for employment.

- Transportation of materials and equipment to the site will see the Coral Spring community negatively impacted when heavy vehicles are entering and leaving the property for deliveries, etc. This is expected to be intermittent and short term but will potentially be a nuisance to the residents nearest the access road. During the operations it is expected that the access road will be improve through the Stewart Castle and Coral Spring area which would be a positive impact.
- Activities generally associated with construction will generate noise of varying intensity based on location from the source of noise. The nearest community is approximately 1 km away and should therefore not be affected. Workers should be provided with relevant PPE and be required to wear them.

### 1.15 Conclusion

This project fits within the national economic growth and development agenda which has tourism as one of the primary sector to drive growth. Jamaica will benefit from increased employment, increased earnings, increased in the number of hotel room the introduction of a new brand (H10) leading to a greater diversity in the tourism product and opportunity for new markets, increased foreign investment, and increased standard of living,

The proposed site although located in an area zoned for development and previous approval was granted for development on the said site, the study has revealed that the site is bordered by sensitive ecological, archaeological and geological features. Should the project proceed to implementation, the necessary mitigation and monitoring must be applied.



## 2 Introduction

### 2.1 Project Background

Felicitas Limited, through a Joint venture with the H10 Hotels Group, proposes to develop approximately 25.33 hectares of land located in Coral Spring in the Parish of Trelawny. The proposed development will be a hotel/resort to be done in three phases, under the world renowned H10 brand. H10 Hotels was established in the early 1980s, when it began operating in Spain's main holiday destinations. Today, the company has **55 hotels in 18 destinations**, with more than 14,000 rooms, the majority of which it owns.

H10 Hotels is one of Spain's top 10 hotel companies, with its current business plan aiming at providing its clientele with destination options in the Caribbean.

The proposed location and development satisfies the company's business plan as well as complies with the objectives and policies of the Trelawny Parish Development Order. The tourism objectives presented below are direct quotes from the Development order

#### **TOURISM**

- Obj. TO1 To develop tourism potential where they exist in both urban and rural areas of the parish.
- Obj. TO2 To encourage tourism through the establishment and improvement of attractions and amenities whilst safeguarding the environment and interests of local communities.
- Obj. TO3 To encourage and facilitate the extension and development of new tourist accommodation and other facilities especially along the coast.

The Development order recognizes that the tourism industry is one of the main contributors to the growth of the economy of the parish of Trelawny, and will continue to be so as it is located between two prime tourism oriented parishes, with the potential to grow. Policy SP To1 and To2 are quoted below:

*Policy SP TO1: Proposals for new or improved tourism facilities and attractions will be supported on appropriate sites for such development subject to the siting, design, environmental and visitor management considerations being satisfactory.*

*Policy SP TO2: In resort areas and urban areas permission will be given for hotels, conference facilities, villas and other serviced accommodation, provided they are consistent with the requirements for the areas.*

The proposed concept design is represented in the three Dimensional Rendering, Figure 2.1.1. The development Phasing Plan, Landscape Plan and preliminary designs are presented in the Project Description.



*Figure 2.1.1: Proposed Concept Design*

Recognizing the regulatory approvals required to allow for a development of this nature and magnitude, an environmental permit application pursuant to the Natural Resources Conservation (Permits and Licenses) (Amendment) Regulations 2015, was submitted to the National Environment and Planning Agency (NEPA). Based on a screening done by the Agency, it was determined that an Environmental Impact Assessment was required. A Terms of Reference was drafted by NEPA and presented to the developers on 2 August 2016, which was accepted by the developer/consultant without any changes. NEPA then issued a letter giving authorization to proceed with the EIA as per the Terms of Reference.

EnviroPlanners Ltd, who had previously been retained by Felicitas Limited as environmental consultants, drawing on references from recent EIA conducted for sites in close proximity to the proposed site had commenced collection of field data in advance of the approved Terms of Reference (ToR). This was done in order to shorten the timeline for conducting the study and preparing the report. On receipt of the approved ToR, data/information gaps were identified and filled to draft this Environmental Impact Assessment, in conformance with the approved Terms of Reference. See Appendix 1 for the Terms of Reference.

Please note that following the submission of this EIA and as requested by NEPA, an addendum was prepared by CL Environmental Co. Ltd in January 2017 (*Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica*) in order to present additional information deemed crucial to the proposed project and its potential impacts.

## **2.2 Project Location**

The Coral Spring Hotel Development will be located off the north-coast high way and on part of Stewart Castle, Coral Spring in Trelawny. It is situated approximately 8.4km east of the capital town centre of Falmouth and 4.3km south west of the town of Duncans in north eastern Trelawny (Figure 2.2.1 and Figure 2.2.2). The Coral Spring Village Housing Development is approximately 1km south west of the project site.

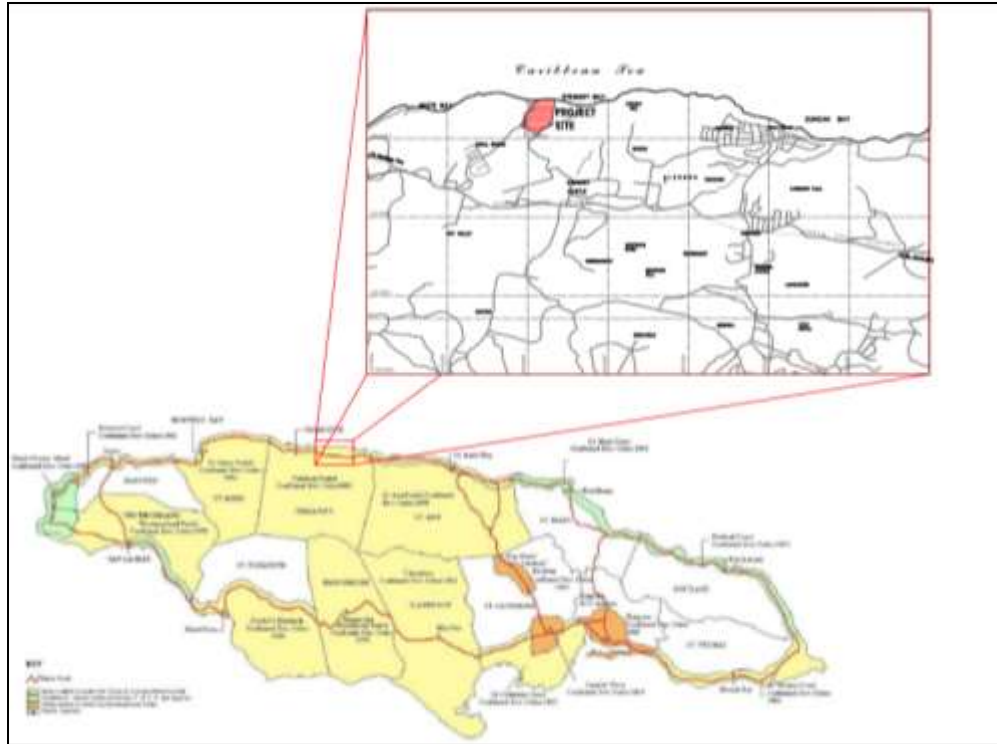


Figure 2.2.1: Site Location for the proposed Coral Spring Hotel Development

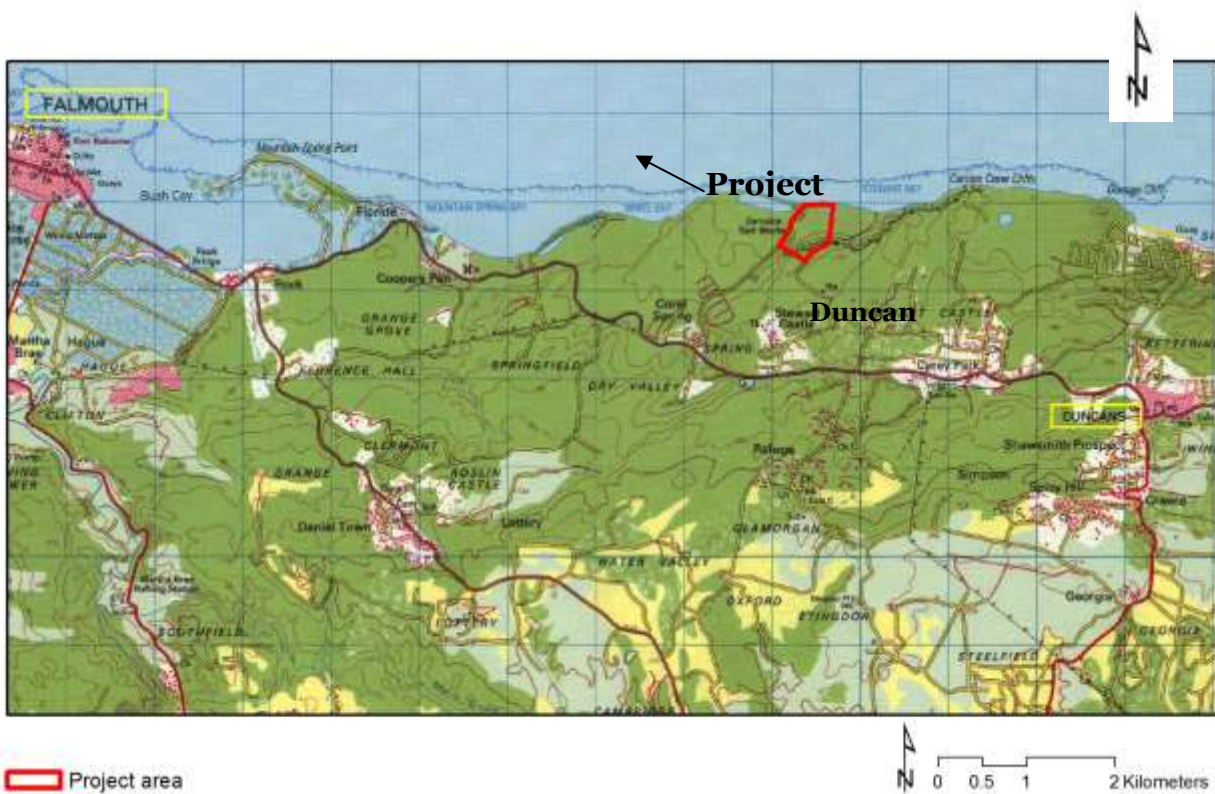


Figure 2.2.2: Site Location for the proposed Coral Spring Hotel Development in relation to Falmouth and Duncans, Trelawny



The proposed project site is approximately 1km east of the CORAL SPRING-MOUNTAIN SPRING PROTECTED AREA, in an area zoned as Shrub Woodland in the Confirmed Town and Country Planning (Trelawny Parish) Development Order, 2015. Figure 2.2.3 below shows the proposed project site in relation to the Coral Springs Protected area and the Coral Springs Housing Development.



*Figure 2.2.3: Google Earth image showing the proposed Coral Spring Hotel Development in relation to Coral Spring Protected Area and Coral Spring Housing Development*

Figure 2.2.4 and Figure 2.2.5 below shows Inset 1 and the proposed project site overlaid on Inset 1 respectively taken from the Trelawny Development Order. The overlay shows that the project site straddles the boundary of the area zoned Shrub woodland in the referred Development Order, as well as the boundary of the Falmouth Local area Plan. The foreshore of the property is located in an area zoned for Conservation in the referred Development Order.



Figure 2.2.4: Trelawny Falmouth Development Area Inset 1



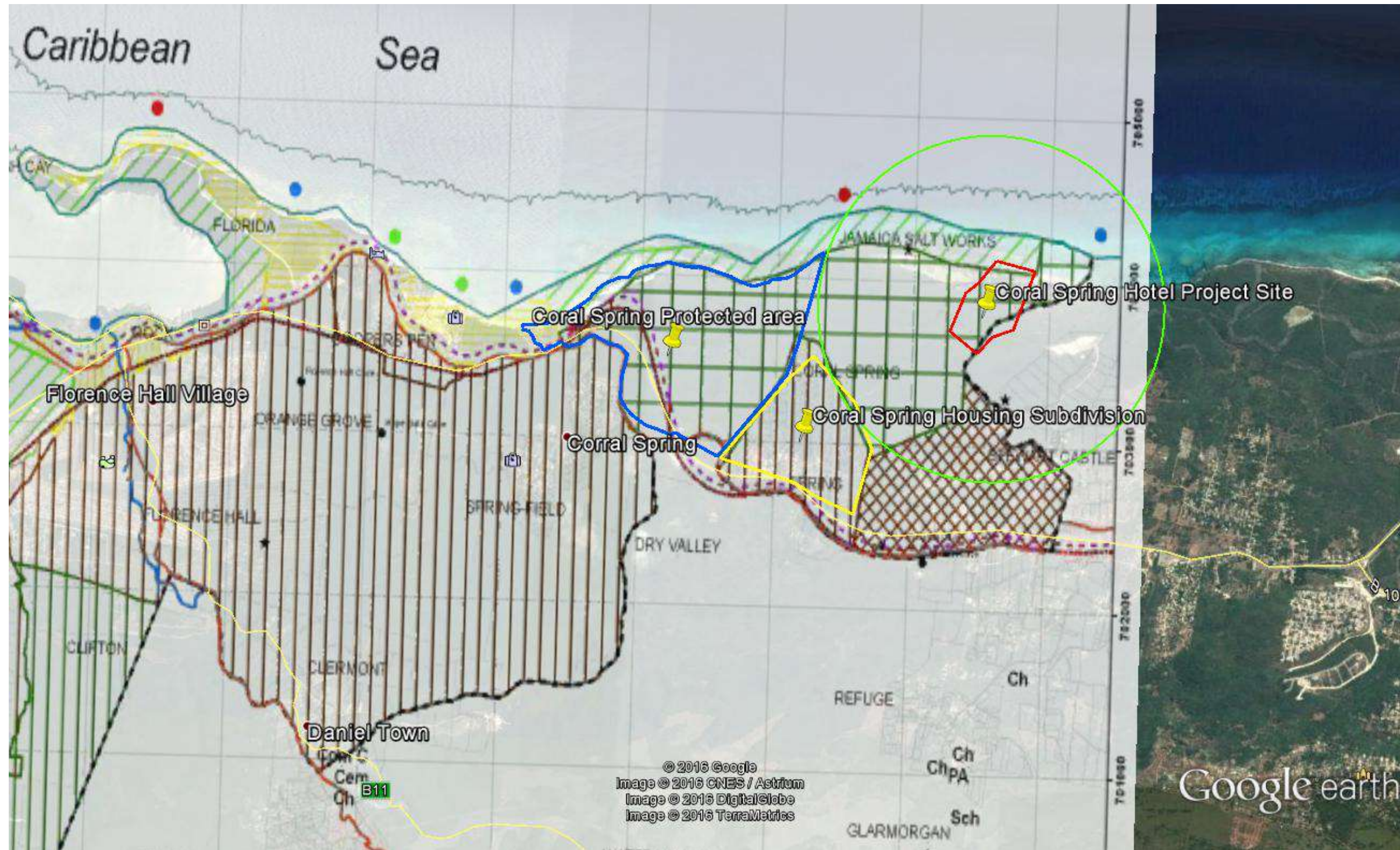


Figure 2.2.5: Trelawny Development Order overlaid on proposed project site. Green circle denotes boundary of the study area.

A 1km radius from the approximate centre of the project site was used to delineate the boundary of the study area. This was deemed suitable as the disturbed areas starts approximately 1 km away in all directions from the project site. This delineation will allow the team to focus the study on the shrub woodland and coastal areas in close proximity to the site, while referring to previous studies done in the area for supplemental information. The project site is also at a low elevation and close to the coast, which limits the hotel's construction and operation zone of influence to very close to the projects own boundaries and the coast and by extension the sea.

### **2.3 Methodology and Approach**

The Environmental Impact Assessment will provide a comprehensive evaluation of the site, in terms of predicted environmental impacts, needed mitigation strategies, potentially viable alternatives to the development proposed ensuring compliance with all related legislation.

A multi-disciplinary team of experienced scientists and environmental professionals was assembled to carry out the required resource assessment, generation and analysis of baseline data, determination of potential impacts and recommendation of mitigation measures. The members of the EIA Professional Team are given in (Appendix 2). An interactive approach among the environmental team members and other project professionals was adopted and was facilitated by team meetings as required.

Baseline data for the study area was generated using a combination of Field studies; Analysis of maps, plans, aerial photos; Review of engineer's reports and drawings; Review of background project documents and EIA reports for other proposed projects completed in the area; Structured interviews; Social surveys; Internet searches; Agency requests and document searches. Searches were undertaken through the Water Resources Authority (WRA), National Water Commission (NWC) and the Office of Disaster Preparedness and Emergency Management (ODPEM). In addition, website searches of the National Environment and Planning Agency (NEPA), Meteorological Service of Jamaica, and NWC were undertaken to obtain any further relevant information.



### 3 Legislation and Regulatory Considerations

An Environmental Impact Assessment (EIA) is “a structured approach for obtaining and evaluating environmental information prior to its use in decision-making in the development process. This information consists, basically, of predictions of how the environment is expected to change if certain alternative actions are implemented and advice on how best to manage environmental changes if one alternative is selected and implemented” (Bisset, 1996).

In undertaking the EIA, a review was conducted of pertinent policies, legislation and regulations of the Government of Jamaica in relation to the proposed development. International obligations such as treaties and protocols to which the Government of Jamaica is signatory were also reviewed in light of the development. We have examined several critical areas that are applicable to the proposed development.

**These are listed below:**

- The Natural Resources Conservation Authority (NRCA) Act (1991)
- Natural Resources Conservation Regulations 1996, amended 2015
- Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013
- Beach Control Act
- The Jamaica National Heritage Trust Act (1985)
- The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996)
- Watersheds Protection Act (1963)
- Water Resources Act (1995)
- Quarries Control Act (1983)
- Wildlife Protection Act (1945)
- The Pesticides (Amendment) Act (1996)
- Clean Air Act (1964)
- Endangered Species (Protection, Conservation and Regulation of Trade) Act (2000)
- Town and Country Planning Act (1958)
- Building Act

- Trelawny Development Order
- Land Development and Utilization Act (1966)
- Public Health Act (1976)
- National Solid Waste Management Authority Act (2001)
- Country Fires Act (1942)
- Land Acquisition Act (1947)
- Registration of Titles Act (1989)
- The Housing Act (1968)
- Draft Noise Standard

### 3.1 The NRCA 1991, Act

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

The NRCA Act is the parent act to the giving power to drafting of Natural Resources Conservation Regulations 1996, amended 2015, and the Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013.

### **3.2 The Beach Control Act, 1956 and the Beach Control (Amendment) Act 2004**

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) 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.

The Beach Control act also makes provisions, where it can be proven, that prescriptive rights for any person to the use of the beach be maintained (Regulation 12, 13 and 14). The *Beach Control (Licensing) Regulations 1956* require a permit for any works on a beach, coastline or foreshore. Application for this permit must be made to NEPA. In addition, the following regulations also fall under the Beach Control Act 1956:

- *The Beach Control (Hotel, Commercial and Public Recreational Beaches) Regulations 1978*
- *The Beach Control (Safety Measures) Regulations 1957*

### **3.3 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.

### **3.4 The Natural Resources (Prescribed Areas) ...Order 1996**

The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order, 1996 and the Permits & Licensing Regulations was passed pursuant to section 9 of the Natural Resources Conservation Authority Act,

1991. The Order provides that the entire island of Jamaica is a prescribed area and lists specified categories of enterprise, construction or development that require a permit. The Act also addresses Sewage and Trade Effluent discharges as well as air emissions.

### **3.5 Policy for the National System of Protected Areas 1997**

This is a White Paper and proposes a comprehensive protected areas system for Jamaica. The NRCA/NEPA is the lead agency with responsibility for the protected area system; however, a number of other government, local management entities, non-governmental entities, private sector and individuals are outlined as important role players as well.

Six types of protected areas are proposed:

- 1) National Nature Reserve/Wilderness Area (Equivalent to IUCN Category I)
- 2) National Park, Marine Park (Equivalent to IUCN Category II).
- 3) Natural Landmark/National Monument (Equivalent to IUCN Category III)
- 4) Habitat/Species Management Area (Equivalent to IUCN Category IV)
- 5) National Protected Landscape, or Seascape (Equivalent to IUCN Category V)
- 6) Managed Resource Protected Area (Equivalent to IUCN Category VI)

Figure 2.2.3 shows the proposed project site in relation to the Coral Springs Protected area; the project site is situated 1 km east of this protected area.

### **3.6 The Watersheds Protection Act (1963)**

The purpose of this Act is to provide for the protection of watersheds and areas adjoining watersheds and promote the conservation of water resources. The entire island however is considered to be one watershed, but for management purposes is divided into smaller units. The Act makes provision for conservation of watersheds through the implementation of provisional improvement schemes whereby soil conservation practices are carried out on land.

### **3.7 The Water Resources Act (1995)**

The Act provide for the management, protection and controlled allocation and use of the water resources of Jamaica; to provide for water quality control and for the establishment

and functions of a Water Resources Authority. This Act will apply should the development of the hotel it is consider necessary to drill a well whether for abstraction or discharge.

### **3.8 Quarries Control Act (1983) Amended**

This act governs the licensing and operations of quarry as well as the transportation of quarried material. The Quarries Control Act of 1983 established the Quarries Advisory Committee, which advises the Minister on general policy relating to quarries as well as on applications for licenses. The Act provides for the establishment of quarry zones, and controls licensing and operations of all quarries.

Any person found in possession of quarry material, shall upon request by any person with the requisite authority produce a receipt or dispatch voucher for the quarry material or the licence granted in accordance with section 8. This will be applicable to the project for obtaining material to fill the pond area on the site.

No quarrying activity is proposed for the project, but developers' should stipulate requirements for the use of material only from licensed quarries.

### **3.9 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.

It should be mentioned that the proposed development area is approximately 4.5 km east of the Glistening Waters Game Reserve.

### **3.10 The Pesticides (Amendment) Act (1996)**

The Pesticides (Amendment) Act of 1996 amended sections of the principal act, which came into effect in 1975 and established the Pesticides Control Authority. This Act gives the Authority the responsibility of controlling the importation, manufacture, packaging,

sale, use and disposal of pesticides. Section 11 states that the Authority is required to keep a register or record of all relevant information such as registered pesticides, restricted pesticides, pest control operators and persons licensed to import or manufacture pesticides. Under Section 16 of the Act, the Authority may also, with the approval of the Minister, make regulations which relate to areas such as:

- Aerial application of pesticides;
- Supervision required for the use of pesticides, the prescribed protective clothing to be worn and other precautionary measures;
- The permissible levels of pesticides to be used;
- The periods during which particular pesticides may or may not be used on certain agricultural crops;
- The disposal of pesticides and packages.

The hotel will likely require pesticides for use in landscaping as well as routine pest control activities in and around buildings.

### **3.11 Clean Air Act (1964)**

The Clean Air Act is administered by the Central Board of Health. The Act designates specific personnel who are given the responsibility of and the required power to ensure compliance.

The Act makes it an offence for the owner of affected premises to:

- Obstruct an inspector in the course of carrying out his duties
- Fail to provide an inspector with relevant information as requested.

Affected premises" means any premises with industrial works, the operation of which is in the opinion of an inspector likely to result in the discharge of smoke, fumes, gases or dust into the air. The hotel will qualify as an "Affected premises" during construction.

### **3.12 The Endangered Species (Protection, Conservation and Regulation of Trade) Act (1999) (Amended 2015)**

This Act deals with restriction on trade in endangered species, regulation of trade in species specified in the schedule, suspension and revocation of permits or certificates, offences and penalties, and enforcement. Many species of reptile, amphibian and birds that are endemic to Jamaica but not previously listed under national protective legislation, or under international legislation, are listed in the Appendices of this Act. Endangered species in Jamaica which are often involved in international trade include sea turtles, yellow snakes and two species of Amazon parrots. Yellow snake and parrots are often involved in international through the tourism industry. The H10 Hotel management should be aware of the potential for trade.

### **3.13 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.

Any person may, under Section 6 of the Act, object to any development order on the grounds that it is:

- impractical and unnecessary;
- against the interests of the economic welfare of the locality.

If the provisions of section 9A of the Natural Resources Conservation Authority (NRCA) Act apply to the development, the application can only be approved by the Planning Authority after the NRCA has granted a permit for the development. (Section 11 (1A). The



Authority may impose a "tree preservation order" under Section 25 of the Act if it considers it important to make provision for the preservation of trees and woodlands in the area of the development. This order may:

- prohibit the cutting down, topping, lopping or willful destruction of trees;
- secure the replanting of any Sector of the woodland area in which trees were felled during the forestry operations permitted under the order.

### **3.14 Parish Councils Act 1901 (Amended 2007)**

Under the Parish Council Act, local planning authorities may revoke or alter regulations concerning buildings built with the approval of the relevant Minister. It may also make regulations concerning the installation of sewers on premises.

### **3.15 The Building Act, 2011**

This Act repeal the Kingston and St. Andrew Building Act and the Parish Councils Building Act and make new provisions for the regulation of the building industry: to facilitate the adoption and efficient application of national building standards to be called the National Building Code of Jamaica for ensuring safety in the building environment, enhancing amenities and promoting sustainable development: and for connected matters.

The objectives of this Act are to:

- a) regulate the design, construction, maintenance, demolition, removal, alteration, repair and use of buildings and building work so as to protect the public safety and health;
- b) give effect to the National Building Code of Jamaica;
- c) facilitate:
  - i. the adoption and efficient application of internationally-recognized building standards; and
  - ii. the accreditation of building products, construction, methods, building components and building systems;

- d) enhance amenities in general and require the construction of buildings that provide easy access and adequate amenities for persons with disabilities in particular;
- e) promote cost effectiveness in the construction of buildings;
- f) promote the construction of environmentally and energy efficient buildings;
- g) establish an efficient and effective system for issuing building permits and certificates of occupancy and for resolving building disputes, including through alternative dispute resolution;
- h) regulate the standard of training and certification and provide for the licensing of building practitioners and the recognition of building professionals who are regulated under other Acts; and
- i) establish a building and an appeal process.

### **3.16 Trelawny Development Order**

The Town & Country Planning Act, 1957 (as amended) empowers the Town & Country Planning Authority to prepare, in conjunction with the Local Planning Authority, legal documents called Development Orders for specific areas across Jamaica.

The aim of these documents is to regulate and control the use of land; ensuring that land is not mis-used but is complementary rather than conflicting.

Development Orders were first prepared for sensitive areas extending along the coast of parishes then they were done for entire parishes which had an intense development thrust happening.

The Development Order for Trelawny covers the entire parish and was confirmed in 2013 – it is the newest Development Order in the country. It is called The Town & Country Planning (Trelawny Parish) Development Order, 2013 (Confirmation).

#### **Functions of Development Orders**

- Specify the specific areas to which they relate.
- Give directions as to how one may obtain planning permission for development within the areas to which the Orders apply.

- Include a development plan showing a proposed land-use strategy for special areas such as parish capitals, scenic areas, road side parks etc.
- Restrict development to those areas where major services either exist or are planned to be implemented

This order strongly support tourism development throughout the parish where the potential exist.

### **3.17 Land Development and Utilization Act (1966)**

Under Section 3 of the of the Land Development and Utilization Act (1966), the Land Development and Utilization Commission is authorized to designate as agricultural land, any land which because of its "situation, character and other relevant circumstances" should be brought into use for agriculture. However, this order is not applicable to land, which has been approved under the Town and Country Planning Act for development purposes other than that of agriculture. Among the duties of the Commission outlined in Section 14 of the Act is its responsibility to ensure that agricultural land is "as far as possible, properly developed and utilized".

### **3.18 The Fishing Industry Act (1975)**

The Fishing Industry Act speaks to registration and licensing, fisheries protection, prohibited activities and the declaration of an area as a fish sanctuary, or a Special Fishery Conservation Area (SFCA) as worded in the most recent Fishing Industry (Special Fishery Conservation Area) Regulations 2012. Although the proposed project does not fall within the boundaries of a sanctuary (closest is about 15 km east of project), offences under this Act are still applicable and should be mentioned; for example it is an offence, during closed seasons, to take, disturb or injure fish, as well as to destroy or land berried lobster and spiny lobster smaller than 3 inches (7.5 cm).

### **3.19 The Exclusive Economic Zone Act (1993)**

The Exclusive Economic Zone Act is designed to protect the living and non-living resources in the Exclusive Economic Zone (EEZ), a marine zone prescribed by the *United*

*Nations Convention on the Law of the Sea.* Under this Act, it is an offence, to exploit living and non-living creatures and conduct research without a licence.

### **3.20 The Forest Act 1996**

The Forestry Department is the lead agency responsible for the management and conservation of forest resources in Jamaica. This Act is important if any project activities are situated in proximity of a forest reserve.

### **3.21 Towards an Ocean and Coastal Zone Management Policy in Jamaica (2000)**

The aim is to develop a policy that will “enhance the contribution of economic sectors to the integrated management of coastal areas by developing awareness in sector line agencies and resource users.”

### **3.22 Towards a Beach Policy for Jamaica (A Policy on the Foreshore and the Floor of the Sea), 2000 (DRAFT)**

This green paper recognizes the value of beaches in Jamaica and importance of proper management and protection. It seeks to balance, the different interests of the main users of the beach - the public, the private sector and fishermen.

### **3.23 National Policy for the Conservation of Seagrasses, 1996 (DRAFT)**

The issuing of licenses or permits for development activities including dredging and the disposal of dredged material which have the potential to affect seagrass beds are covered by this draft policy.

### **3.24 Coral Reef Protection and Preservation Policy and Regulation, 1997 (DRAFT)**

This draft policy and regulation document aims to regulate coastal zone development as it relates to coral reef destruction and or degradation.

### **3.25 DRAFT Policy and Regulation for Mangrove & Coastal Wetlands Protection**

As outline in this draft policy, the Government of Jamaica has adopted the policy and regulation in order to promote the management of coastal wetlands. The policy seeks to:

- Provide protection against dredging, filling, and other development;
- Designate wetlands as protected areas;
- Protect wetlands from pollution particularly industrial effluent sewage, and sediment;
- Ensure that all developments planned for wetlands are subject to an Environmental Impact Assessment (EIA);
- Ensure that traditional uses of wetlands are maintained;

### **3.26 Public Health Act (1976)**

The Public Health (Air, Soil and Water Pollution) Regulations 1976, aim at controlling, reducing, removing or preventing air, soil and water pollution in all possible forms. Under the regulations:

- ❖ No individual or corporation is allowed to emit, deposit, issue or discharge into the environment from any source.
- ❖ Whoever is responsible for the accidental presence in the environment of a contaminant must advise the Environmental Control Division of the Ministry of Health and Environmental Control, without delay.
- ❖ Any person or organization that conducts activities which release air contaminants such as dust and other particulates is required to institute measures to reduce or eliminate the presence of such contaminants.
- ❖ No industrial waste should be discharged into any water body which will result in the deterioration of the quality of the water. (Regulations of 1998)
  - a. The owner or occupier of any commercial or industrial premises shall:
    - ❖ Ensure that all garbage not being garbage to be collected by a contractor is disposed of at least twice in every seven days by incineration or burial or by any other approved means
    - ❖ Garbage is stored in an approved manner

These regulations are applicable to the development both during the construction and operation phases of the Resort.

### 3.27 National Solid Waste Management Authority Act (2001)

The Solid Waste Management Authority Act (2001) subsumes the Litter Act and seeks to prevent the disposal of solid waste in undesignated areas, as well as the delegation of garbage collection.

This Act seeks to control the proper disposal of garbage in undesignated areas, to include public places as described under Section 2 ( c ) of the Act, which includes public gardens, parks or open spaces, or ‘any place of general resort to which the general public has been granted access with or without payment of any fees’.... Or ‘any other place in the open air to which the public has right of access without payment of any fees’. As such, disposal of refuse in the area during any phase of the development would constitute an offence under this Act.

### 3.28 Water Quality Standards

The NRCA has primary responsibility for control of water pollution in Jamaica. Draft guidelines require a facility to meet certain basic water quality standards for trade effluent including sewage (Table 3.28.1).

Table 3.28.1: Draft national ambient marine water quality standards for Jamaica, 2009

Parameter	Measured as	Standard Range	Unit
Phosphate,	P*	0.001-0.003	mg/L
Nitrate,	N**	0.007-0.014	mg/L
BOD <sub>5</sub>	O	0.0-1.16	mg/L
pH		8.00-8.40	
Total Coliform		2-256	MPN/100mL
Faecal Coliform		<2-13	MPN/100mL

\*Reactive phosphorus as P

\*\*Nitrates as Nitrogen

Table 3.28.2: Draft national ambient freshwater water quality standards for Jamaica, 2009

Parameter	Measured as	Standard Range	Unit
Calcium	(Ca)	40.0-101.0	mg/L
Chloride	(Cl <sup>-</sup> )	5.0- 20.0	mg/L
Magnesium	(Mg <sup>2+</sup> )	3.6- 27.0	mg/L
Nitrate	(NO <sub>3</sub> <sup>-</sup> )	0.1- 7.5	mg/L
Phosphate	(PO <sub>4</sub> <sup>3-</sup> )	0.01 - 0.8	mg/L
Potassium	(K <sup>+</sup> )	0.74- 5.0	mg/L
Silica	(SiO <sub>2</sub> )	5.0- 39.0	mg/L
Sodium	(Na <sup>+</sup> )	4.5- 12.0	mg/L
Sulfate	(SO <sub>4</sub> <sup>2-</sup> )	3.0- 10.0	mg/L
Hardness	(CaCO <sub>3</sub> )	127.0-381.0	mg/L (as CaCO <sub>3</sub> )
Biochemical Oxygen Demand	(O)	0.8- 1.7	mg/L
Total Dissolved Solids		120.0-300	mg/L
pH		7.00- 8.40	
Conductivity		150.0-600	μS/cm

### 3.29 Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013

Wastewater refers to water that has been used and contains dissolved or suspended solids and is carried from residential, business or industrial sources. Under these regulations, the operation of a treatment plant for the discharge of trade effluent or sewage effluent requires a licence. Specifications for treatment plants, outfalls, monitoring and reporting and standards (Table 3.29.1) are also detailed.

Table 3.29.1: Trade Effluent Standards

PARAMETER	TRADE EFFLUENT LIMIT
Ammonia/ammonium measured as $\text{NH}_4$	1.0 mg/L
Barium	5.0 mg/L
Beryllium	0.5 mg/L
Biological oxygen demand (BOD)	<30 mg/L
Boron	5.0 mg/L
Calcium	No standard
Chemical Oxygen Demand (COD)	<100mg/L or <0.01 kg/1000 kg product
Chloride	300 mg/L
Colour	100 TCU
Cyanide (free)	0.1 mg/L
Cyanide (Total as CN)	0.2 mg/L
Detergent	15 mg/L
Dissolved oxygen (DO)	>4mg/L
Faecal Coliform	<100 MPN/100 ml
Fluoride	3.0 mg/L
Iron	3.0 mg/L
Magnesium	No standard
Manganese	1.0 mg/L
Nitrate as $\text{NO}_3$	10 mg/L
Oil and Grease	10 mg/L or < 0.01 kg/1000 kg product
PH	6.5 - 8.5
Phenols	0.1 mg/L
Phosphate as $\text{PO}_4$	5 mg/L
Sodium	100 mg/L
Sulphate	250 mg/L
Sulphide	0.2 mg/L
Temperature	$\pm 2^\circ$ of ambient
Total Coliform	<500 MPN/100 ml
Total Dissolved Solids (TDS)	1000 mg/L
Total Organic Carbon (TOC)	100 mg/L
Total Suspended Solids (TSS) (maximum monthly average)	50 mg/L
Total Suspended Solids (TSS) maximum daily average	<150mg/L
Trace Metals:	
Zinc	1.5 mg/L
Lead	0.1 mg/L
Cadmium	0.1 mg/L
Arsenic	0.5 mg/L
Chromium	1.0 mg/L
Copper	0.1 mg/L
Mercury	0.02 mg/L
Nickel	1.0 mg/L
Selenium	0.5 mg/L
Silver	0.1 mg/L
Tin	No standard
Total Heavy Metals	2.0 mg/L



### **3.30 Noise Abatement Act 1997**

The Noise Abatement Act of 1997 was created in order to regulate noise caused by amplified sound and other specified equipment.

### **3.31 Country Fire Act (1942)**

Section 4 of the Country Fires Act of 1942 prohibits the setting of fire to trash without prior notice being given to the nearest police station and the occupiers of all adjoining lands. In addition, a space of at least fifteen feet in width must be cleared around all trash to be burnt and all inflammable material removed from the area. Section 6 of the Act empowers the Minister to prohibit, as may be necessary, the setting of fire to trash without a permit. Offences against this Act include:

- Setting fire to trash between the hours of 6.00 p.m. and 6.00 a.m. (Section 5a);
- Leaving open-air fires unattended before they have been completely extinguished (Section 5b);
- Setting fires without a permit and contrary to the provisions outlined in Section 6 (Section 8);
- Negligent use or management of a fire which could result in damage to property (Section 13a);
- Smoking a pipe, cigar or cigarette on the grounds of a plantation which could result in damage to property (Section 13b).

During land clearing activity for the hotel fires should not be used to clear vegetation or dispose of garbage.

### **3.32 Cartagena Convention (1983)**

Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region) (1983)

Adopted in March 1983 in Cartagena, Colombia, the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, also known as the Cartagena Convention, is the only legally binding environmental treaty for the Wider Caribbean. The Convention came into force in October 1996 as a legal instrument for the

implementation of the Caribbean Action Plan and represents a commitment by the participating governments to protect, develop and manage their common waters individually and jointly.

Ratified by twenty countries, the Cartagena Convention is a framework agreement, which sets out the political and legal foundations for actions to be developed. The operational Protocols, which direct these actions, are designed to address special issues and to initiate concrete actions. The Convention is currently supported by three Protocols. These are: The Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region (The Oil Spills Protocol), which was adopted and entered into force at the same time as the Cartagena Convention; The Protocol Concerning Specially Protected Areas and Wildlife in the Wider Caribbean Region (The SPAW Protocol), which was adopted in two stages, the text in January, 1990 and its Annexes in June, 1991. The Protocol entered into force in 2000. The Protocol Concerning Pollution from Land-based Sources and Activities in the Wider Caribbean Region (LBS Protocol), which was adopted in October, 1999. Pollutions issues in the context of the Cartagena Convention will be relevant to this project.

### **3.33 Biodiversity Convention**

The objectives of the Convention on Biological Diversity are "the conservation of biological diversity, sustainable use of its components and the fair equitable sharing of the benefits arising out of the utilization of genetic resources". This is the first global, comprehensive agreement which has as its focus all aspects of biological diversity: genetic resources, species and ecosystems. The Convention acknowledges that the "conservation of biological diversity is a common concern of humankind and an integral part of the development process". In order to achieve its goals, the signatories are required to:

- Develop plans for protecting habitat and species.
- Provide funds and technology to help developing countries provide protection.
- Ensure commercial access to biological resources for development.
- Share revenues fairly among source countries and developers.
- Establish safe regulations and liability for risks associated with biotechnology development.

Jamaica's Green Paper Number 3/01, entitled Towards a National Strategy and Action Plan on Biological Diversity in Jamaica, speaks to Jamaica's continuing commitment to its obligations as a signatory to the Convention.

The content of the Biodiversity Convention will have implication for site clearing activities.

### **3.34 The Montreal Protocol**

Jamaica became a party to Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on March 31, 1993. The Protocol requires State Parties to gradually phase out the production and consumption of Chlorofluorocarbons(CFC's),hydrochlorofluorocarbons, halons, methylbromide and other ozone depleting substances. Jamaica has implemented its obligations under the Protocol through the promulgation of Regulations and Orders and the implementation of a Country program. Jamaica began implementation of the Protocol through the design of a "country program" in March 1997. The Country Program sets out the projects that need to be implemented to achieve the phase out under the Protocol.

Jamaica does not manufacture any ozone depleting substances or refrigeration equipment and therefore implementation of the convention has been through the restriction of imports into the country. The Protocol requires developing countries to phase out consumption of ozone depleting substances and equipment using ODS to prescribed levels required by the Protocol. The Trade (Prohibition of Importation) (Equipment containing CFC's) Order was passed in 1998 to ban the importation of equipment containing CFC's and halons (except propellants in metered dose inhalers).

The hotel is likely to be importing air-conditioning units of various sizes and should therefore be cognizant of the requirements of this protocol.

### **3.35 United Nations Convention on the Law of the Sea (UNCLOS III) 1982**

The United Nations Convention on the Law of the Sea (UNCLOS), also referred to as the Law of the Sea Convention and the Law of the Sea treaty, defines the rights and

responsibilities of nations in their use of the world's oceans, establishing guidelines for businesses, the environment, and the management of marine natural resources. The United Nations has no direct operational role in the implementation of the Convention; however organizations such as the International Maritime Organization, the International Whaling Commission, and the International Seabed Authority do play roles in the implementation.

### **3.36 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter**

Commonly known as the London Convention, it prohibits the dumping of certain hazardous materials and specifies that a special permit is required prior to dumping of a number of identified materials and a general permit for other wastes or matter.

### **3.37 International Convention on Oil Pollution Preparedness, Response and Co-operation 1990**

The International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC Convention) is an international maritime convention that sets measures for the preparation for and response to marine oil pollution incidents.

### **3.38 Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)**

CITES generally seeks to protect endangered plants and animals and owing to the cross boundary nature of animals and plants, this protection requires international cooperation.

## 4 Project Description

### 4.1 Project Background

In 2007 Felicitas Limited acquired 25.33 hectares of land on the northern coast of Jamaica at Stewart Bay in the Coral Spring area of Trelawny for resort development. The initial proposal was for the development of a Marina and Luxury Villas, for which basic concept designs and coastline studies were done. Following an incident of illegal sand mining this proposal was forfeited. Felicitas Limited now proposes the development of a hotel resort on the site.

The proposal at full build out consists of 1,017 rooms, 227 parking lots and a total building area of 126,625m<sup>2</sup>. The amenity area will include bars and restaurants, kids' zones, a conventional centre and theatre, a spa, swimming pools tennis courts and a lobby area (Figure 4.1.1). Service areas cover administration, warehouses and mechanical rooms. Floor area ratio for the hotel development is projected to be 0.5:1 with a plot area ratio of 30%.

The development is to take place under the Ocean by H10 Hotels brand through a joint venture between Felicitas Limited and the H10 Hotels Group. H10 Hotels was established in the early 1980s, when it began operating in Spain's main holiday destinations. Today, the company has 55 hotels in 18 destinations, with more than 14,000 rooms, the majority of which it owns. H10 Hotels is one of Spain's top 10 hotel companies, with its current business plan aiming at providing its clientele with destination options in the Caribbean.

Ocean by H10 Hotels was founded in 2008 as the brand under which the company H10 Hotels operates in the Caribbean. Currently its hotels are located in Riviera Maya and Riviera Cancún in Mexico, Punta Cana in the Dominican Republic and Varadero and Cayo Santa María in Cuba. The Ocean by H10 Hotels establishments are characterized by their privileged locations on the seafront, high quality facilities, wide range of services and all-inclusive programmes, health and beauty centres, diving centres and theme restaurants with exclusive and select cuisine.



Figure 4.1.1: Site Layout and Land Use of the proposed Coral Spring Hotel Development, Trelawny



## 4.2 Project Location

The Coral Spring Hotel Development will be located off the north-coast highway on part of Stewart Castle, Coral Spring in Trelawny. The detail description is already presented in section 2.2.

## 4.3 Project Design and Phases

### 4.3.1 Project Design

The design proposes the main access to the complex from the southwest end of the land (Figure 4.3.1). This will enhance the experience of guests arriving and exiting the property. In addition, the main entrance will have control points for staff and deliveries. There is also a proposed secondary access point from the southeast, which will be used as a private entrance to the villas. This secondary entrance will be at the highest point of the property and will create viewing vistas to both hotels.

### DEVELOPMENT DATA

LAND SIZE	253,251,00 SqM / 62.58 Acres		
FLOOR AREA RATIO	0.50 : 1		
TOTAL FLOOR AREA	126.625,50 sqm		
TOTAL NUMBER OF ROOMS	1017		
PROPOSED DENSITY	20 H.R./AC. =1.252 H.R.		
NUMBER OF JUNIOR SUITES	930	X 1 H.R. =	930
NUMBER OF MASTER SUITES	50	X 2 H.R. =	100
NUMBER OF VILLAS	37	X 6 H.R. =	222
TOTAL NUMBER OF HABITABLE ROOMS			1252 H.R.
NUMBER OF STORIES	5	= 17,5 m	
PLOT AREA RATIO	30 %		
NUMBER OF PARKING SPACES	1 space to each 3 guest units		
			339 parking space
SET BACKS	30 m. from the High Water Mark		
	1,5 m. from boundrles per floor		







#### 4.3.2 Project Phases

The complex is proposed to be erected in three phases. Each hotel has its own separate formal and functional identity, without losing sight of the unified image of the Hotel Complex.

The first phase, **HOTEL 1**, has a slightly larger built area per room impact than the rest of the phases given that it covers most of the common entertainment and administration areas. It has a surface parking for 192 vehicles.

The entrance to the lobby (reception, lobby-bar, business centre, ...) is on level +10.00, from where we can access level +5.15, which is the restaurant area housing the main buffet restaurant and several themed restaurants, all with spacious terraces looking out towards the north-east and the pool, open air and entertainment areas.

Between both hotels, on level +10.00, there is transition area with equipment that, although located in **HOTEL 1**, it constitutes shared services with other phases (**HOTEL 2 and VILLAS**). These unique buildings distributed around a square correspond to the entertainment area (casino, theatre, sports bar, etc.), as well as some administrative areas. Further east, and also shared between phases, is the Convention Centre and sports area.

Whilst guests of **HOTEL 2** have access to the shared services described above for **HOTEL 1**, its common areas are exclusive to this hotel, intended for adults only. It is close to the surface parking for 78 vehicles. As happens with the counterpart building, from level +10.00, we access the lobby - reception. The restaurants are located on the lower level, +5.15, and have terraces looking out towards the north and the pool, open air and entertainment areas.

Both hotels will have an independent **PRIVILEGE** area located on first line beach with an exclusive lounge area and reception.

The **VILLAS** will also have their own reception, club, exclusive restaurant and pool with a sun terrace located on the highest area of the plot, next to a surface parking for 65 vehicles.

#### 4.3.2.1 Phase 1/Hotel 1

Phase 1-hotel will be a family hotel with its own design features, but will have similar defining elements as the other phases. Phase 1-hotel will have 410 junior suites and 20 master suites (Figure 4.3.2). This phase is to be constructed on the north-western section of the site near to the northern coast.

<b>PHASE 1 - TOTAL NUMBER OF ROOMS</b>	530		
<b>NUMBER OF JUNIOR SUITES</b>	500	<b>X 1 H.R. =</b>	500
<b>NUMBER OF MASTER SUITES</b>	30	<b>X 2 H.R. =</b>	60
<b>TOTAL NUMBER OF HABITABLE ROOMS</b>			560 H.R.

#### 4.3.2.2 Phase 2/Hotel 2

Phase 2-hotel will be an adult facility with its own character, but like Phase 1, it will have similar defining aesthetic features. Phase 2-hotel will have 355 junior suites, 15 master suites and private amenity spaces (Figure 4.3.3). Phase 2- hotel will be constructed on the north-eastern side of the property near to the coast.

<b>PHASE 2 - TOTAL NUMBER OF ROOMS</b>	450		
<b>NUMBER OF JUNIOR SUITES</b>	430	<b>X 1 H.R. =</b>	430
<b>NUMBER OF MASTER SUITES</b>	20	<b>X 2 H.R. =</b>	40
<b>TOTAL NUMBER OF HABITABLE ROOMS</b>			470 H.R.



Figure 4.3.2: Preliminary Rooms Layout - Hotel 1



Figure 4.3.3: Preliminary Rooms Layout - Hotel 2

Both Phases 1 and 2 will be constructed as 5- storey blocks for the guest rooms and suites, while the administrative blocks and other building spaces are 1-2 storeys high. These will be located on the flat to gentle sloping land on the northern section of the site near to the sandy shoreline.

#### 4.3.2.3 Phase 3/Villas

Phase 3 villas will be built in four modules with two bedrooms, living room and dining room, two bathrooms and a pool (Figure 4.3.4). The villas will have a checking area, club, exclusive restaurant, a common swimming pool, 25 suites and 150rooms. The villas will be operated by an independent company/Hotel.

<b>PHASE 3</b>	<b>TOTAL NUMBER OF ROOMS</b>	37	
	<b>NUMBER OF VILLAS SUITES</b>	37	<b>X 6 H.R. = 222</b>
	<b>TOTAL NUMBER OF HABITABLE ROOMS</b>		<b>222 H.R</b>

## Villas Layout Plan



Figure 4.3.4: Villas rooms layout plan



In order to follow H10's conviction, the complex will be designed without "author signature", therefore it is proposed that an anonymous architecture will be integrated in the natural landscaping. The architecture of the hotel will take in consideration the natural elements (landscaping and the tropical climate). The integration will be realized with elements such as balconies, terraces, outdoor pools and walkways (covered and semi-covered). These elements will afford the opportunity to create private and intimacy spaces. All rooms are designed to have views to the Caribbean Sea.



*Figure 4.3.5: A 3-dimensional architectural view of the proposed Coral Spring Hotel, phases 1, 2 and 3*



Figure 4.3.6: A 3-dimensional architectural view of the proposed Coral Spring Hotel - elevations

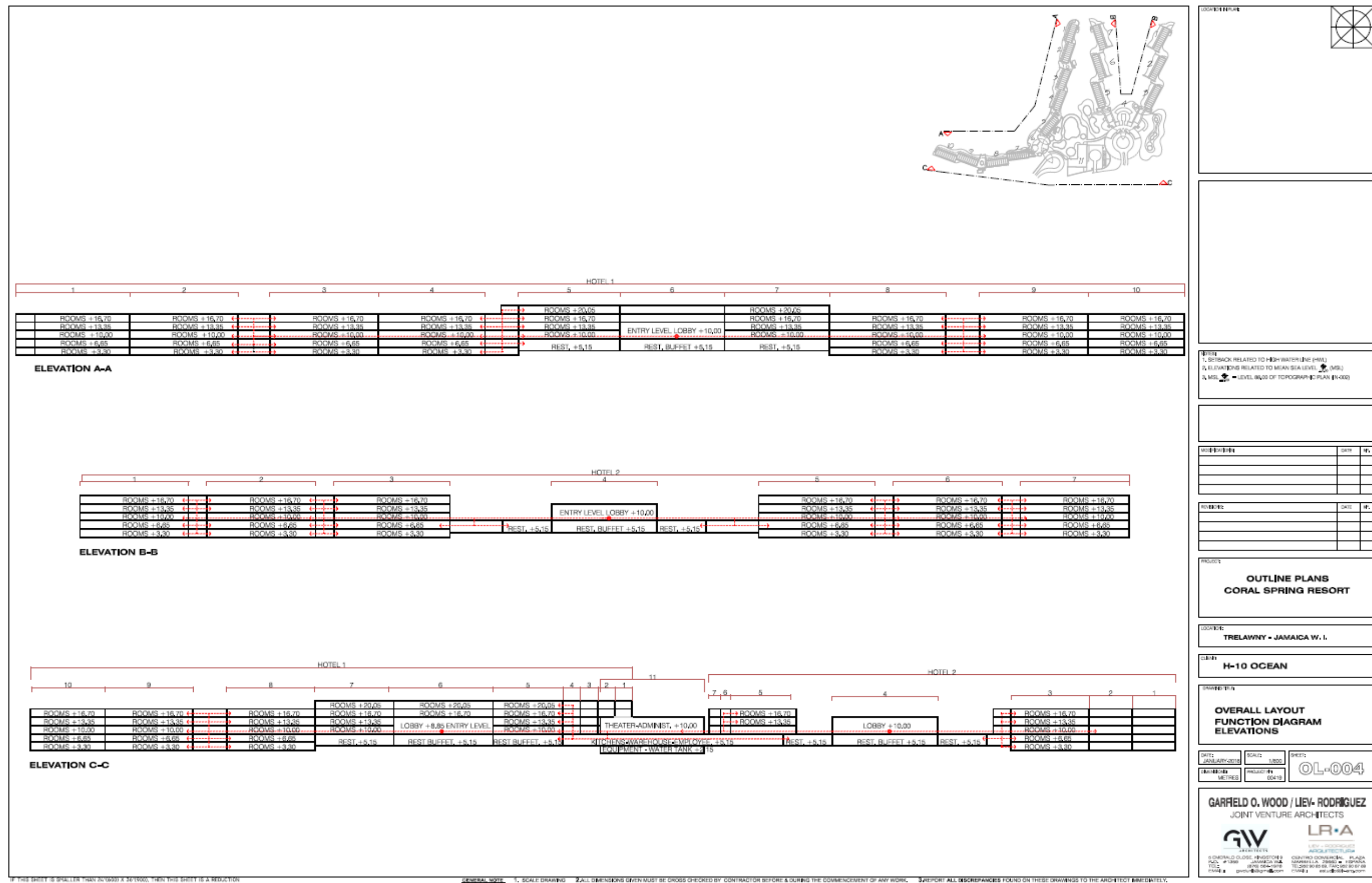


Figure 4.3.7: Building Elevations

## **4.4 Project Features**

### **4.4.1 Coastline Modification**

The coastline modification involved in this project will be to achieve beach and wading area as per concept drawing in Figure 4.3.5 above.

The proposed development will have, as a component of its recreational attractions, a wading area immediately adjoining the property's beach. The wading area is proposed to be 30 meters wide and approximately 1.2 meters deep. Figure 4.4.1 illustrates the proposed location and dimensions of the wading area. The area of the proposed wading area is approximately 1.13 hectares

The current depths in approximately half of the proposed wading area (0.54 hectares) are less than 0.5 meters. Dredging will therefore be required to achieve the required depths. It is estimated that approximately 4,300 cubic meters of material will have to be removed from the proposed wading area in order to achieve the required wading depth. It is also estimated that approximately 0.23 hectares of seagrass resources will be impacted by proposed dredging activities, if mitigations are not implemented (Figure 4.4.2).



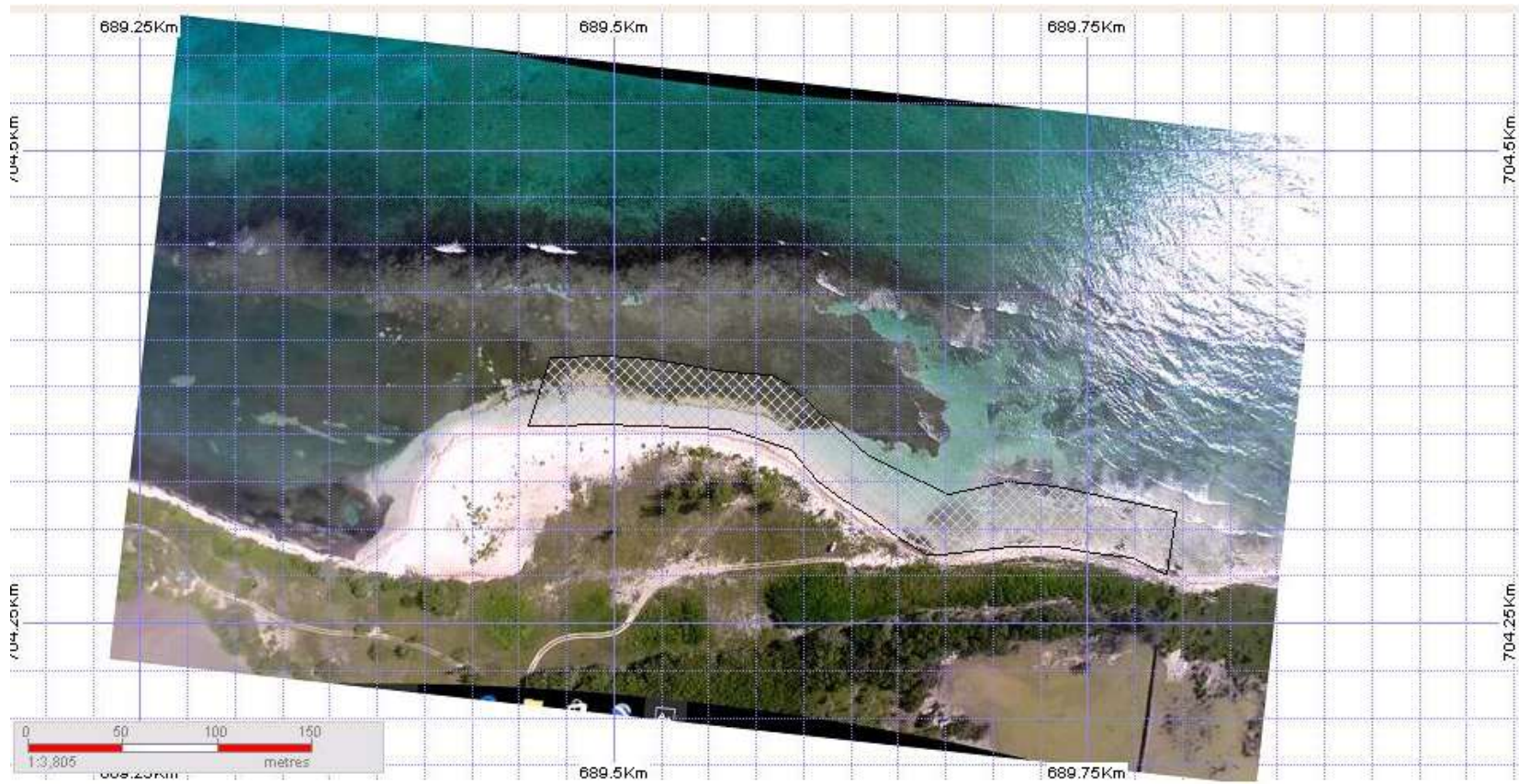
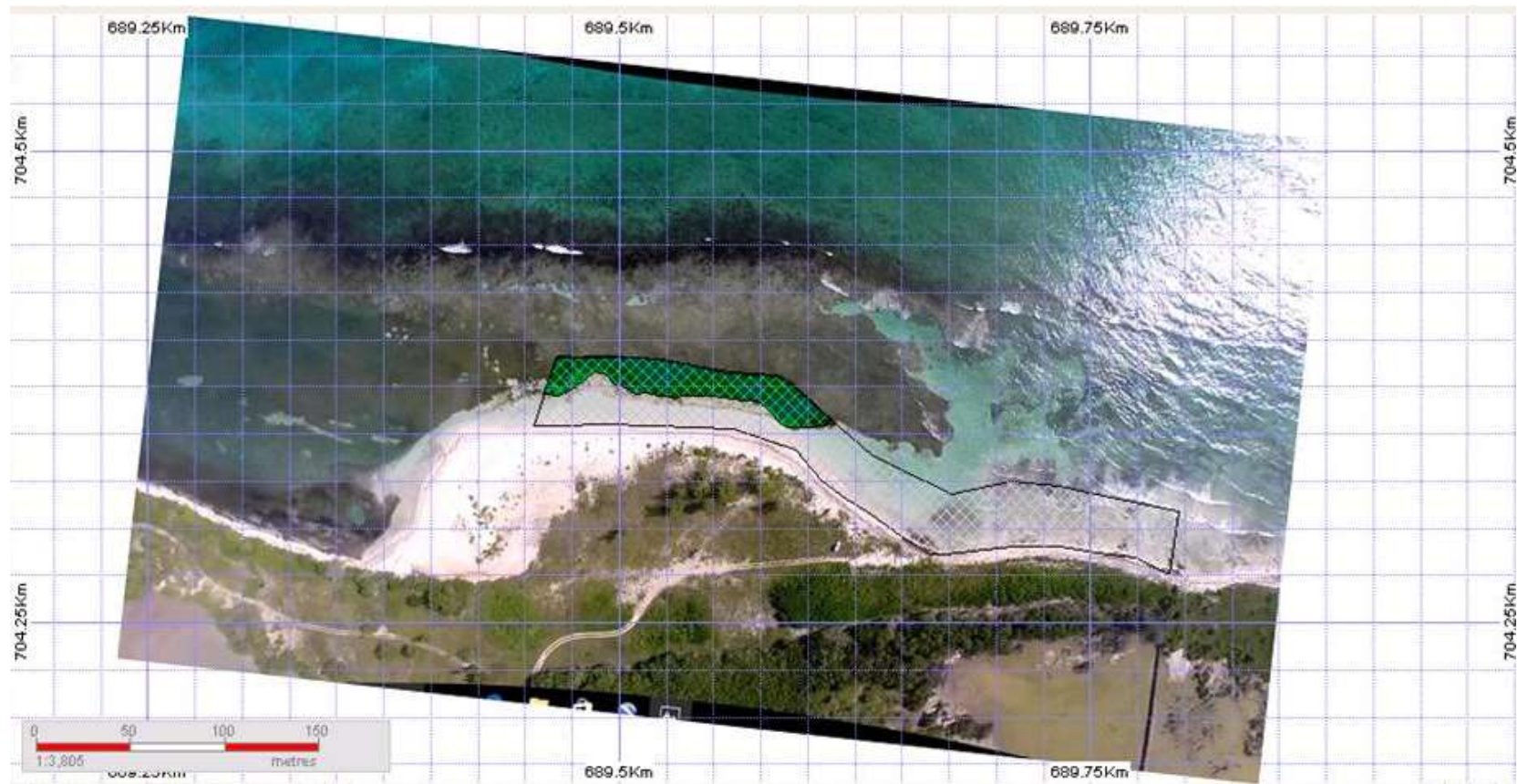


Figure 4.4.1: Proposed location for wading area



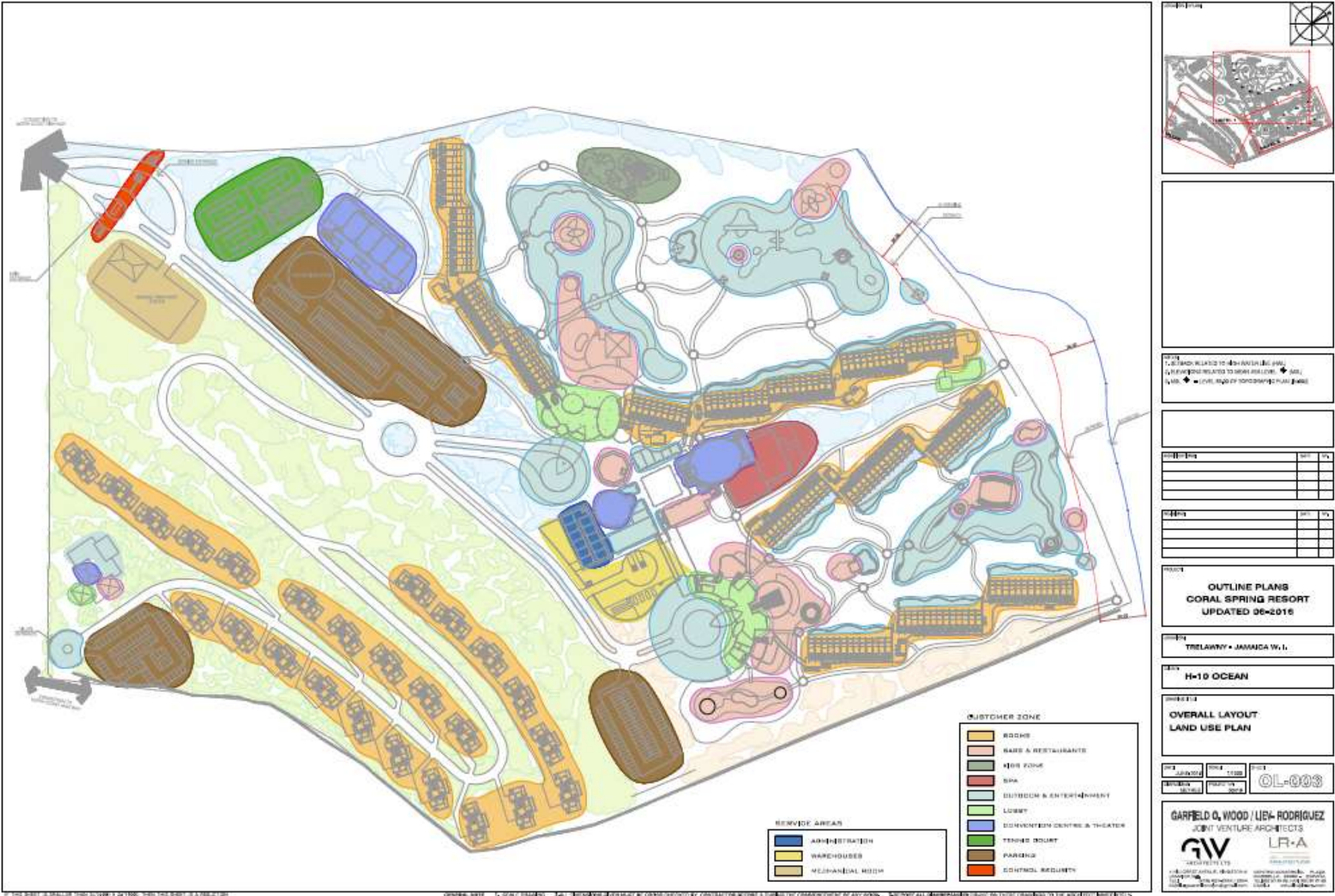


*Figure 4.4.2: Area of Seagrass within Proposed Wading Area that will require Mitigation (green hatched area).*



4.4.2 Proposed Use of Spaces and Alternatives

The assignment of use of spaces is presented in Figure 4.1.1 and Figure 4.4.1, presenting the alternatives that are being considered.





4.4.3 Landscape Design



Figure 1.1.2: Landscape Layout



The approach to landscaping will be to first of all retain as much of the natural vegetation as is possible (at least 30%), especially on the steeper slopes. Where the vegetation has been disturbed during construction and no structures erected, the vegetation will be reestablished using local varieties of plants as much as possible. Topsoil for the landscaping will be derived from a contracted recognized landscaping company, one such who has done work for several of the major hotels on the north coast is Camelot Landscaping.

#### **4.4.4 Earthworks and Site Modification for Pond**

In order to achieve the objective for hotel development, the north eastern section of the property where a pond/swamp is located will be modified to accommodate hotel Phase 2 construction. The following will be carried out:

- The shallow water pond will be drained using water pumps and cleaned with scrapers to remove the thin layer (<7cm) of mud and organic silt
- An estimated 12,000 m<sup>3</sup> - 18,000 m<sup>3</sup> of approved backfill with a minimum and maximum thickness of 1m and 1.5m respectively and is devoid of organic material and detritus will be spread over the area.
- Backfill must meet a minimum of 95% Standard Proctor Compaction
- Fill must be placed at a maximum loose lift of 305 mm (12 inches)
- Density tests per lift should be performed indicating location, dry density and moisture content as per ASTM D6938. This will be necessary for structures that are to be constructed using shallow foundations.
- Site to be graded to prevent water from ponding over the backfill area.

#### **4.4.5 Rainwater Ground Control Plan**

A system of rainwater capture has been designed (see Figure 1.1.3). Rainwater from all paved surfaces will be captured in a sub-surface drainage structures and channeled to infiltration wells which are located throughout the property. The developer will be encouraged to convert some of the infiltration wells to rainwater storage facilities especially at the higher to mid-level elevation which would allow it to be used for a gravity fed irrigation system in the lower elevations.

#### 4.4.6 Site Access

As shown on the site layout plan (Figure 4.3.1), access to the site will be gained from the south west and south east corner of the property. The south west access will be the main access to the hotels 1 and 2. This access will join the North Coast Highway via an existing parochial road which runs between the phases of the Coral Spring Housing Development. This access is also the access to be utilized during the construction phase. The developer will need to undertake major upgrading works along this access road between the site boundary and the highway.

The second access in the south-east corner will serve as a private entrance to the villas. This access will join the North Coast Highway via a parochial road which traverse the Stewart Castle community passing along the Stewart Castle Ruins. The developer will also need to undertake major upgrading works along this access road between the site boundary and the highway, this however will not be required until the construction of the third phase (villas).

The developer will need to establish dialogue with the NWA concerning both access and parochial road upgrading.



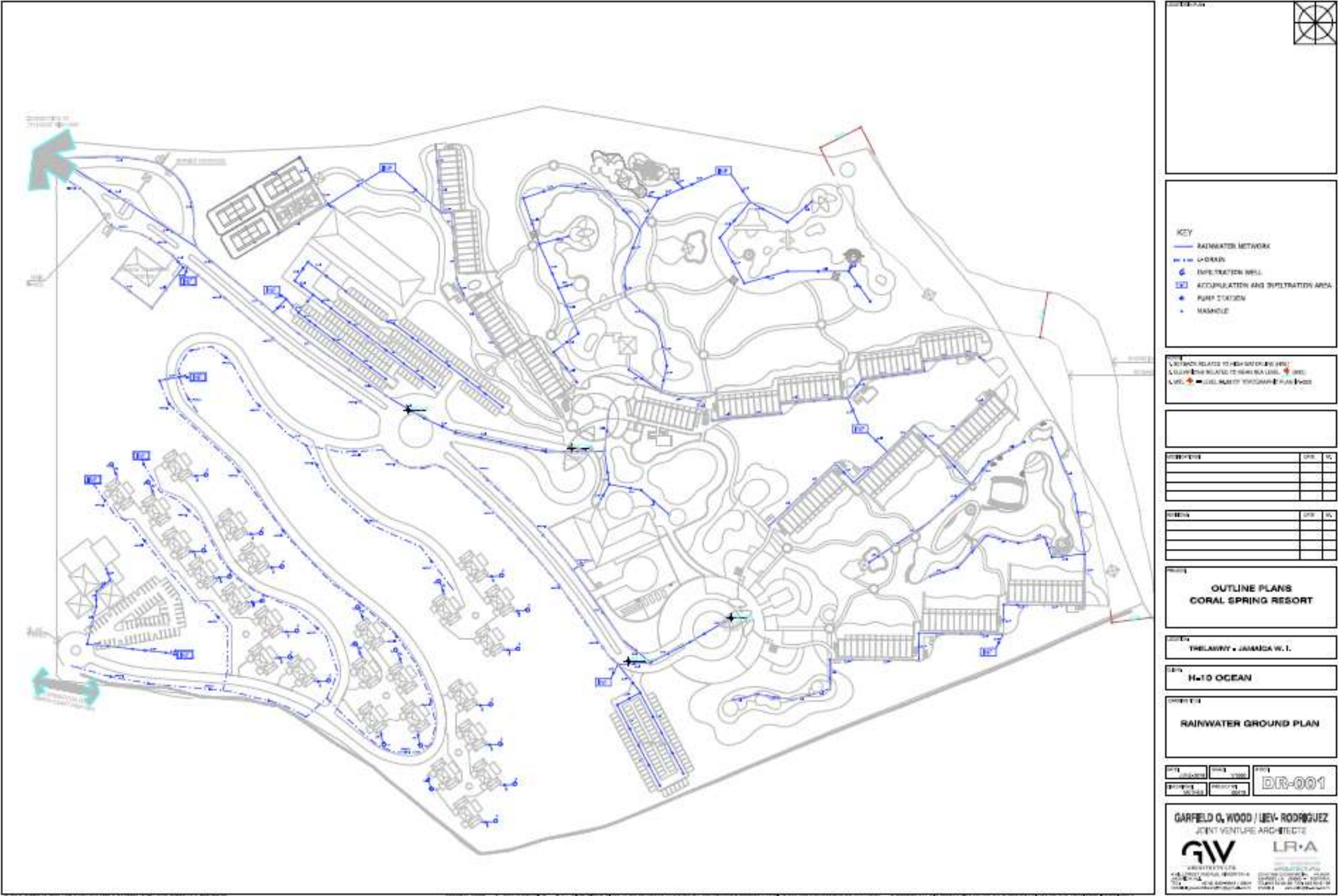


Figure 1.1.3: Rainwater control Plan

#### 4.4.7 Sewage Treatment

The proposed sewage treatment facility will treat the wastewater as a resource, ensuring it is reused for landscaping. Two types of wastewater will be generated at the hotel development:

1. Black Water (faecal content and general human egested/excreted waste)
2. Grey Water (bath, laundry and wash basin water)

\*The grey water to black water ratio is expected to be approximately 3:1

The estimated values, of the quality of water to be treated are detailed as follows:

Flow for design:	1200 m <sup>3</sup> /day	· 250 mg/l SS pH: 6-9
· Oils and grease:	40 mg/l	
· COD (Chemical Oxygen Demand):	550 mg/l	
· BOD (Biochemical Oxygen Demand) BO <sub>5</sub> :	240 mg/l	

The limit values expressed are those listed as follows

- <15mg/l BioChemical Oxygen Demand BOD<sub>5</sub>
- <100 mg/l Chemical Oxygen Demand (COD)
- <15 mg /l Total Suspended Solids (TSS)
- <10 mg /l Oil and Grease
- <10 mg/l N Total Nitrogen
- pH: 5.5-9.0

The other substances must fulfil at least the following value limits:

- DO (Dissolved Oxygen) :>5 mg/l
- Faecal coliforms :<12MPN /100ml

##### 4.4.7.1 Basis of Design

The National Water Commission Developer's Manual was used as a guide in the selection of the most appropriate Sewage Treatment Plant (STP) to be used. The plant was designed

to minimize energy consumption, maintenance requirements and operational inputs. The Oxidation Ditch System was selected over the Constructed Wetland and Stabilization Ponds due to set-back requirements of the Environmental Health Unit of the Ministry of Health, and associated spatial constraints of the available lands. The proposed system is robust, able to withstand shock loading, easy to maintain, and free of any foul odours. This system precludes the need for additional basin or hydraulic retention capacity, facilitating treatment of variable flows, which best suits a phased development such as this. The system requires continuous power supply, and a back-up electrical supply will have to be put in place and utilized by the treatment plant and lift stations in case of power outage. Continuous power supply is required for the pumping stations to lift sewage to the treatment plant also. The system is designed for a minimum fifty-year life-span.

#### 4.4.7.2 Design Capacity of the Sewage Treatment Plant (STP)

The STP was designed in two (2) phases each to accommodate and treat design flows of 600m<sup>3</sup> per day. Phase I of the STP will be completed simultaneously with Phase 1 of the Hotel while Phase II of the STP will be completed along with the remaining Phases (2 & 3) of the hotel's expansion. Sewers are designed to allow maximum expected hourly flows, based on Jamaica Institute of Engineers (JIE) Guidelines. The maximum sewage flow for design was estimated at 1200 m<sup>3</sup> per day; as seen in Table 1.1.1, this includes 985 m<sup>3</sup> per day based on the parameters given, in addition to a contingency of 22%. Details of the design will be provided in the engineering report and drawings. The STP setbacks will be maintained at least 40m from the closest boundary (Figure 1.1.4).

*Table 1.1.1: Sewage Estimates (Daily production)*

Category	Number of unit	Number of bedrooms	Litres/ room/ day	Sewage (m <sup>3</sup> / day)
Villas	37	5	1000	185
Junior Suites	753	1	1000	753
Master Suites	47	1	1000	47
<b>Total</b>	<b>837 units</b>			<b>985 m<sup>3</sup> / day</b> <b>+22% contingency (~216 m<sup>3</sup> / day)</b> <b>= 1200 m<sup>3</sup> / day</b>



Figure 1.1.4: Schematic illustrating the proposed Site Layout of STP with setback

#### 4.4.7.3 Treatment Process Flow

The Oxidation Ditch System process (Figure 1.1.5) uses a completely mixed activated sludge process with additional treatment components for nutrients removal. Aeration and mixing is achieved through a combination of mixing and air diffusion in the ditch flows. Multiple mixing and aeration units are distributed around the ditch. The flow from the oxidation ditch proceeds to the clarifiers for solids separation. Activated sludge is sent to the aerobic digester for storage and further solids reduction. Flow from the clarifiers goes to the disinfecting unit then to the effluent storage tank. The effluent will be disinfected through chlorination and/or UV disinfection system, to produce a tertiary effluent that meets the Sewage Effluent Standards for Irrigation.



100



will lead to hazardous waste generation, including waste oil, spent batteries, oil filter. All maintenance work will be done off site.



*Figure 1.1.6: Figure showing Proposed staging site for Heavy Equipment storage and office locations, area eventually to become parking space*

Waste expected to be generated will consist mainly of topsoil, sand shrubs and trees and traditional construction debris consisting of tailings, Iron and other metal pieces, broken tiles and municipal solid waste, which are all non-hazardous materials. A solid waste management plan will be employed, where construction debris are managed separately from municipal solid waste, allowing for routine collection by the National Solid Waste Management Authority (NSWMA) trucks serving the area. Municipal waste disposal bins will be provided, along with training sessions with the workers on proper waste disposal noting the nature of the area the construction is being done in. Top soil removed will be stored and used as fill material as required, while the remaining will be disposed of as approved by the NSWMA. During phase 1 operation, waste and construction material will be stored at phase 2 pre-construction site and during phase 2 operation, construction material will be stored near the SE boundary of the site. It must be noted that the nearest NSWMA operated Dump site is in St. James at the Retirement Dump.

Any hazardous waste identified will be brought to the site manager's attention for their action. The training sessions mentioned previously will delve into identifying waste materials that do not fall under municipal solid waste or regular construction debris. Phase 3 (villas) will take a different approach, since it is the final phase of development following the completion of Phases 1 and 2 and will be located on the moderate to steep slope overlooking phases 1 and 2 and the Caribbean Sea. Heavy duty equipment such as excavators, bulldozers for excavation of earth material, removal of woodland vegetation and loaders for loading and removing material off/on-site will be conducted.

As mentioned previously, mobile temporary chemical toilets will be provided throughout the construction phase through contract with an approved company. These units will be fully contained and will be removed from the site by the chemical toilet providers.

#### **4.5 Construction Phase**

During construction, the property will be fenced along the boundary lines to provide for security and minimize the potential for fugitive emissions of dust. Temporary buildings will be utilized onsite during construction for storage and field offices. These buildings will be removable containers and/or temporary structures on the site. Restricted Access to the site during construction is proposed to be taken from the south-eastern boundary.

Mobile temporary chemical toilets will be provided throughout the construction phase through contract with an approved company. These units will be fully contained and will be removed from the site by the chemical toilet providers.

As much as possible of the land will be preserved in its existing state (more or less) with brush removal and landscaping being done to maintain the aesthetics of the development and the area. Mature trees will be left in place, as much as practicable.

All structures to be built on the site will adhere to and fall within the regulations standards of the Trelawny Parish Council and the Natural Resources Conservation Act of 1991, which is enforced by the statutory body, the National Environmental Planning Authority (NEPA).

In order to achieve the objective for hotel development, the area on the eastern section of the property consisting of the pond will be modified to accommodate construction. The

shallow water pond will be drained and cleaned by removing thin layer (<7cm) of mud and organic silt and then replaced by spreading approved fill and compacted in accordance with ASTM standard. The backfill will be graded and compacted to ensure that there is no ponding or settling of water in the graded area.

#### **4.5.1 Machinery and Equipment**

##### **4.5.1.1 Types of Construction Equipment**

The types of equipment to be used on the Coral Spring construction site include hammer drills and compressors, pneumatic drills, excavators and bulldozers for land clearance and hard digging. Heavy duty trucks (trailers) for transporting construction material and equipment to and from the site will be an integral part of site preparation activity. Other equipment such as water pumps, dumper trucks, loaders, scrapers and compactors will be used as part of earthworks construction activity. During building construction, heavy duty equipment such as excavators, loaders, compactors, mobile cranes, rollers, graders and pavers will be used.

Additionally, a concrete batching plant will be set up on site for mixing cement to improve construction efficiencies. This batching plant will combine water, fine aggregate (mainly sand) and coarse aggregate (gravel and/or crushed stone) and cement. Mineral admixtures may also be added to the cement slurry to improve strength, permeability and to add economic value.

##### **4.5.1.2 Movement of Equipment and Machinery on and off the Site**

The construction site is approximately 1.4 Km from the North Coast Highway and is some distance away from the main road. Direct interference with the movement of highway traffic is therefore minimized on a day to day basis. However, heavy construction equipment such as crawler excavators, bulldozers and cranes etc., will be loaded on trailers and piloted on the highway using escort vehicles fitted with flashing lights. With the assistance of flagmen, the equipment will be transported to the construction site. The heavy equipment and machinery are expected to remain on site until they have completed their tasks. The route to be taken in transporting the equipment will be planned to ensure that there are no unforeseen problems during the transportation process. The intensity of

movement and type of equipment on and off site will vary during the life of the project as it will largely depend on the stages of the project construction.

With respect to the movement of heavy equipment and machinery on the construction site, it is necessary to ensure that the hazards are identified, their risks assessed and effectively managed. Identifying and managing risks relating machinery and equipment operations on the construction site at Coral Spring will include the following:

- Moving equipment and machinery must be isolated from workers/pedestrians on the site. This will necessitate the use of barriers/barricades to secure the area where machinery and equipment is working
- Movement and direction of heavy duty moving equipment will be planned in such a way that visibility of operators is not restricted
- Safe working distances will be implemented to minimize risks
- Delivery and turning areas will be specially identified as these are areas that may present hazards especially when reversing, loading and unloading.
- Construction equipment and essential service vehicles will be fitted with alarm devices as part of safety measures.
- Safety observers/personnel will be used to control and manage traffic movement on site
- Hiring and training of equipment operators is critical to ensure their competence in order to minimize risks on the construction site
- Warning signs to be placed strategically, in areas identified as hazard zones
- A system of management and control will be implemented at entrances and exits where construction vehicles and equipment enter and leave the work area.
- Separate entry and exit gateways for workers and vehicles will be provided.

#### **4.5.1.3 Equipment Storage**

Construction will be done in phases at the Coral Spring site. During construction, machinery and equipment will be stored on the south-eastern side of the flat, low lying area so that it is maintained at reasonable distance from the coast (Figure 1.1.6). The storage area will be maintained for all phases of construction. The concrete batching plant will also be operated in this area, so that it is far removed from the coast.

#### **4.5.2 Workforce Mobilization**

At the peak of the construction activities it is envisioned that there will be the need for a maximum of 1,200 workers of various skill set on the site. Temporary structures will be erected to be used as site office, stores and welfare facilities, but no living accommodations will be made for workers on site save and except for security personnel. Construction workers will be recruited from the local area to reduce the carbon foot print of the construction phase, and reduce the need for additional housing facilities.

As a condition of the contract which will be established with contractors and subcontractors, they will be required to hire worker from in and around the area. Where this may not be possible the contractors will be required to ensure proper living accommodation is provided offsite for their workers.

### **4.6 Project Schedule & Timelines**

Phase 1, Hotel 1 is expected to commence construction in June 2017 with a duration of 375 days, which should see Hotel 1 being opened in December 2018. The realization of this schedule is however dependent on receiving the permit approval by June 2017. The schedule for the other phases will be finalized during construction of phase 1.

A preliminary schedule for outlined phases 1 though to 3 is shown in Figure 4.6.1.



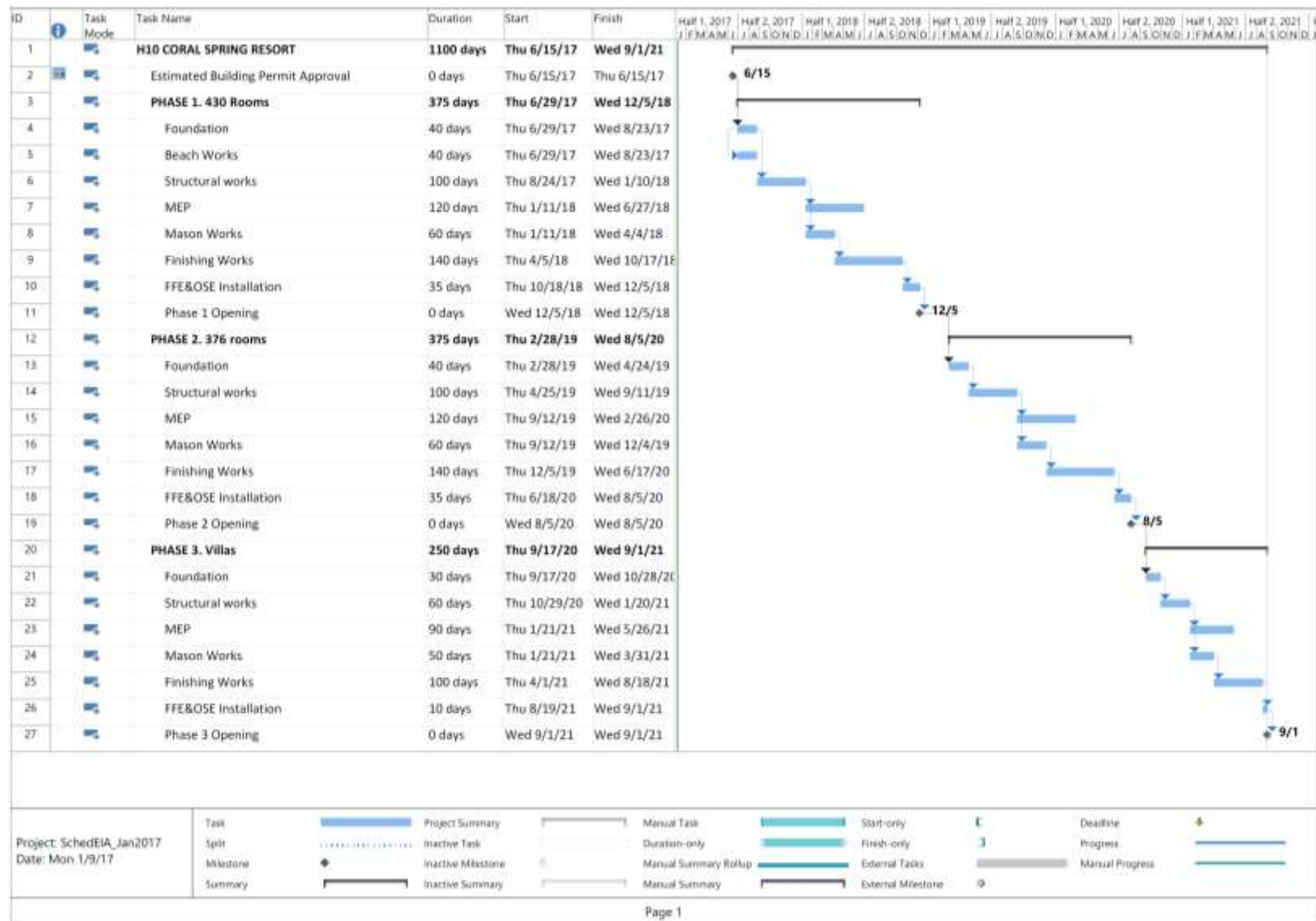


Figure 4.6.1: Preliminary schedule for all project phases

## **5 Description of the Environment**

### **5.1 Physical Environment**

#### **5.1.1 Topography**

The project area is a greenfield site located along the northern coastline and forms part of Stewart Bay coastal area in Trelawny (Figure 2.2.1). The property is bounded by the Caribbean Sea in the north, the crest of the upland hilly region in the south, and a stone wall in the east that cuts through the centre of a wetland area. The western boundary is partly defined by the narrow, unpaved parochial access road to the site.

The Coral Spring hotel site consists of a flat to gentle sloping low-lying area on the northern section and upland or hilly area on the southern section of the property (Figure 5.1.1). Slope gradient on the northern low lying area does not exceed 5 degrees while in the upland area slopes are moderate to steep ranging from 15 degrees (37 percent slope) to a little over 26 degrees (50 percent slope). The hill steepens gradually from the south west to the south east.

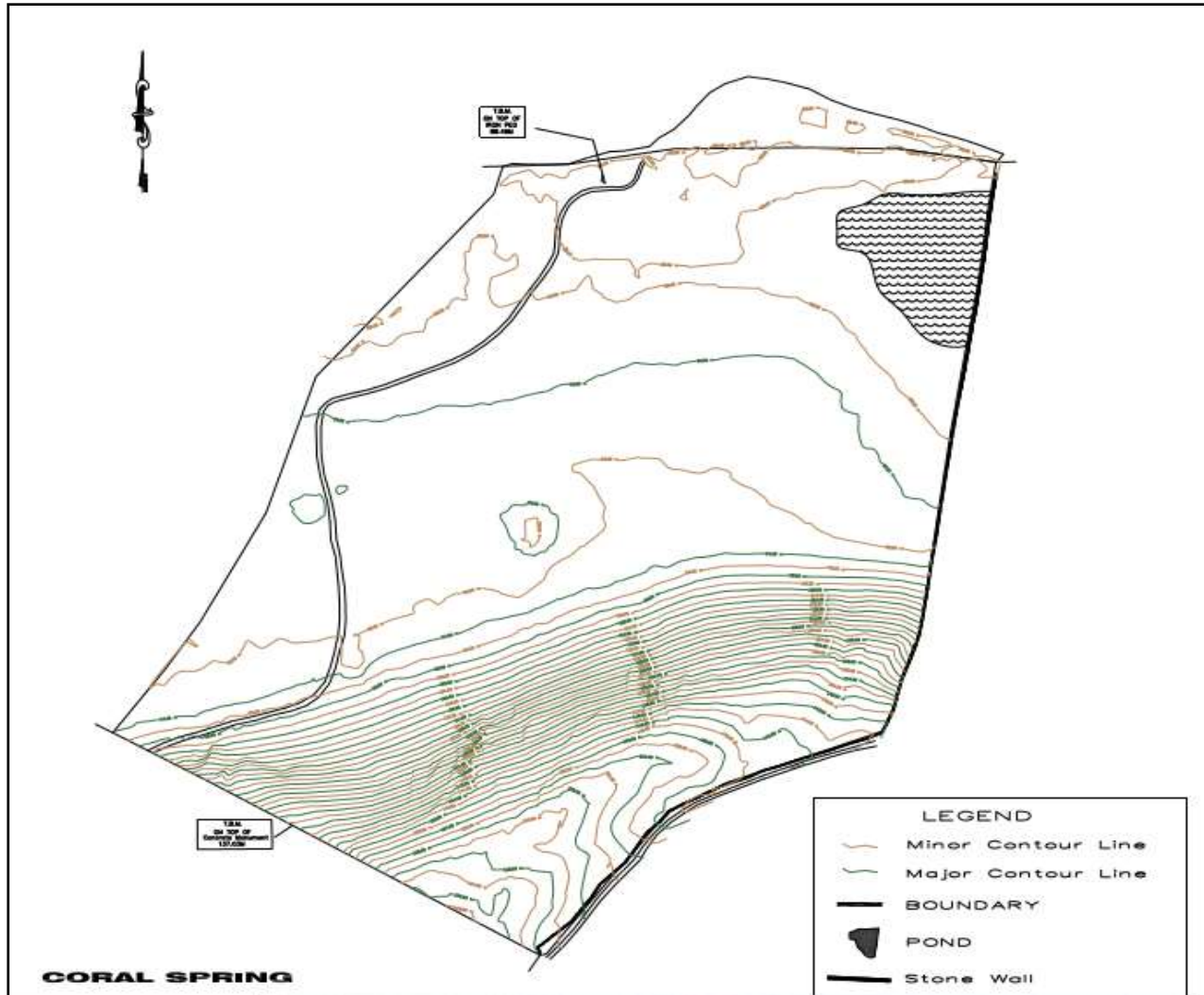


Figure 5.1.1: Contour plan of Coral Spring Hotel Project Site

### 5.1.2 Climate

Jamaica is surrounded by the Caribbean Sea and is located in the Tropics at approximately latitude 18°N and longitude 77°W. 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 climate of the general Falmouth area, like the rest of Jamaica, is subtropical with gentle to moderate northeasterly prevailing winds and average daily temperatures varying from 23°C in January to about 28°C in July. Humidity ranges from 66% to 87%

with a significant diurnal variation resulting in high morning humidity dropping off significantly in the afternoon.

The long term (1951-1980) mean annual parish rainfall for Trelawny is just over 1,600 mm. The 30-year monthly mean rainfall ranges between 69 mm (minimum) to 222 mm (maximum). The drier period is December to March where the long term average rarely exceeds 130 mm. Rainfall data from the Meteorological Office over the period 1951 - 1980 indicates mean monthly rainfall for Falmouth in the order of 85 mm with a high of 163 mm in November and 105 mm in May. There are two distinct periods of higher than average rainfall from October to January and during May.

Northers that form over the North American continent produce slow moving cold fronts that approach the island from the north and bring with them rainfall that can persist for days. During the period June to November each year extreme weather conditions can be influenced by tropical systems that develop in the North Atlantic and Caribbean Basins. These systems are typically tropical storms and hurricanes that move westwards through the Caribbean region generating intense rainfall of long duration. In addition to the rainfall, tropical storms or hurricanes are usually accompanied by high velocity winds.

#### 5.1.2.1 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 5.1.2). 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.

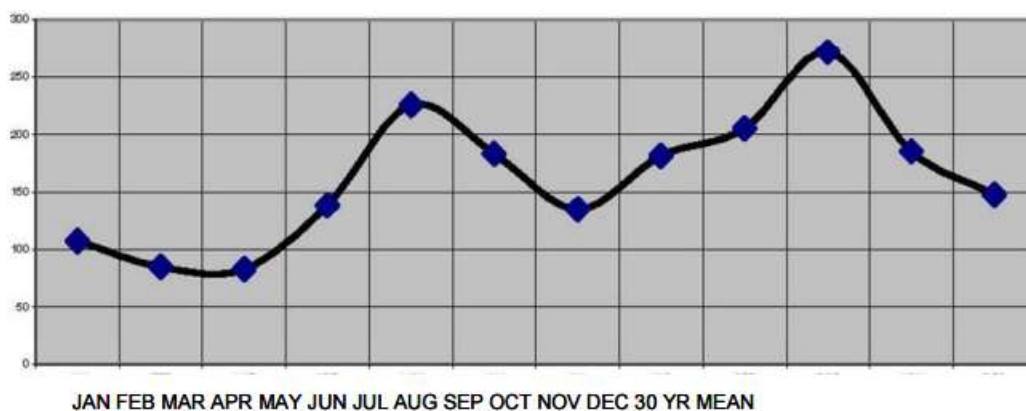


Figure 5.1.2: Jamaica 30 Year Rainfall Mean (1951-1980)

Of the weather parameters, rainfall is the most variable. Island wide, 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 5.1.3 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 5.1.4 shows the average yearly rainfall for Braco, the closest available rainfall monitoring site.



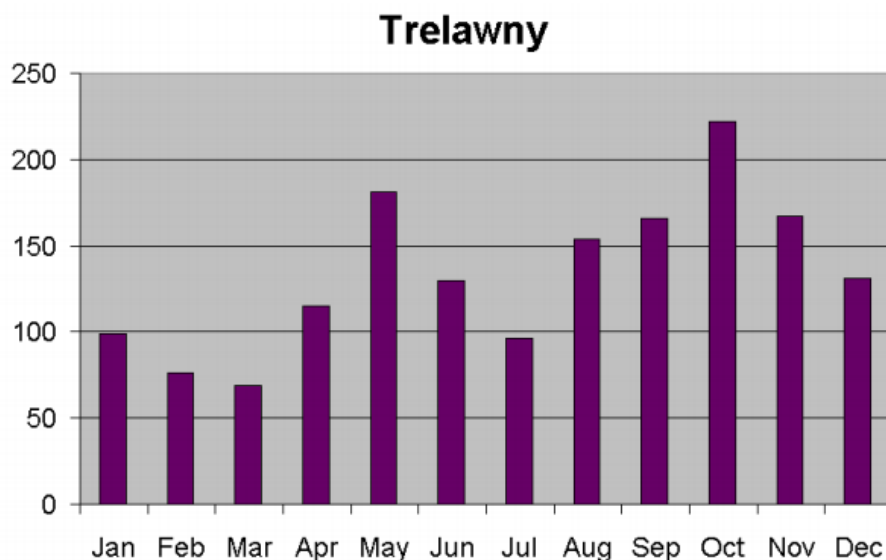


Figure 5.1.3: Trelawny Long-term Mean Rainfall (mm) 1951-19802

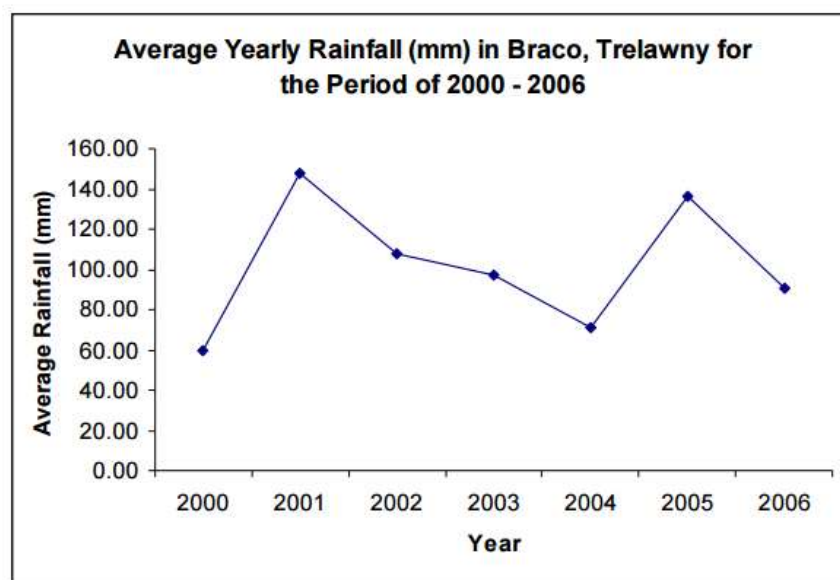


Figure 5.1.4: Average yearly rainfall for Braco, closest monitoring site to proposed location

#### 5.1.2.2 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.

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 5.1.5).

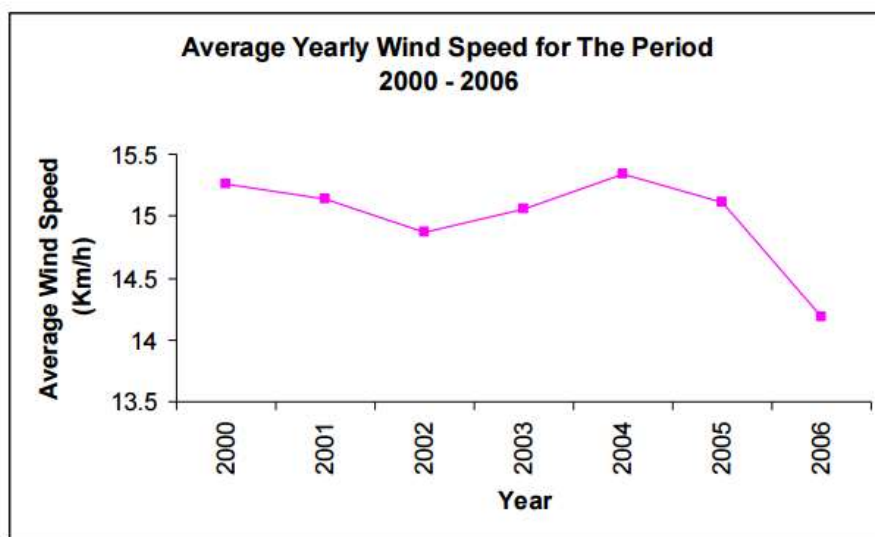


Figure 5.1.5: Average yearly wind speeds at Sangster's International Airport, Montego Bay<sup>4</sup>

#### 5.1.2.3 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 (79.2°F), with an average maximum of 30.3°C (86.5°F) and an average minimum of 22.0°C (71.6°F). The warmest months are June to August and the coolest December to February. Night-time values range from 18.9 to 25.6°C (66 to 78.1°F) 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 (°C), therefore, little or no discomfort results. At 1 p.m. the average relative humidity on the coasts is 71%.

Table 5.1.1 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 5.1.1: 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*

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

### 5.1.3 Geology

#### 5.1.3.1 Description of Ground Surface

The north-central and north western sections of the flat, low-lying area are covered with white carbonate sand extending inland to approximately 75m-80m from the shoreline (Plate 5.1.1). Beyond this distance the white sand changes gradually to yellowish brown and brown sand. Along the eastern section near the coastline the white, carbonate sand

is limited to approximately 8m-15m from the shoreline. Beyond this point, the sandy area is mainly covered by brown and grayish brown sand with copious amount of broken pieces of limestone rock and shell fragments (Plate 5.1.2). Further inland, towards the south the site grades into a hilly, upland area consisting of moderate to steep slopes with abundant limestone boulders and cobblestone on the surface of the sloping ground.



*Plate 5.1.1: White carbonate sand on the central and eastern section of property near the coastline.*



*Plate 5.1.2: Broken pieces of limestone and shell fragments embedded in greyish brown sand material*

Within the near-shore marine area, partially submerged limestone flat rock extends for approximately 40m into the sea on the eastern side of the northern coastline. Further out to sea are the submerged coral reefs which are aligned parallel/sub-parallel to the coastline.



*Plate 5.1.3: Partially submerged rock on eastern boundary of shoreline on project site*

#### 5.1.3.2 Soil

Soils are thin to non-existent on the site, with the exception of the coastline area. The back beach on the coastline has an estimated maximum thickness of 1m and the storm bank an estimated 50cm-80cm thick. The elevated platform and the limestone hills in the south have little or no soil cover. The hilly terrain is covered with occasional thin soils, cobblestones and boulder size material.

Based on the Soil Map of Jamaica (Figure 5.1.6) produced by the Rural & Physical Planning Division, the Bonny Gate Stony Loam is the dominant soil type within the proposed site. The Bonny Gate soil type is characterized by its sandy loam texture with high erodibility, very low moisture content and very rapid internal drainage.



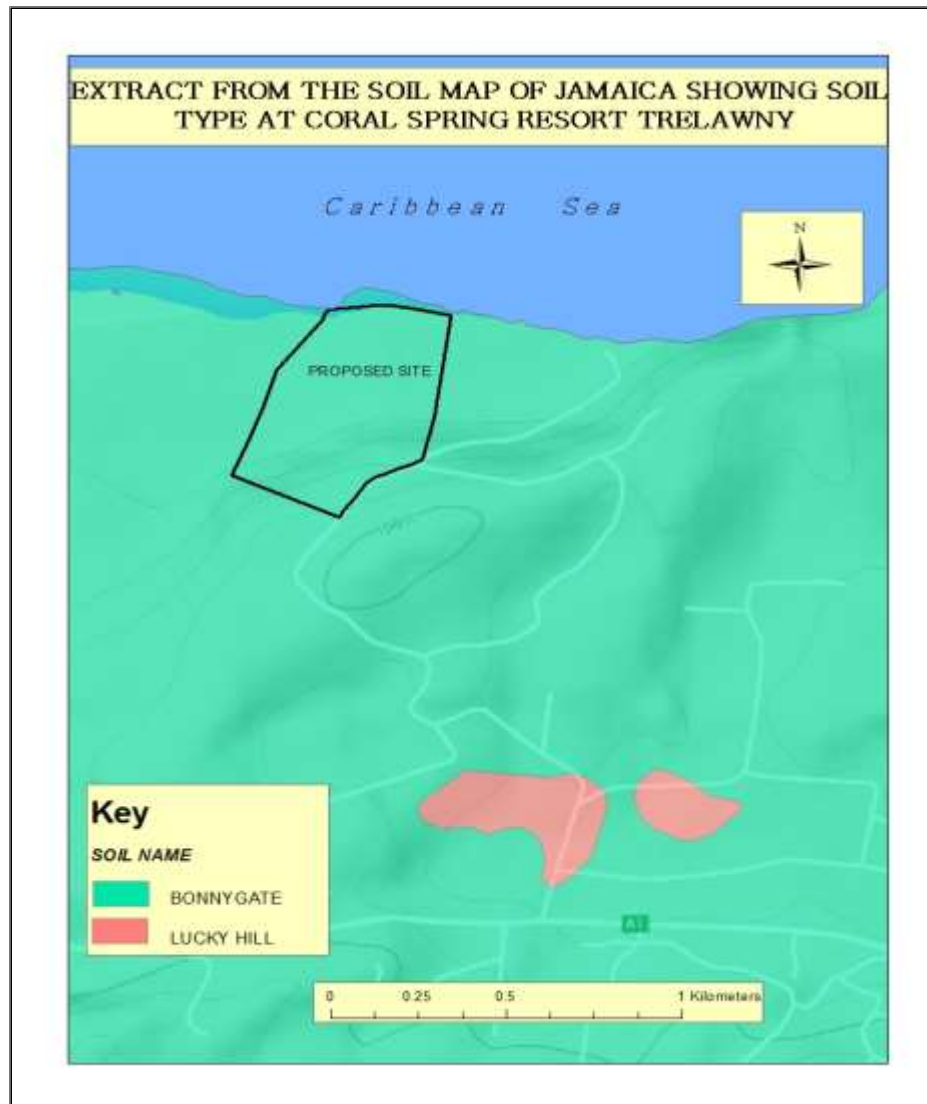


Figure 5.1.6: Soil Map of Coral Spring Hotel site (Source: Rural and Physical Planning Division, Ministry of Agriculture)

### 5.1.3.3 Lithology

The geology of the hotel site and surrounding areas is largely made up of limestone consisting of three different types: the Montpelier Limestone Formation (Mm), the older coastal limestone reefs and marls (Mp) and the younger Coastal Limestone known as the Falmouth Formation (Figure 5.1.7). Additionally, there are surficial deposits on the northern coastline.

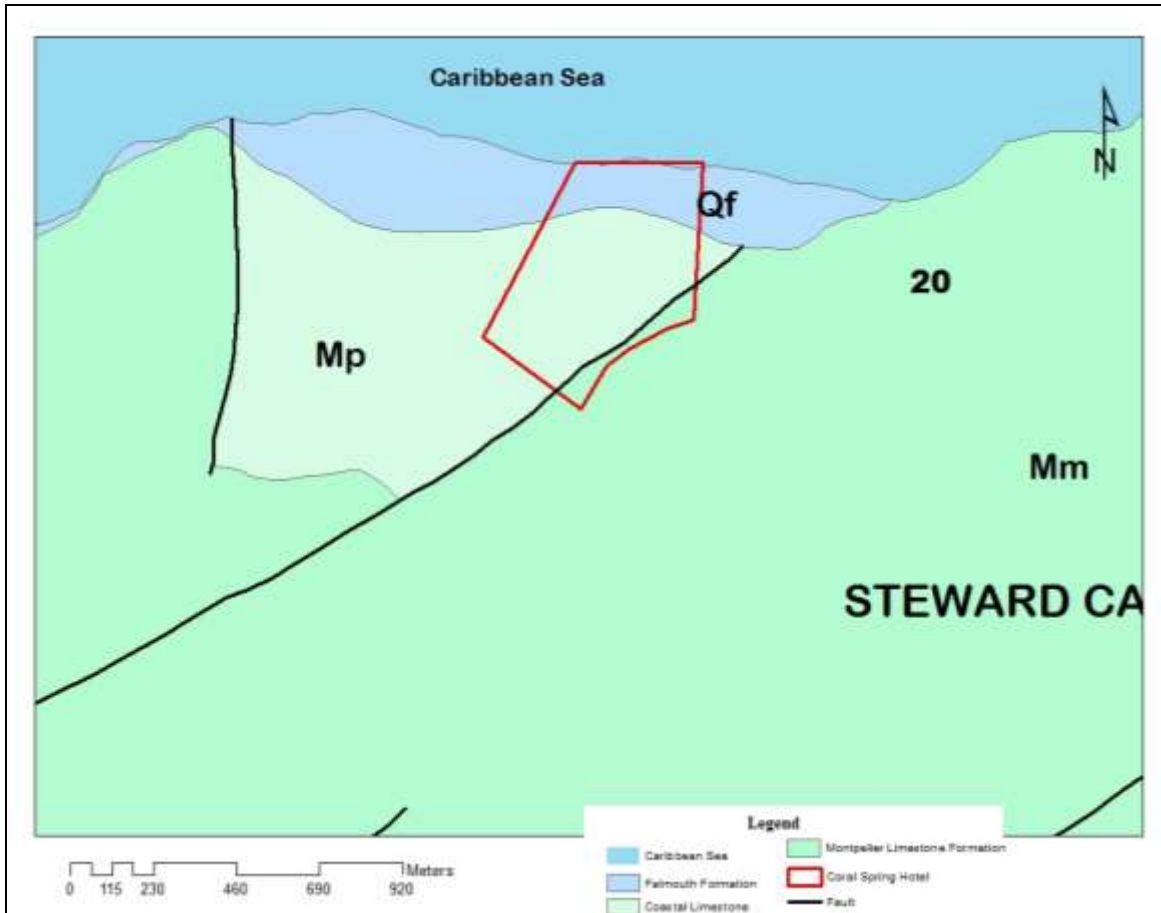


Figure 5.1.7: Geology of Coral Spring Site and surrounding areas (Source: MGD Provisional 1:50,000 Metric Geology Series Sheet 4)

The **Montpelier Limestone** of Miocene age is the youngest of the White Limestone Group. This limestone formation can be described as cream to buff colour moderately soft to moderately hard micrites and marls rich in foraminifera faunal assemblage. This limestone outcrops along the south eastern boundary of the property and forms the major rock formation south and south east of the site. It is the limestone on which the subdued karst landform features have been developed.

The **Coastline Limestone** (Mp) dominates the southern half of the project site and forms the hills and the steep limb of the escarpment. It consists of white to cream, moderately soft, poorly bedded marls, older reef deposits and fossiliferous limestone with a poorly preserved molluscan fauna (Robinson 1958). A NE- SW fault separates the Montpelier Limestone from the Coastal Limestone.

At the site, the ground surface in the hilly area within the older Coastal Limestone is dominated by large and medium size boulders and partly detached limestone on bedrock. On the south western side of the property, massive outcrops (bedrock) were identified but were infrequent (Plate 5.1.4 and Plate 5.1.5).



*Plate 5.1.4: Outcrop of Coastal Limestone near the south western boundary of the site with large open fracture.*



*Plate 5.1.5: Detached rock dominate the hillside in the Coastal Limestone*

The **Falmouth Formation** which forms the Younger Coastal Group is comprised of an elevated reef platform consisting of soft cream to buff colour limestone with well-

preserved fauna of corals and molluscs cemented together and infilled with detrital material (material derived from the weathering of limestone or parent rock) (Robinson 1969). The limestone is often indurated i.e., it forms a hard or solid limestone mass at the surface due to the process of evaporation. This hard mass may occur to depths of a metre, but becomes soft and sometimes fractured at depth. This formation is often found along the coastal fringe of the north coast in the Trelawny, St. Ann and St. James

The Falmouth Formation is to be found on the northern half of the proposed site and forms the flat, low-lying limestone platform (Plate 5.1.6). The pond on the eastern boundary and the Salt Pond to the west of the site are located in the Falmouth Formation.



*Plate 5.1.6: Falmouth Formation as raised reef platform on the site*

**Surficial deposits** (not presented on the geology map) include beach sand and storm debris located on and near to the shoreline of the site. The beach can be described as white carbonate sand consisting of medium course grain sand with varying amount of shell fragments (Plate 5.1.7). Results of a grain size distribution analysis (Table 5.1.2) for the beach sand samples collected at the edge of the beach (waterline) at the project site shows that the sand is poorly graded consisting of medium–fine sand with 25-30 percent silt (Smith Warner International 2009). The beach sand is extensive on the coastline, especially on the northern fringe of the site. A review of aerial photographs and Google images show that the beach sand in the back beach area on the western side of the



shoreline was probably due to recent deposition of sand as a result of a shifting shoreline. This is also backed up by anecdotal evidence.

An investigative report conducted for the Stewart Bay/Coral Spring site by the Mines and Geology Division (MGD) in 2007 indicates that the carbonate sand has a depth up to 1m.

The storm bank is a 0.4m -0.8m thick unconsolidated sediments consisting of a mixture of cobble and pebble size angular rock material and shell fragments embedded in loose grayish brown sandy soil (Plate 5.1.7). The storm bank is extensive on the north eastern section of the site and is observed at varying distances of 8m-21m from the high water mark.



Plate 5.1.7: Beach (carbonate) sand with shell fragments on shoreline

Table 5.1.2: Result of Grain size distribution analysis for the beach sand at Coral Spring site (Source: Smith Warner International 2009)

Name	Description	D50 (mm)	% Gravel ( $\Phi > 4.75\text{mm}$ )	% Sand ( $0.075\text{mm} < \Phi < 4.75\text{mm}$ )	% Silt ( $\Phi < 0.075\text{mm}$ )
Sample #1 Eastern Beach	Poorly Graded Sand	0.23	0.0	73.1	26.9
Sample #2 – Central Beach	Poorly Graded Sand	0.65	5.2	68.5	31.5
Sample #3 – Western Beach	Poorly Graded Sand	0.19	4.0	68.2	31.8





*Plate 5.1.8: Storm bank deposits near the eastern side of shoreline on project site*

#### 5.1.3.4 Geological Structure

Parallel Miocene NE – SW geological faults cut the northern coastline between White Bay and Duncans Bay in the parish, resulting in the displacement the older reefs of the Coastal Limestone. One of the faults cuts across the SE section of the property, which has resulting in a ‘down-throw’ block on the NW (Mines and Geology Division Provisional 1:50,000 Metric Geology Map, Falmouth Sheet 4). A fault scarp has been created as a result of movement along this fault and can be traced to the coastline in the form of a cliff (Plate 5.1.9). Movement along the fault has also resulted in the development of large limestone blocks, boulders and cobblestones that dominate the steep hillside.

There is no evidence to indicate that the fault is active as there is no seismic activity recorded on the fault in recent history.



*Plate 5.1.9: Fault scarp which terminates at the coastline as Carrion Crow Cliff*

#### **5.1.4 Geomorphology**

##### **5.1.4.1 Geomorphic Features**

The project site is made up of a number of distinct geomorphic features. These are: the marine coastline features, a low-lying limestone platform, distinct upland region, the wetland area, storm bank and low karst landform.

##### **5.1.4.2 Marine and Coastline Features**

The hotel site forms a part of Stewart Bay, which is a coastal landform stretching from the Carrion Crow Cliff in the east to the White Bay in the west (Figure 5.1.8). Within the Stewart Bay area are small indentations along the shoreline. The marine area includes beaches, storm berm, cliffs and coral reefs on the sea floor.

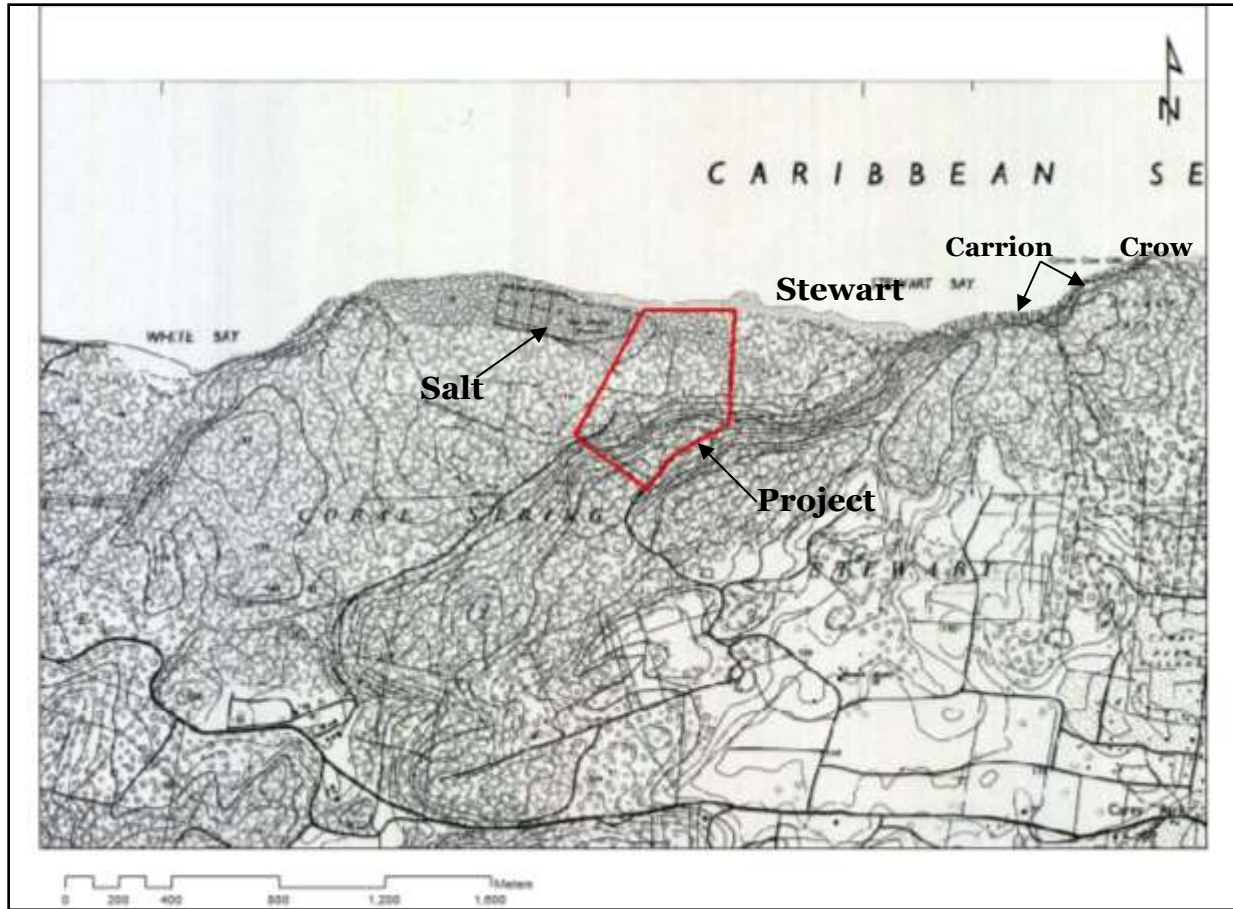


Figure 5.1.8: Map of Project site showing some of the coastal features (Source: 1:12,500 Topographic Map, Sheet 51D)

#### 5.1.4.2.1 Beach Area

The beach area consists of an active beach front and a back beach area. The beach front is the area described as located between the low water mark (LWM) and high water mark (HWM) created by wave action (Plate 5.1.10). The beach face consist of white, well-sorted medium carbonate sand with varying amount of visible shell fragments situated on a gentle slope. Dry sea grass is evident on the beach front, particularly on the eastern section. Measurements taken along the beach front show that its width varies from a low of 5m in the west to a high of 13.5m towards the centre. On the eastern coastline of the site, the average width is 8.5m.

The back beach area consists of greyish brown sand, white carbonate sand and storm debris. The white carbonate sand is dominant at the centre and western section of the site near to the coastline, while the storm debris bank is observed on the eastern section

near to the coastline. The back beach area extends for about 30 -40 m on the eastern side to about 75m-80 m in the centre and for a distance of over 80m from the HWM. This area has sparse vegetation that is mainly covered with patches of grass.



*Plate 5.1.10: Beach front, measuring 8.5m across at its eastern side of the coastline*



*Plate 5.1.11: Back beach area measuring up to 80m inland from the shoreline*

#### 5.1.4.2.2 Storm Bank

The storm debris was brought to its present location by the storm events in the past in which pieces of rock were broken off from the partly submerged rock in the sea caused by



the forces of storm wave action. The storm debris front varies from 8m-21m inland from the HWM and the measures approximately 22m at its maximum width. The storm debris is evident near the eastern section of the site, but is absent on the western section. The total distance of the end of the debris bank from the HWM is approximately 43m at its widest.

The low small shrub land vegetation is dominant on the storm debris and is identified as vegetation re-growth from the more mature sea cotton trees that are in abundance behind the back beach area (Plate 5.1.12).



*Plate 5.1.12: Storm bank with growth of low shrubs consisting of sea cotton*

#### 5.1.4.2.3 Coastal Cliff

The coastal cliffs known as Carrion Crow Cliffs are essentially the linear extension of the hills on the south of the property formed as a result of earth movement which eventually terminates along the coastline approximately 600m east of the project site. The Carrion Crow Cliffs define the eastern boundary of Stewart Bay on the northern coastline.

#### 5.1.4.3 Raised Limestone Platform

The limestone platform stretches from the shoreline for a distance of approximately 400m to the edge of the upland area in the south (Figure 5.1.9). This raised platform is the site for phases 1 and 2 of the hotel development. It consists mainly of flat rock and



carbonate sand. Carbonate sand decreases inland from the shoreline, while the limestone platform stretches further inland to the foot of the hill in the centre.

The vegetation consists mainly of the more mature sea cotton trees that are dominant on the site. Elevation on the raised platform ranges from 1m to approximately 5m above mean sea level. The storm debris partially sits on top of the raised reef platform.



*Figure 5.1.9: Flat to gentle sloping raised platform which stretches from the coastline to the foot of the upland/hilly area in the south.*

#### 5.1.4.4 Wetland Area/Pond

A wetland area/pond is situated on the north-eastern section of the property and extends over into the adjoining lands to the east (Figure 5.1.10). A stone wall forms the boundary which cuts through the centre of the wetland (Plate 5.1.13). Dry mangrove and other vegetation were observed but are relatively sparse within the pond.

This pond is shallow (<0.75m) and brackish, having very thin to non-existent overlying soils consisting of sparse dry trees and shrubs which probably survived in earlier periods (Plate 5.1.14). The pond covers a distance of 107m from north to south and 214m from east to west. On the Coral Spring Hotel property, the size of the pond has an area of approximately 3 acres. The pond extends beyond the property boundary to the adjoining lands to the east.



Figure 5.1.10: Google Image of Coral Spring Hotel showing location of ponds (Source: Google Image 2013)



Plate 5.1.13: Pond is separated by a stonewall which forms the east boundary of site



*Plate 5.1.14: Dried vegetation in the pond on the Coral Spring hotel site*

The pond may have been developed as a shallow depression within the low-lying limestone platform and the source of the water is the high water table which intersects the shallow depression leading to the formation of the pond. The pond may have also been influenced by tidal flows within the limestone as the elevation of the pond at the northern section is 0.8m above sea level and at the southern section 5m above sea level. The permeability of the surface rock at that location has allowed for the sea water barrier to extent within the shoreline.

To the west of the site near the coastline is a large pond which runs almost parallel to the coastline (Plate 5.1.15). This pond, formerly the site for Jamaica Salt Works was used for the extraction of salt in the past. The operation has ceased and the area has remained inactive for many years.



*Plate 5.1.15: Salt Pond located 100m west of the project site*



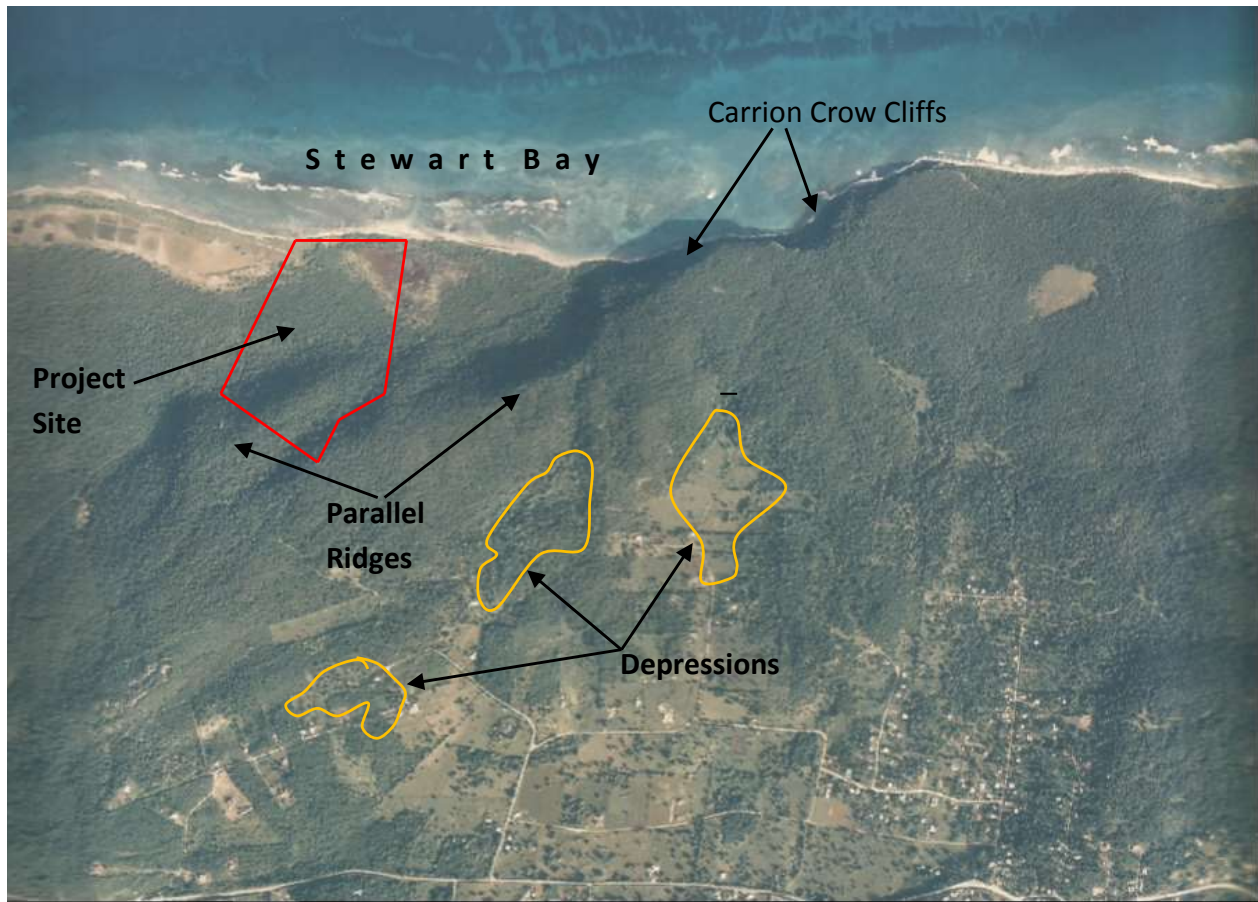
#### 5.1.4.5 Limestone Escarpment

The limestone escarpment consists of a steep scarp slope on the north facing slope and a gentler slope which decreases gradually south of the site. The scarp slope of the escarpment forms the hilly, upland terrain on the project site (Plate 5.1.16), while the southern slope of the escarpment forms poorly developed karst features consisting of low, semi conical hills and limestone depressions. The southern slope of the escarpment is formed outside the boundary of the project site.

The steep-sided slope of the escarpment takes up approximately 40% of the hotel property on its southern section. The land rises from an elevation of 5m to 83m at its highest elevation. There are two NE-SW linear ridges separated by a narrow valley that forms the limestone hills on the site. The smaller ridge dies out before it reaches the shoreline, while the larger and more southerly ridge continues and terminates at the coastline where it forms the Carrion Crow Cliff on the Stewart Bay coastline as it juts out into the sea (Plate 5.1.17).



*Plate 5.1.16: Limestone Hills (Background) which forms the upland area on the south of project site*



Aerial Photograph of Coral Spring area with geomorphic features (1:15,000, 1991 photo)

*Plate 5.1.17: Aerial Photograph of Coral Spring area with geomorphic features (1:15,000, 1991 photo)*

#### 5.1.4.6 Karst Topography

South and south east of the site the landform gradually changes to a poorly developed karst topography consisting of low semi-rounded and elongated hills and moderate to large depressions. The depression closest to the site is at a distance of 350m from its SE boundary. A review of aerial photographs for the Coral Spring area shows that there are a number of the limestone hills that have been truncated by NE - SW geological faults which dominate the area.

There are no karst features located within the site proposed for the development of the Coral Spring Hotel and Resort.



## 5.1.5 Mineral Resource

### 5.1.5.1 Dimension Stone

The Mineral Resource Map developed by the MGD (2015) indicates that the rocks in the area have the potential for use as dimension stone in the industrial mineral sector (Plate 5.1.8).

Dolomitic limestone has been found in the Stewart Bay area and is suitable for dimension stone because of its hardness, colour and ability to take a polish.

### 5.1.5.2 Construction Aggregate

There is a large quarry at approximately 240m east of the site. This quarry supplies limestone aggregate for use in the road and building construction industry in the parish of Trelawny. The Stewart Bay Quarry Zone borders the south western section of the site. The limestone is considered low-grade and can be used as fill-grade material and crushed stone in the construction industry.

At present, there are no quarries in the Stewart Bay Quarry Zone. The site was probably earmarked for such purposes because it is located away from populated areas in order to minimize or eliminate land-use conflicts.



Figure 5.1.11: Mineral Resource Map for the parish of Trelawny. (Source: MGD 2014)

## 5.1.6 Geotechnical Assessment

### 5.1.6.1 Geotechnical Parameters

Site specific geotechnical studies have not been done as yet and therefore general engineering geology is being applied. The developer will undertake detail geotechnical assessment of the site to inform final designs. If the results of the geotechnical studies dictates the need for changes to what is proposed in the permit application; then an application for modification to the permit must be made to NEPA.

The engineering geology characteristics within the different limestone formations is described in general terms, as there is no readily available information on the specific site. It therefore focuses on three main engineering parameters namely; permeability, bearing capacity and Liquefaction potential (Table 5.1.3).

*Table 5.1.3: Engineering Parameters for Limestone Rocks in the Coral Spring Site (Source: Bryce and O'Hara, Bulletin 10, MGD 1982)*

<b>Geological Formation</b>	<b>Permeability</b>	<b>Liquefaction Potential</b>	<b>Presumed Bearing Capacity</b>
<b>Montpelier Limestone</b>	Primary-low Secondary-moderate to high	low	<4000 KN/m <sup>2</sup>
<b>Coastal Limestone</b>	Variable-Low in marls, moderate in vuggy limestone	low	600-2000KN/m <sup>2</sup> depending on presence of clays etc
<b>Falmouth Formation/Raised Reef</b>	variable	low	60-600KN/m <sup>2</sup>

### 5.1.6.2 Bearing Capacity and Building Foundations

In the Falmouth Formation or raised reef, the hard mass may occur to depths of a metre, but becomes soft and sometimes fractured at depth. Slab foundations would be recommended for light to medium structures on a lightly trimmed surface, while for heavier buildings, deep foundations would be recommended (Randel, Palmer and Tritton, 1977).

Plain slab raft foundations will be the preferred option for light structures (1-2 storey buildings) such as the administrative block, gazebos, bars, restaurants, club-houses and store-rooms etc, that are to be found in the raised reefal limestone near the coastline with

a high water table (< 1.5m below existing ground level). Large ground settlements are not anticipated in the earth material which makes slab rafts foundation the suitable choice for the light-weight structures.

The villas which are proposed for phase 3 development will have its foundation loads transmitted in the more competent coastal limestone that has higher presumed bearing pressure values. The type of building foundation will be pad foundations that are expected to bear the structural loads of the villas.

Structural loads for the 5-storey apartment blocks (Phases 1 and 2) are to be transmitted in rocks comprising of the raised reef which has less competent or weak bearing strata with relatively low presumed bearing pressure values based on empirical data. The preferred and most suitable building foundation in this formation is deep foundations consisting of end bearing piles which will carry the heavier structural loads of the apartment blocks for guest-rooms and suites.

Detailed designs for piles (pile length and type of piles) as well as for the different type of shallow foundation (slab raft and pads) will be based on more detailed site-specific geotechnical investigation to guide the process at the building approval stage.

#### 5.1.6.3 Slope Stability

Field investigation conducted on the south western section and south eastern sections of the hilly terrain shows strong evidence of the potential for rock falls. There are many large limestone boulders that are detached/partly detached from bedrock which will increase the risk for rock falls on the hillside. The large boulders are more prominent on the upper section at higher elevations on the slope and there is evidence that a number of boulders perched on the slope come to rest on the trunks of slender trees which prevent them from being mobilized down slope.

Phase 3 of the hotel development is proposed to be located on the moderate to steep slope. During site preparation, vegetation will be removed to clear sections of the land for construction of access roads and the erection of villas as well as a sewage treatment plant.

#### 5.1.6.4 Percolation Test

Percolation tests were not conducted on the site for the following reasons:

- The flat, low lying area on the northern section of the site, particularly in the back beach area has a high water table not exceeding 1 m in most instances.
- Test pits, if dug under these conditions will intercept the water table which would mean the tests could not be conducted.
- The southern section of the property consists of limestone hills of the Coastal Formation. The soils are thin (a few cm) to non-existent. It implies that any excavation or digging for the construction of a test pit would pose great challenges in competent limestone.
- Percolation tests are best conducted in soils (disaggregated particles of earth material) and in the worst case, in soft marls and highly weathered rocks in which there are high levels of decomposition to form soil.

### 5.1.7 Hydrogeology

#### 5.1.7.1 Hydrostratigraphy

The site lies atop the Coastal and Falmouth Formations classified as Limestone Aquiclude Hydrostratigraphic Units (Water Resources Authority Hydrological Database: <http://webmapjam.dyndns.pro/>), comprising a series of elevated reefs. The Montpelier Formation lies along the southern fringe of the project site as well as to the south and east of the site. This geological formation is impermeable and acts as barriers to groundwater flows. The Coastal Limestone and Falmouth Formations however, are even bedded limestones with faults and fractures resulting in high permeability and lower runoff potential. Faulting may create zones of increased permeability which could yield water to wells and springs.

#### 5.1.7.2 Ground Water Resources

The region is highly faulted with a SW -NE trending fault traversing the property. The Stewart Castle Well with depth to groundwater of 50m is located approximately 1.5 km south of the site within the Montpelier Formation which was never commissioned due to lack of groundwater resources. The Springfield and Johnson Pen dug wells sunk to a depth of 26.8m and 11m respectfully are located 3.2km east and 3.3km west of the site (Water Resources Authority Hydrological Database: <http://webmapjam.dyndns.pro/>)



(Figure 5.1.12). The marine environment is contiguous with the northern boundary of the site. The site lies in the Martha Watershed Management of the Martha Brae Hydrologic Basin. The Draft Water Resources Development Master Plan (2005) prepared by the Water Resources Authority indicates that the exploitable yield for the Martha Watershed Management Unit is  $12.7 \times 10^6 \text{ m}^3/\text{year}$ .



Figure 5.1.12: Topographic Map of Coral Spring Site showing nearest well locations

### 5.1.7.3 Drainage

The site is located in the watershed drained by the Martha Brae River. There is no surface water/river close to the site. The presence of the coastal limestone has resulted in much of the overland flows being swiftly diverted into groundwater and overland flow to sea is minimized. The site is located within the North Eastern Subdivision (Duncans) Sub-Watershed Management Unit of the Martha Brae Watershed Management Unit and Hydrological Basin (Water Resources Authority Hydrological Database: <http://webmapjam.dyndns.pro/>). Site assessments along with topographical maps

reviewed have shown that there is no significant feature traversing the site. A depression/pond is observed at the north eastern section of the site. Overlying soils are very thin and in some areas nonexistent within the depressed/pond area.

### 5.1.8 Water Quality

#### 5.1.8.1 Pond

Baseline water quality samplings were conducted on June 1 and June 12, 2016 at four sites within the pond for this project. Two samples were collected on the 8<sup>th</sup> of June 2016 at JAD 2001 coordinate points 689702.891E 704204.47N and 689 784.353 E 704219.626N (Appendix 4). The other samples were collected on June 18, 2016 at JAD 2001 coordinate points 689751.2E 704227.204N and 689 744.569E 704141.953N (Figure 5.1.13).



Figure 5.1.13: Google image of Coral Spring showing location of water quality sampling points

Samples were collected in pre-sterilized bottles acquired from the laboratory, stored on ice and taken to the Scientific Research Council Laboratory for analysis of all parameters. Parameters tested are full chemical analysis to include BOD, Total Hardness, Total Dissolved Solids, Nitrate, Chloride, Iron, Potassium, pH, Conductivity, Total Coliform, Sulphate, Calcium, Manganese, Magnesium and Ammonia-Nitrogen in keeping with approved TOR by the National Environment and Planning Agency.

Results are compared with the NRCA Ambient Water Quality Standard (Table 5.1.4).

*Table 5.1.4: Results of Water Sample Tests*

Parameter	Pond 1 JAD 2001: 689702.891N 704204.47E	Pond 2 JAD 2001: 689784.353N 704219.626E	Pond 3 JAD 2001: 689750.77N 704226.82E	Pond 4 JAD 2001: 689744.569N 704141.953E	NRCA Marine Standard
<b>BOD mg/L</b>	<b>2.8</b>	<b>16.8</b>	<b>22.8</b>	<b>41.3</b>	<b>1.16</b>
<b>Total Hardness mg/L</b>	<b><math>8.22 \times 10^3</math></b>	<b><math>8.51 \times 10^3</math></b>	<b><math>2.10 \times 10^4</math></b>	<b><math>2.18 \times 10^4</math></b>	
<b>Total Dissolved Solids mg/L</b>	<b><math>5.25 \times 10^4</math></b>	<b><math>5.41 \times 10^4</math></b>	<b><math>1.04 \times 10^5</math></b>	<b><math>9.56 \times 10^4</math></b>	
<b>Nitrate mg/L</b>	<b>3.96</b>	<b>2.2</b>	<b>&lt;0.9</b>	<b>6.6</b>	<b>0.014</b>
<b>Chloride mg/L</b>	<b><math>2.64 \times 10^4</math></b>	<b><math>2.64 \times 10^4</math></b>	<b><math>6.60 \times 10^4</math></b>	<b><math>4.21 \times 10^4</math></b>	
<b>Iron mg/L</b>	<b>&lt;0.14</b>	<b>&lt;0.14</b>	<b>&lt;0.04</b>	<b>&lt;0.04</b>	
<b>Potassium mg/L</b>	<b>473</b>	<b>530</b>	<b><math>1.29 \times 10^3</math></b>	<b><math>1.13 \times 10^3</math></b>	
<b>Faecal Coliform MPN/100mL</b>	<b>&lt;1.8</b>	<b>&lt;1.8</b>	<b>&lt;1.8</b>	<b>&lt;1.8</b>	<b>13</b>
<b>pH</b>	<b>8.2@23°</b>	<b>8.4@23°</b>	<b>8.7@21°</b>	<b>8.5@22°</b>	<b>8.5</b>
<b>Conductivity mS/cm</b>	<b>74</b>	<b>76</b>	<b>182.8</b>	<b>189</b>	
<b>Total Coliform MPN/100mL</b>	<b>11</b>	<b>49</b>	<b>&lt;1.8</b>	<b>&lt;1.8</b>	<b>256</b>
<b>Sulphate mg/L</b>	<b><math>3.40 \times 10^3</math></b>	<b><math>3.35 \times 10^3</math></b>	<b><math>7.6 \times 10^3</math></b>	<b><math>7.2 \times 10^3</math></b>	
<b>Calcium mg/L</b>	<b>540</b>	<b>611</b>	<b><math>1.6 \times 10^3</math></b>	<b><math>1.26 \times 10^3</math></b>	
<b>Manganese mg/L</b>	<b>0.13</b>	<b>0.11</b>	<b>&lt;0.04</b>	<b>&lt;0.04</b>	
<b>Magnesium mg/L</b>	<b>767</b>	<b>786</b>	<b><math>2.45 \times 10^3</math></b>	<b><math>2.04 \times 10^3</math></b>	
<b>Ammonia mg/L</b>	<b>1.12</b>	<b>1.18</b>	<b>-</b>	<b>-</b>	
<b>Sodium mh/L</b>	<b><math>1.35 \times 10^4</math></b>	<b><math>1.38 \times 10^4</math></b>	<b><math>4.15 \times 10^4</math></b>	<b><math>3.29 \times 10^4</math></b>	

The water quality within the pond indicates that it is influenced by sea water intrusion through tidal activities. The average concentrations of the major dissolved elements or

ions are similar to those expected within seawater. The two primary indicators for marine water quality are chloride and sodium. The chloride concentration in the pond ranged from 26,400 to 66,000 mg/L and sodium ranged from 13,500 to 41,500 mg/L. The general composition of sea water is expected to be 19,000mg/L for chloride and sodium 10,500 mg/L. The BOD is due to the stagnation of the water and the activities of birds and others wildlife within the pond. The faecal and total coliform levels are very low within the pond.

#### 5.1.8.2 Marine Water Quality

The marine area has indicated good water quality. The historical data has indicated that water quality tests were conducted for the following parameters: Total Suspended Solids (TSS), Biological Oxygen Demand (BOD), Nitrates, Faecal Coliform (FC) and Phosphorus. All parameters except for TSS were within the NRCA recreational water quality standard. The elevated TSS could be attributed to the sediments suspension due to wave action.

Please note that additional information is presented in Section 3.1.2 of the *Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica* (submitted by CL Environmental Co. Ltd, January 2017).

#### 5.1.9 Hydrological Assessment

Please note that additional information is presented in section 2, *Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica* (submitted by CL Environmental Co. Ltd, January 2017).

##### 5.1.9.1 Pre-Development Conditions

The pre-development conditions were assessed by visiting the site and reviewing Google Earth images and the 1:12,500 topographic maps of the area. No significant waterways were observed either on the map or during the site visit. This suggests that storm water sheet flows over the land surface.

The south of the property is characterized by a steep escarpment which forms a ridge line running in a north-east to south-west direction. On the northern side of the ridge where the property is located the land slopes generally to the north and north-west. On the southern side, the land slopes generally to the south-east conveying storm runoff away



from the property. This ridge acts as a buffer from storm runoff from the south of the property and reduces its vulnerability to flooding. Site observations show a thick dense tree canopy of covering the hill bordering the south of the property (Figure 5.1.14, Figure 5.1.15 and Figure 5.1.16). The insets show the location of the picture relative to the project site.



*Figure 5.1.14: Photograph showing hill and coastal plain to the east of the Project site*





Figure 5.1.15: Photograph showing hill and coastal plain to the south of the Project site



Figure 5.1.16: Photograph showing hill and coastal plain to the south-west of the Project site

The 1:12,500 topographic map shows 3 large depressions spread across the toe of the hill which slopes to the south-east. These depressions collect and stores storm runoff from the hill (Figure 5.1.17).

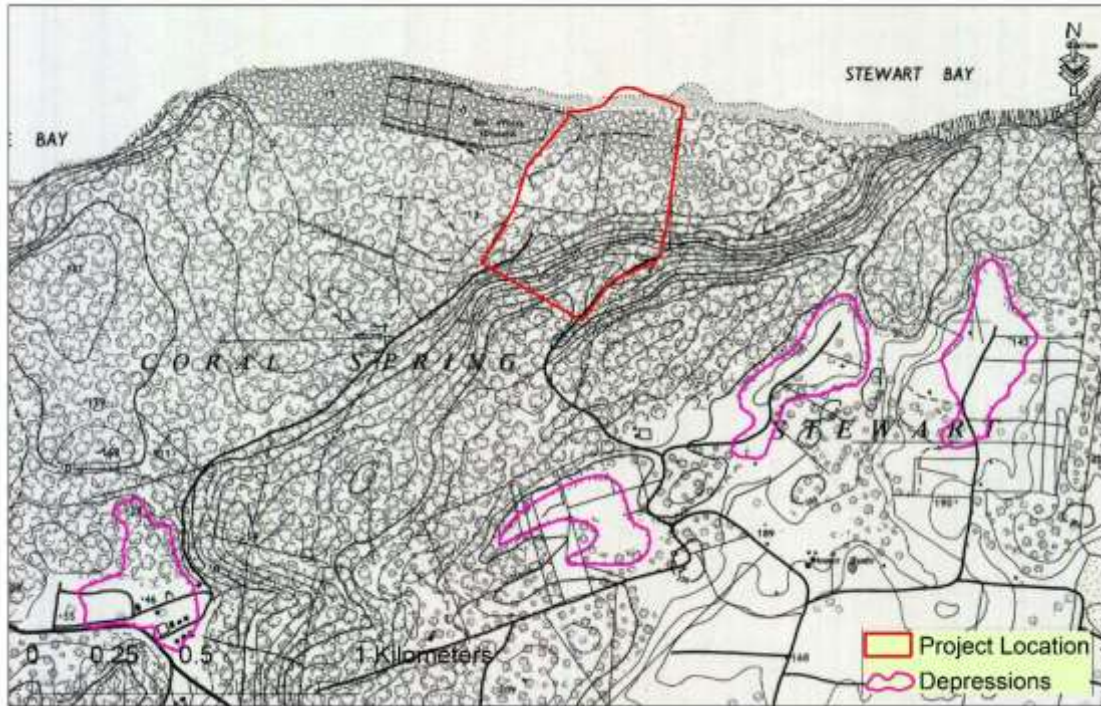


Figure 5.1.17: Map showing depressions around the site to the south and south-west

A fourth depression is located at the end of the ridge to the south-west which collects storm runoff coming from the east and from the south (Figure 5.1.18). The land further south which generally slopes to the north consist of numerous other depressions which collects and stores storm runoff preventing overland flow in the area and towards the property.

The central and northern part of the project site consists of flat coastal plains. This section of the property is characterized by sand and grass and shrubbery, typically found in swamp areas and along the coast (Figure 5.1.19 and Figure 5.1.20). The insets show the location of the picture relative to the project site.

Google Earth images show swamp/pond areas to the west and east of the property (Figure 5.1.21).



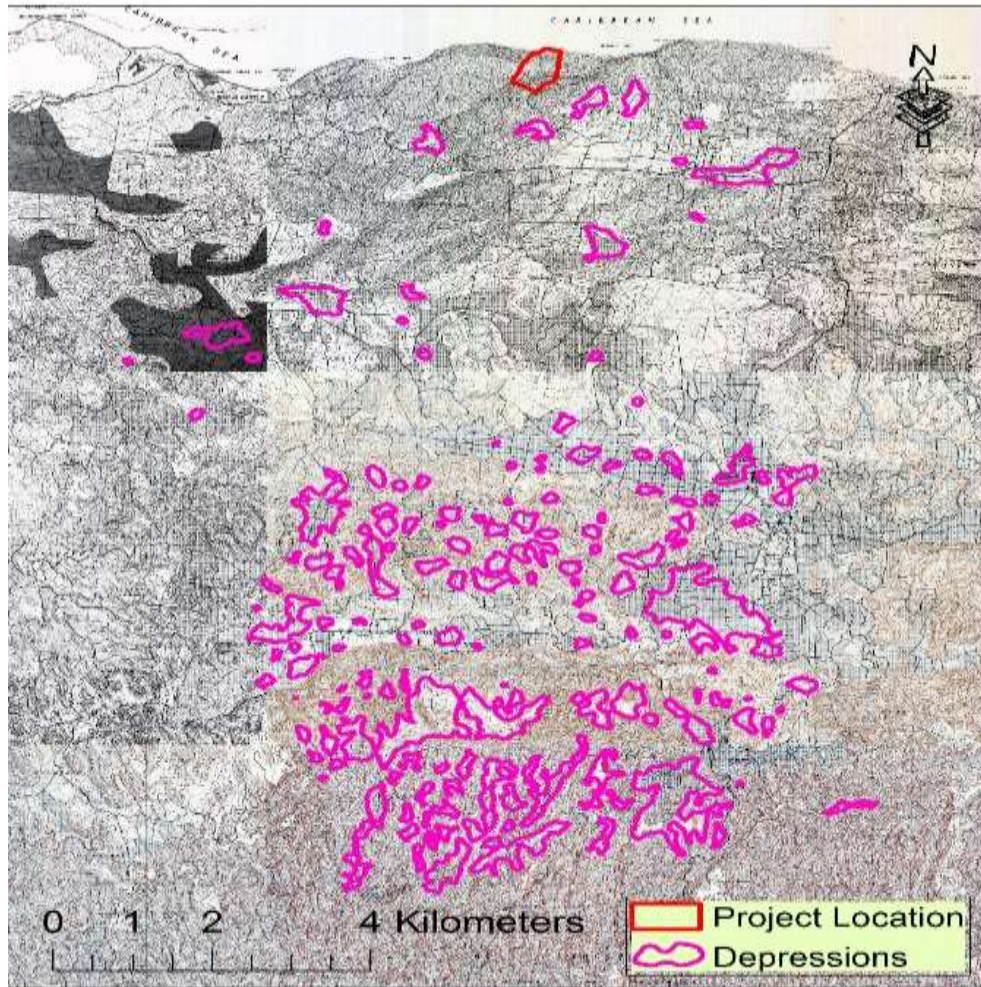


Figure 5.1.18: Map showing numerous depressions to the south of the Project site



*Figure 5.1.19: Map showing coastal plain to the east of the site*



*Figure 5.1.20: Map showing coastal plain to the west of the site*





*Figure 5.1.21: Google Earth image showing pond/swamp area to the east and west of the site*

### 5.1.9.2 Methodology

#### 5.1.9.2.1 Catchment Area Delineation

The catchment areas were delineated manually using the 1:12,500 topographic maps. Flow paths were also delineated manually to show general flow directions. Two main catchment areas were delineated: the catchment area for the Salt Water Works to the west of the property and the catchment area for the Project site. The catchment area for the Project site was further delineated into 4 smaller sub-catchments based on the flow paths. This will allow more accurate assessment of the areas directly impacted by the proposed development. The delineated catchment areas are shown in Figure 5.1.22.



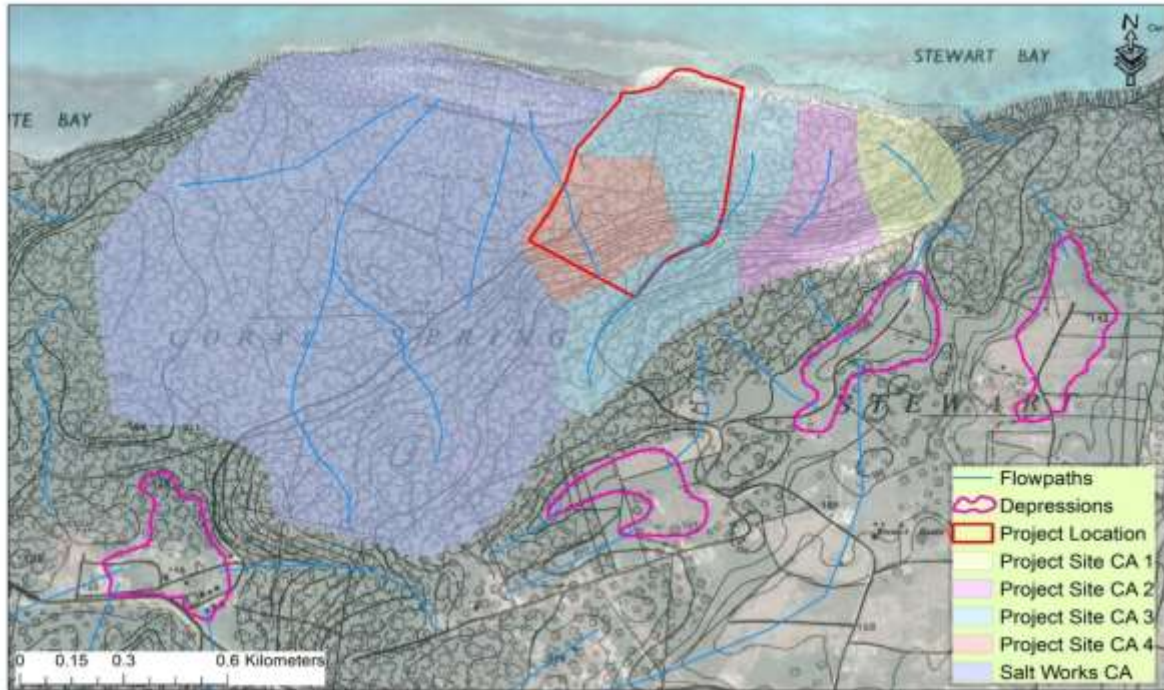


Figure 5.1.22: Map showing delineated catchment areas for the Project site

#### 5.1.9.2.2 Rainfall Data

Rainfall data was obtained from the Meteorological Office 24-hour rainfall database which is based on data collected over a 50-year period between the 1930s and the 1980s. The Duncans, Ettingdom and Lottery rainfall stations which are closest to the Project site that are likely to have the most impact on the site in terms of storm events (Figure 5.1.23). The arithmetic average of these rainfall totals was used in the runoff calculations. The rainfall data used are presented in Table 5.1.5 below.



Figure 5.1.23: Location and spatial distribution of rainfall stations for the project site.

Table 5.1.5: Rainfall data for the Corals Spring area

Rainfall Station	Period	No. of years with missing data	Years of Record	2 year (mm)	5 year (mm)	10 year (mm)	25 year (mm)	50 year (mm)	100 year (mm)
Duncans	1950-86	9	28	64	104	130	164	189	213
Ettingdom	1959-85	4	23	95	138	166	202	228	255
Lottery	1959-85	5	22	117	151	183	223	253	282
Average 24-hour Rainfall Totals				92	131	160	196	223	250

### 5.1.9.3 Runoff Calculations

Based on the size of the catchment areas for the Project site which range from 9 to 36 hectares, the Rational Method was used to estimate the storm runoffs.

The formula for the Rational Method is as follows:

$$Q = 0.0028CiA$$

Where:  $Q$  = peak storm water runoff ( $m^3/s$ )

$C$  = runoff coefficient

$i$  = rainfall intensity (mm/hr)

$A$  = drainage area (ha)

The Velocity Method was used to estimate the time of concentration used in the Rational Method. The Velocity was estimated based on the TR-55 velocity versus slope for shallow concentrated flow diagram (Appendix 5 A) and that runoff is conveyed above ground in natural waterways.

The Montego Bay intensity duration frequency (IDF) regression equations developed by Mr. Ruddy Harrison was used compute the rainfall intensities (Figure 5.1.24). The regression equations allow for the IDF curves to be used with localized 24-hour rainfall totals. A minimum Time of Concentration of 10 minutes was used to determine rainfall intensities.

<b>Table 2-2: Sangster International Airport</b>		
<b>Return Period (years)</b>	<b>Rainfall Intensity in i.p.h. or mm/hr</b>	
	<b><math>t &lt; 60</math> min</b>	<b><math>t &gt; 60</math> min</b>
2	$i = 5.6559 P \times t^{-0.5171}$	$i = 24.8880 P \times t^{-0.8790}$
5	$i = 6.4753 P \times t^{-0.5704}$	$i = 20.5852 P \times t^{-0.8529}$
10	$i = 6.7976 P \times t^{-0.5893}$	$i = 19.2810 P \times t^{-0.8439}$
25	$i = 7.0630 P \times t^{-0.6047}$	$i = 18.2178 P \times t^{-0.8361}$
50	$i = 7.1972 P \times t^{-0.6123}$	$i = 17.6826 P \times t^{-0.8320}$
100	$i = 7.2901 P \times t^{-0.6181}$	$i = 17.2759 P \times t^{-0.8288}$

*i* = Rainfall intensity in inches per hour (inch/hour) or millimeters per hour (mm/hr).  
*P* = 24-hour rainfall in inches or mm  
*t* = rainfall duration in minutes

Figure 5.1.24: Rainfall IDF relationships at the Sangster's International Airports developed by Mr. Ruddy Harrison in 2009

#### 5.1.9.4 Pre-Development Peak Runoffs

The pre-development peak discharges are presented in Table 5.1.6. Runoff coefficients are based on Appendix 5 B.

*Table 5.1.6: Pre-Development Discharges*

Catchment Area	Area (ha)	Watershed Slope (m/m)	Runoff Coeff.	Runoff Coefficient Surface Type Description Table 2, HEC 12	Shallow Concentrated Flow Velocity (m/s)	Watercourse Length (m)	Time of Concentration (mins)	Intensity (mm/hr)	Peak Discharge (cms)
<b>Pre-Development - 2 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	147	1.1
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	113	1.2
Project Site CA 3	36.0	0.10060	0.30	woods (max. value)	0.243	1004	68.9	58	1.8
Project Site CA 4	14.0	0.39175	0.30	woods (max. value)	0.480	194	6.7	158	1.9
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	39	2.7
<b>Pre-Development - 5 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	210	1.6
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	157	1.7
Project Site CA 3	36.0	0.10060	0.30	woods (max. value)	0.243	1004	68.9	76	2.3
Project Site CA 4	14.0	0.39175	0.30	woods (max. value)	0.480	194	6.7	228	2.7
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	49	3.4
<b>Pre-Development - 10 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	256	1.9
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	190	2.1
Project Site CA 3	36.0	0.10060	0.30	woods (max. value)	0.243	1004	68.9	90	2.7
Project Site CA 4	14.0	0.39175	0.30	woods (max. value)	0.480	194	6.7	279	3.3
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	57	4.0
<b>Pre-Development - 25 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	315	2.4
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	232	2.5
Project Site CA 3	36.0	0.10060	0.30	woods (max. value)	0.243	1004	68.9	107	3.2
Project Site CA 4	14.0	0.39175	0.30	woods (max. value)	0.480	194	6.7	345	4.1
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	68	4.7
<b>Pre-Development - 50 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	359	2.7
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	263	2.9



Catchment Area	Area (ha)	Watershed Slope (m/m)	Runoff Coeff.	Runoff Coefficient Surface Type Description Table 2, HEC 12	Shallow Concentrated Flow Velocity (m/s)	Waterc ourse Length (m)	Time of Concent ration (mins)	Intensity (mm/hr)	Peak Discharge (cms)
Project Site CA 3	36.0	0.10060	0.30	woods (max. value)	0.243	1004	68.9	120	3.6
Project Site CA 4	14.0	0.39175	0.30	woods (max. value)	0.480	194	6.7	393	4.6
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	75	5.2
Pre-Development - 100 Year Storm									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	401	3.0
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	293	3.2
Project Site CA 3	36.0	0.10060	0.30	woods (max. value)	0.243	1004	68.9	133	4.0
Project Site CA 4	14.0	0.39175	0.30	woods (max. value)	0.480	194	6.7	439	5.2
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	83	5.7

### 5.1.10 Existing Pollution Sources

Informal dumping of plastic bottles and other solid waste occurs along the coast near to the start of the vegetation, about 60m from shoreline.



Plate 5.1.18: Oblique aerial drone photo showing disposal of plastics in vegetated area on the proposed site (Photo Credit: CL Environmental Co. Ltd., 17 Nov 2016)

### 5.1.11 Solid Waste Management

NSWMA is responsible for solid waste management in the area; the nearest NSWMA operated dump site is in St. James at the Retirement Dump (~ 32 km west of project site).

## 5.2 Ecological Carrying Capacity

Wikipedia.org defines the carrying capacity of a biological species in an environment as “the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment”. By extension, the ecological carrying capacity is therefore assumed to be the maximum number of assemblages of both floral and faunal species that can be sustained within the boundaries of a location, through the interactions between both lifeform types and the supporting physical environment present. This statement is somewhat corroborated by Wang (2010)<sup>1</sup>, who has indicated that “ecological carrying capacity is the capacity of self-maintenance and self- regulation.....the accommodating ability of resources and environmental subsystems...”.

In conducting an ecological carrying capacity for the project area, one would have to determine what the carrier of importance is. The land space and its physical, climatic, hydrological and geochemical characteristics lead it to support particular floral assemblages. As a consequence, one could examine the carrying capacity of the land to support the floral ecology of the project area. Similarly, the floral assemblage provides support for faunal assemblages and, as such the character of the forest of the study area would influence its ability to support various faunal assemblages.

Numerous models for the calculation of carrying capacity exist and all require specific types of inputs for the calculations – whether by inputs into formulas or into specifically designed software. An example, which will be summarized below is the Logistic Growth Model<sup>2</sup>, which calculates carrying capacity as the numbers of a particular resource per carrier area.

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<sup>1</sup> Xilian Wang Research Review of the Ecological Carrying Capacity Journal of Sustainable Development Vol 3, No. 3. September 2010.

<sup>2</sup> <https://services.math.duke.edu/education/ccp/materials/diffeq/logistic/logi1.html>

For the purpose of simplicity, the floral assemblage at the study area will be examined as the ecological carrier and avi-fauna will be examined as the “carried population”. A crosssectional width of search for birds as 8 meters (section 5.4.1.2.1). Figure 5.4.10 (Accessible Survey Areas Examined for Birds and Butterflies at the Study Site) outlines the linear path traversed for the bird survey – calculated at 1800 meters. Therefore, the survey area for birds visually detected during the study period was 14,400 square meters (14.4 hectares).

Table 5.4.4 (List of the Types of Birds Observed at the Site) lists 91 birds that had been observed over the 14.4 hectares of vegetated area surveyed. Assuming homogeneity of bird distributions over the entire site and bearing in mind that the site is approximately 30 hectares in area, simple proportion calculations would suggest that 189 birds would be present over the entire study site – or 6 birds per hectare at the specific time of observation. This is probably a gross overall underestimation because of limited ability to survey populations off cleared tracks and temporal variations in numbers, but it does hint to a quantifiable value for a particular feature dependent on the carrying resource.

Please see section 4.0 in the *Addendum to The Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica* (submitted by CL Environmental Co. Ltd, January 2017) for further information regarding the ecological carrying capacity of the proposed project.

## 5.3 Natural Hazards

### 5.3.1 Shoreline Changes

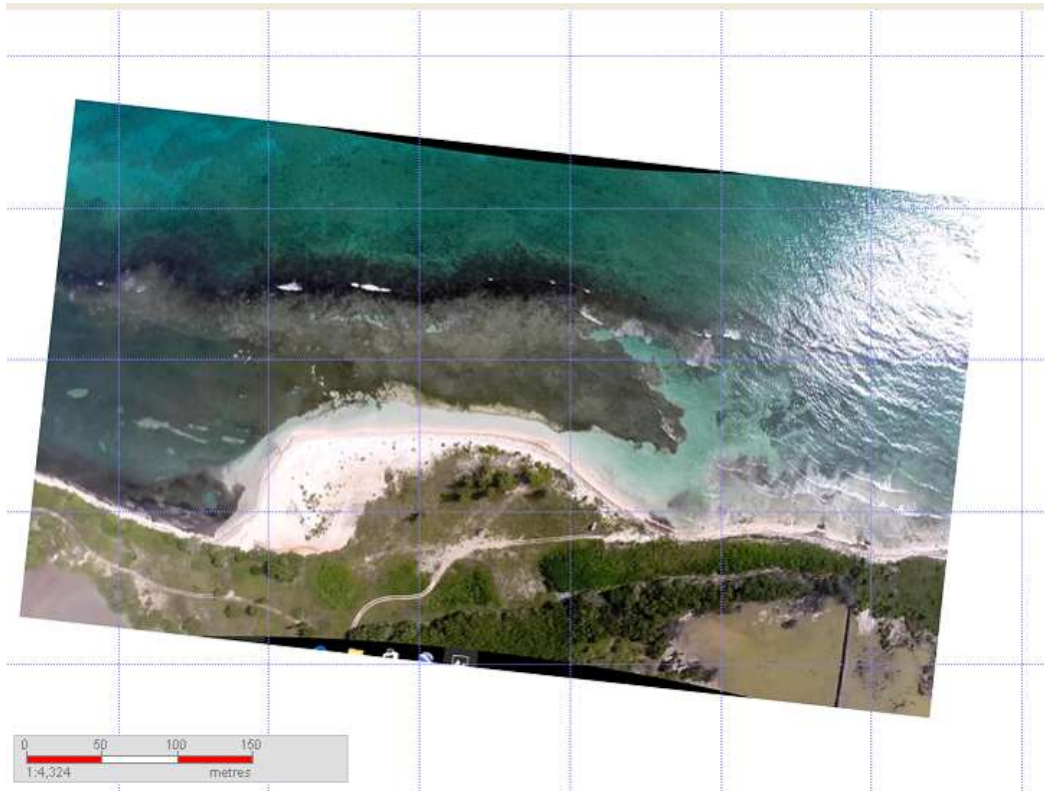
Google Earth images of the location dated 2003, 2005, 2009, 2010 and 2013 were referenced to the JAD2001 coordinate system using a Geographical Information System software<sup>3</sup>. After referencing, the Google Earth images were then used for the determination of shoreline change on the shoreline at the site. A higher resolution aerial image data set was captured for near-shore areas of the property in 2016 using a DJI

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<sup>3</sup> www.mapmaker.com

Phantom II Quadcopter remotely operated camera system flown at an elevation of 200 meters.

All geo-referenced imagery were then inputted into a geographical information system, where the various shorelines exhibited over the years were then examined for variations.



*Figure 5.3.1: Low Altitude Vertical Aerial View of the Coastal Area of the Proposed Development Site.*

Cross-section measurements of the existing beach area were obtained as a basis for comparison with future measurements. Field data was obtained with the use of a tape measure and a Clinometer to measure vertical angles between two positions across the beach along which a significant change in gradient has occurred (Figure 5.3.2). The distances and angles obtained were then inputted into Beach Profile Analysis (Version 3.2) software<sup>4</sup> for the calculation of the shoreline cross section (Figure 5.3.3). Positional data for field information was collected with a Garmin GPS Map 60CSx hand held global

<sup>4</sup> Developed for the Coast and Beach Stability in the Caribbean (COSALC) Project by UNESCO and the University of Puerto Rico – January 2000.



positioning system (GPS), with waypoint and track information being managed through Garmin Map Source software.

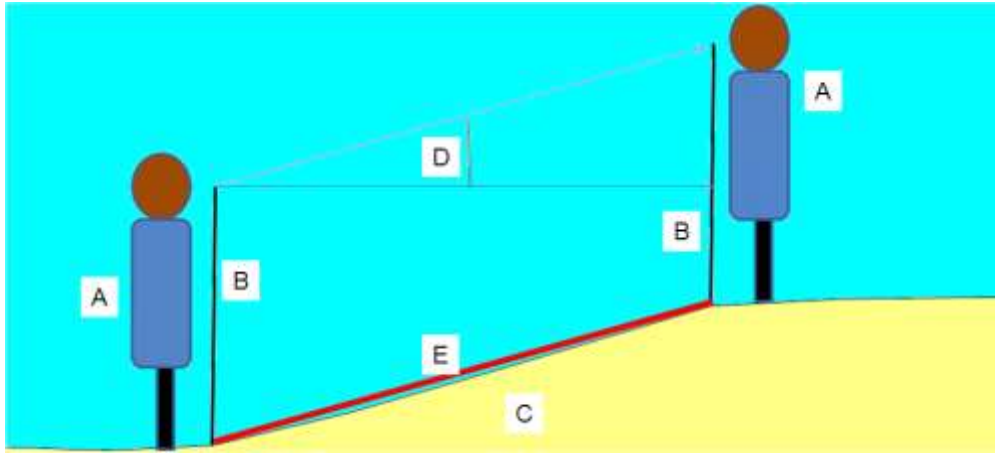


Figure 5.3.2: Representation of Data Collection Process for Cross-section

Measurement A: observers, B: standard height for clinometers measurement, C: area of significant angle change, D: angle of change measured with clinometers, E: distance over which change occurred.

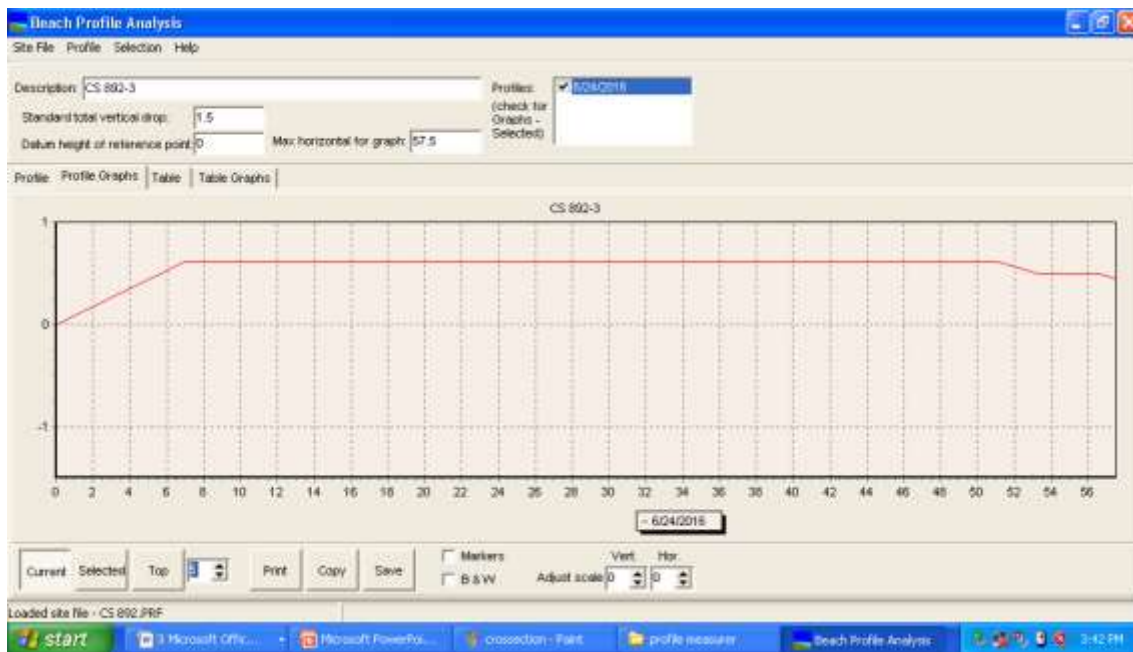


Figure 5.3.3: Screen-shot of Beach Profile Software.

#### 5.3.1.1 Beach Cross-sections

Figure 5.3.4 along with Plate 5.3.1 through to Plate 5.3.4 illustrates shoreline cross sections measured across the shoreline present within the property's coastal boundary. In light of the fact that there were no pre-existing cross section information for comparison, these cross sections are being represented as a baseline for future shoreline stability comparisons.



*Figure 5.3.4: Location of Shoreline Cross Section Measurement Sites at the Development Site.*

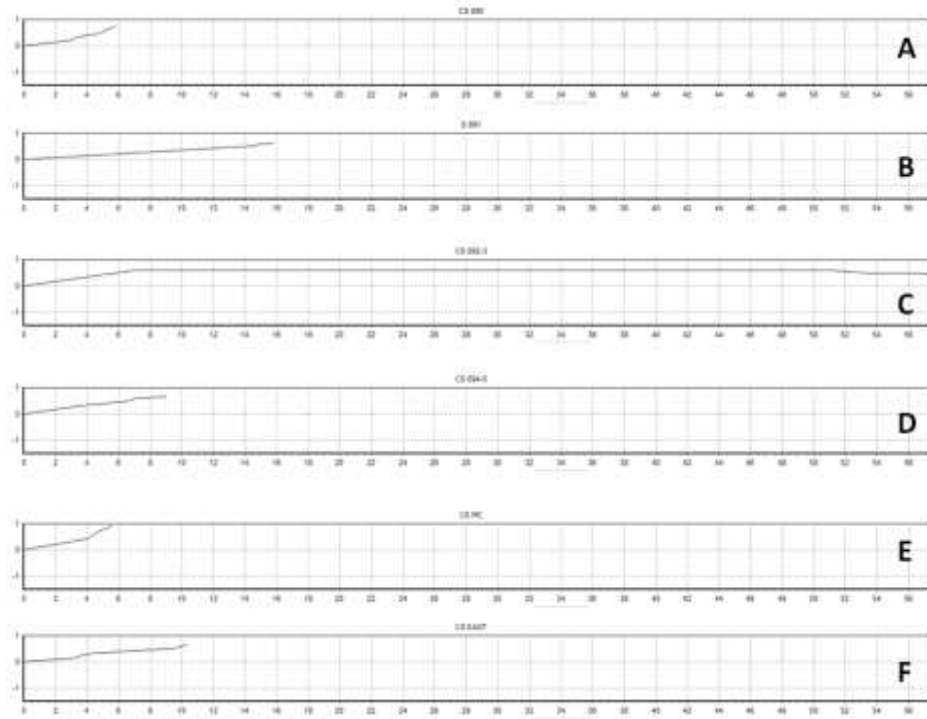


Figure 5.3.5: Shoreline Cross Section Measurement Sites at the Development Site (drawn to similar scales for comparison).



Plate 5.3.1: Image Taken Perpendicular to the Orientation of Cross Section A



*Plate 5.3.2: Image Taken Perpendicular to the Orientation of Cross Section B (foreground), with Cross Section C in the Background (red line)*



*Plate 5.3.3: Image Taken Perpendicular to the Orientation of Cross Section D*





*Plate 5.3.4: Image Taken Perpendicular to the Orientation of Cross Section E (mid foreground) and F (background)*

Though there were no references for temporal comparison, it was obvious that extensive shoreline de-stabilization had occurred in the vicinity of cross section E.

#### 5.3.1.2 Temporal/Spatial Shoreline Change:

Figure 5.3.6 shows shoreline positions existing in 2003, 2005, 2010 and 2013 overlaid on top of a June 2016 image of the coastal area and shoreline within the boundaries at the proposed development site. Additionally, Figure 5.3.7 summarizes the overlaid shorelines down to those that represent the most significant changes in shoreline orientation over the period 2003-2016. Thus, the shorelines present in 2003, 2013 and 2016 are represented.

Both figures represent a significant increase in the width of the beach area extending from the eastern to the central section of the property's shoreline. However, in 2016, the shoreline showed a significant shift in what can be described as a sandy shoreline prominence towards the western property boundary. A corresponding reduction in the width of the beach area was represented approximately 100 meters west of the eastern property boundary (as illustrated on Figure 5.3.8). This significant shift in the orientation and width of the beach area occurred between the periods of 2013 - 2016.



Figure 5.3.6: Shoreline Positions Existing in 2003, 2005, 2010 and 2013 (black lines) Overlaid on top of June 2016 Aerial Imagery



Figure 5.3.7: Shoreline Positions Existing in 2003, 2013 and 2016 Overlaid to Illustrate Shoreline Change



Figure 5.3.8: Areas of Significant Shoreline Accretion and Erosion Occurring Between 2013 and 2106.

It is estimated that 0.7 hectares of new beach area was deposited on the west shoreline and approximately 0.24 hectares of beach area lost over the period 2013-2016. Since the hurricane records show no significant tropical disturbances affecting the area over the period, it can only be concluded that the sudden shoreline variations occurred due to the effects of winter storm events removing sediments from the eastern end of the property shoreline and depositing the sediments on the western end.

Both Figure 5.3.9 and Figure 5.3.10 help to point to the possible reasons that facilitated the westerly shift of sediments along the shoreline. Water movement observations conducted at the site strongly suggest a westerly long-shore movement of currents and marine sediments across the property boundaries.

Figure 5.3.9 shows that the seafloor area immediately adjoining the eastern boundary is the deepest area immediately offshore of the eastern and western property boundaries at the site. This area is also the least protected from the onset of wave action, as illustrated in Figure 5.3.10, where significant wave crest presence is seen at the areas highlighted in red, while no such waves exist in the lee of reef areas to the west.

It is theorized that a significant wave event with winds blowing from the north or north east may have resulted in strong waves pushing through the eastern gap in both reefs and seagrasses and impacting on the shore in the vicinity of Cross Section E (see Figure 5.3.5 above). This impact resulted in the erosion of the shoreline seen at this vicinity. Westerly movement of currents resulted in the eroded materials being transported westerly behind the lee of the reef area and depositing itself on the western end of the existing sand deposits (illustrated as the shoreline present in 2013), thus creating the new area of beach sand now seen in 2016.



*Figure 5.3.9: Spatial Representation of Depths Existing within 100 meters of the Development Site*



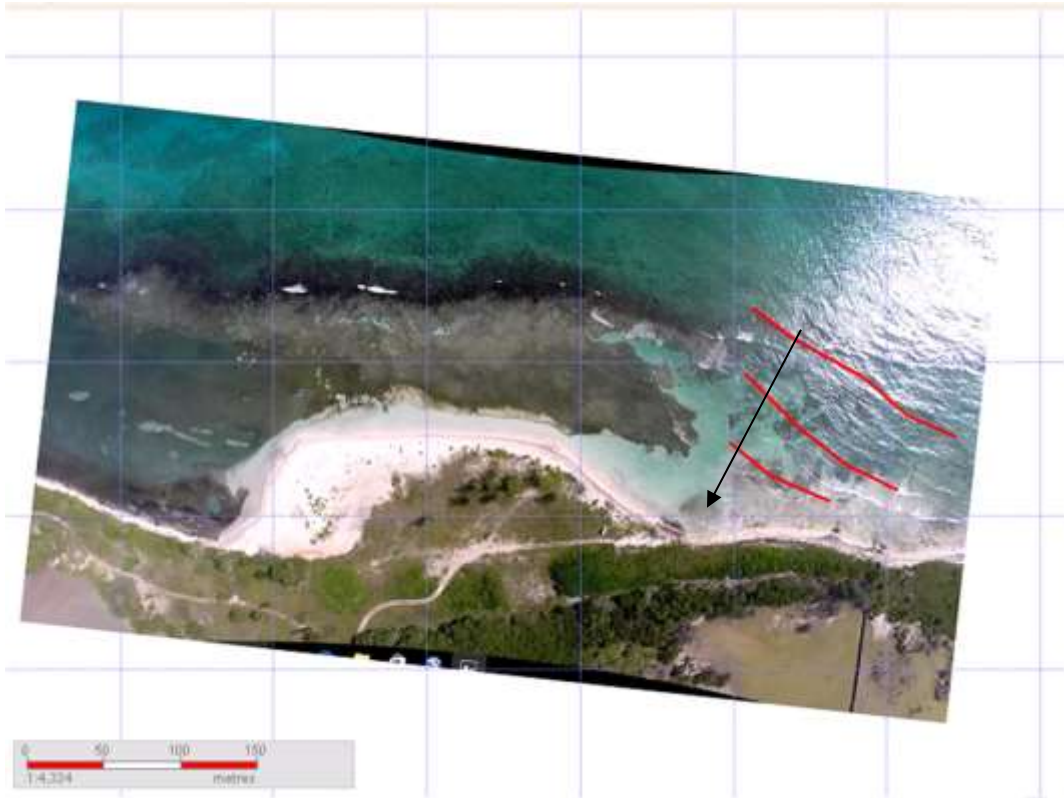


Figure 5.3.10: Illustration of Presence and Direction of Heavy Swells at the Shoreline of the Proposed Development Area (red lines represent swells. Swell movement direction = black arrow).

#### 5.3.1.3 Development Implications

It is therefore concluded that the shoreline within the boundaries of the development site has experienced significant alterations over the period 2003 to 2013, with significant alterations occurring during the periods 2009 (when the first extensive shoreline accretion was observed on Google Earth images) and between 2013-2016. It is possible that the shoreline changes seen occurred as a direct result of an intense wave event that catapulted the movement of marine sediments from sources east of the boundary (as theorized for the 2009 event) and within the boundaries for the 2013-2016 event.

The current change is of great relevance because it suggests that erosion is evident at the east side of the property shoreline, a situation that may have to be addressed not only from the perspective of arresting the immediate recession seen, but also preventing further recession. Considerations may have to be made to the reduction of wave energy impacting on the property's eastern shore.

## 5.3.2 Flooding

### 5.3.2.1 Coastal Flooding/Storm Surge

#### 5.3.2.1.1 Storm Surge Assessment (Modeling Method)

A storm surge analysis for Coral Spring was conducted by Smith Warner International in September 2009 as part of a 'Preliminary Coastal Engineering Report for Coral Spring, Trelawny' to assist with the design of engineering works for coastal and marine development. The analysis utilized hurricane database from National Oceanographic and Atmospheric Administration (NOAA) to identify hurricanes that pass within a radius of 200km from Jamaica. From the hurricanes identified, a wave directional analysis was conducted to include waves from hurricanes that were generated from the NW, N, NE and E directions that were included in the model. A 50-yr return period was used for storm wave design as this is the considered standard design life for coastal and marine structures.

Parametric models were used to determine wave heights in deep water (>200m depth), while the Simulation Wave Near-shore (SWAN) model used to transform the deep water wave conditions to near-shore wave conditions. From the model, maximum wave heights and static storm surge were calculated from all four wave directions. Maximum wave heights and static storm surge were determined to be 1.2m and 1.6m respectively based on storm analysis.

Wave run-up and inundation levels were also computed using a special programme. A wave run-up occurs when the wave breaks near the shore and a part of the wave energy runs up the face of the beach or inland area. A wave run-up of 1.7m and inundation levels of 3.3 m were computed for the Coral Spring site (Figure 5.3.11). The Coral reef off the coastline is thought to be a good protection for the coastline as the reef helps to break the wave energy for storm waves heading to the shore.

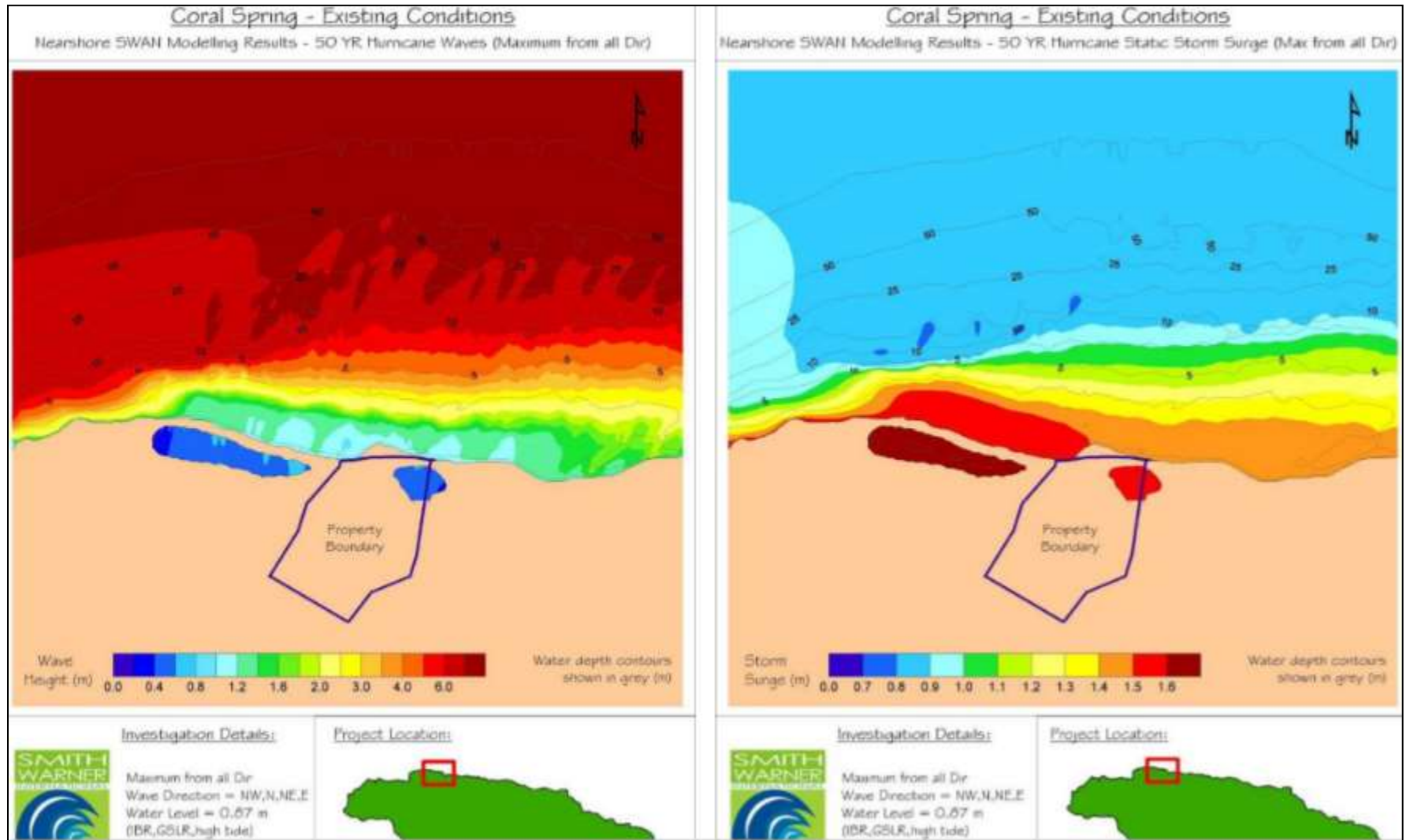


Figure 5.3.11: Overview of a). Wave Heights and Direction and b). Storm surge for 50 yr return period for Coral Spring Site. (Source Smith Warner International 2009)

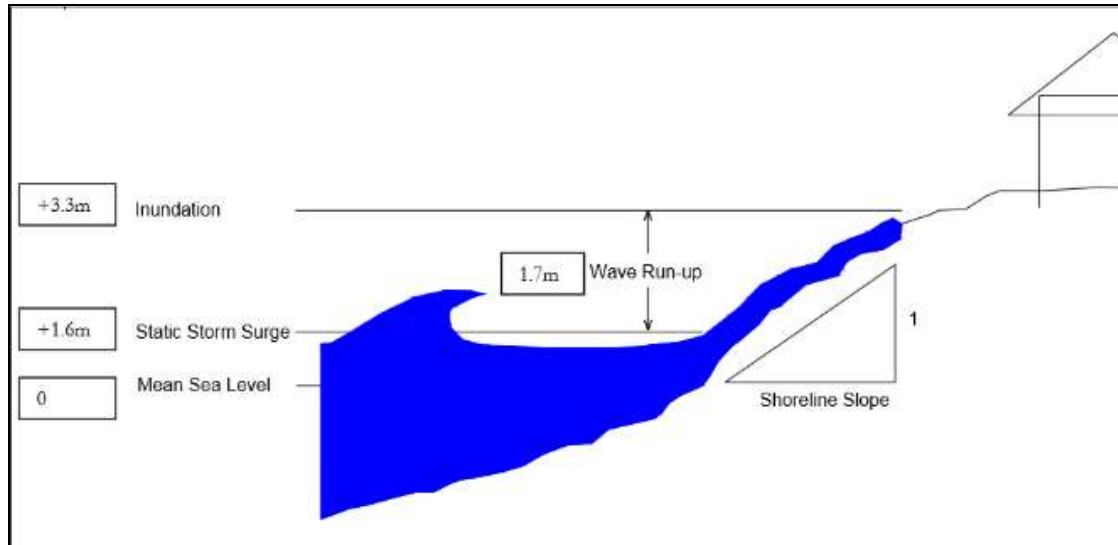


Figure 5.3.12: Wave Inundation levels for 50-yr storm at Coral Spring, Trelawny (Source: Smith Warner International - 2009)

#### 5.3.2.1.2 Storm Surge Assessment Based on Field Evidence

Evidence of storm debris near to the shoreline on the eastern section of the site suggests that storm events would have brought debris from the sea and deposited near the shoreline as a result of high wave action. A Storm Surge Damage Assessment Report prepared by Wilmot Simpson et al (MGD 1980) following the passage of Hurricane Allen in August 1980 estimate storm surge heights and maximum run-up distances of 1.25 m (5 ft) and 18m (60ft) at Silver Sands-Duncans, (4.7 km east of project site) and 1.8m and 136m at Falmouth in Trelawny, respectively. There is also evidence of a concrete residential structure near to the western boundary on the coastline which was destroyed by wave action (Figure 5.3.13). Anecdotal evidence suggests that the house was destroyed by Hurricane Allen in August 1980. The hurricane passed between Jamaica and Hispaniola as a Category 4 and caused significant damage to Jamaica's northern and north eastern coastline.

At the Coral Spring hotel site, the storm berm has a maximum measurement of 43m from the high water mark to the back end of the berm. The site layout plan for the hotel proposes a setback distance of 30 m from the high water mark. A summary of the storm surge for Coral Spring and other nearby coastal communities in Trelawny is provided in Table 5.3.1.



A review of the Google Image 2013 shows Coral Reef offshore which stretches parallel to the coastline across the marine sea floor; however, there is breach or opening in the Coral Reef at approximately 70m from the coastline (Figure 5.3.14). One of its functions is to act as a storm barrier during high wave action that may result from a storm event. The opening in the Coral Reef offshore corresponds to the presence of storm berm on the north eastern side of the property and its absence on the north western and central areas inland from the shoreline. The Coral Reef in this instance acted as a barrier to storm wave action, except for the north eastern section where it resulted in a storm bank caused by a breach in the reef structure.

*Table 5.3.1: Summary of Storm surges for Coral Spring and other Coastal Communities in Trelawny*

<b>Community</b>	<b>Surge Height (m)</b>	<b>Inundation (m)</b>	<b>Storm Event</b>	<b>Method</b>
Coral Spring	1.6	3.3	Storms within 200km radius	Storm surge Modeling
Coral Spring	?	43	Hurricane Allen	Field Evidence
Silver Sands	1.25	18	Hurricane Allen	Field Evidence
Falmouth	1.8	136	Hurricane Allen	Field Evidence



*Figure 5.3.13: Remains of residential structure destroyed by Hurricane Allen –August 1980*



Figure 5.3.14: Coral Reef stretching across the seafloor with a gap in the reef structure

#### 5.3.2.2 Inland Flooding

Potential for inland flooding is expected to be on the eastern side of the site in area around the pond/wetland. The pond straddles the hotel site on the east as well as the adjoining property. As part of the hotel development, this area will be modified by draining the pond, removing the soft mud and organic silt at the base of the pond and then place with approved aggregate and compacted to specifications for construction purposes. Flooding associated with the pond would therefore be eliminated provided site modification is extended beyond the eastern boundary.

#### 5.3.2.3 Slope Stability/Rockfall Potential

A review of the 1:15,000, 1991 aerial photographs for the Coral Spring site reveals that there are no landslides evident on the faulted slope on the southern section of the site. However, field investigation conducted on the south western section and south eastern sections of the hilly terrain shows strong evidence of the potential for rock falls. There are many large limestone boulders that are detached (Plate 5.3.5, Plate 5.3.6) and partly detached from bedrock that result in an increase in the risk for rock falls on the hillside. The potential for rock falls is exacerbated by the fact that phase 3 of the hotel development is proposed to be located on the moderate to steep sided slope. Development on the

hillside will include construction of access roads and the erection of villas as well as a sewage plant.

The large boulders are more prominent on the upper section at higher elevations on the slope and there is evidence that a number of boulders perched on the slope come to rest on the trunks of slender trees which prevent them from being mobilized down slope.



*Plate 5.3.5: Large boulder on the scarp slope near the south eastern boundary of site*



*Plate 5.3.6: Large boulders on the south western side of the limestone hills in the south*

### **5.3.3 Erosion Potential - Qualitative and Quantitative Assessment**

#### **5.3.3.1 Qualitative Assessment**

Erosion potential for the site will be presented based on a quantitative and qualitative assessment. The use of soil loss equation as the methodology for quantitative assessment will be presented, while the geomorphological and geological processes that affect erosion will be identified as the basis for qualitative assessment.

##### **5.3.3.1.1 Coastal/Beach Erosion**

Two areas are highlighted that has shown evidence of erosion or has the potential for erosion. These are the coastline and the hilly, upland area.

The 2013 Google Image was compared with present morphology<sup>2016</sup> of the coastline, based on a recent site inspection. It shows that there are areas of erosion and deposition/accumulation of sediments on the coastline on the site. Coastal sediments are eroded on the eastern side of the shoreline (Plate 5.3.7), is transported by the sea currents and deposited on the western side. The coastline at the site is dynamic based in the episodes of erosion and deposition at short distances along the shoreline. This has resulted in a change in morphology as a result of erosion on the east and deposition on the west along the coastline at the site. This coastal dynamic has been corroborated by residents with knowledge of the area, which suggests that deposition of beach sediments on the western side has been recent.

Additionally, over 2,500 m<sup>3</sup> of beach sand was illegally removed from the site at Coral Spring (MGD 2008) leaving behind large troughs, the largest measuring 100m in length and 20m in width. It is estimated that over 500 truck- loads of sand were removed. At present, the site has been filled by deposition of beach sand which migrated from the eastern side of the coastline and beyond due to erosion.





Plate 5.3.7: Erosion of coastline sediments on the eastern side of the shoreline on the site



Plate 5.3.8: Google Image (2013) depicting areas of beach erosion and accumulation on the project

#### 5.3.3.1.2 Erosion Potential in the limestone Hills/Scarp Slope

Clearing of land will be carried out to facilitate the construction of villas on the hillside. This is expected to be kept to a minimum. In addition to large limestone boulders, there are abundant cobble size limestone rocks which can be eroded during storm events (Plate

5.3.9). There is no evidence of drainage features on the slope as most of the storm water penetrates the fractures in the limestone. However, during severe rainstorm, loose boulders and cobblestones will be removed from the upper slope by storm water and deposited near the foot of the slope. The areas that will be most susceptible are at locations in which vegetation has been removed during site clearance for construction purposes.



Plate 5.3.9: Small boulders and cobblestones strewn on the hillside located on site

### 5.3.3.2 Quantitative Assessment (Universal Soil Loss Equation)

#### 5.3.3.2.1 Methodology

The Universal Soil Loss Equation is an erosion model which was applied to the proposed site to determine the erosion potential of the area by computing the annual tonnage of soil loss per unit area of land.

The Universal Soil Loss Equation involves the evaluation of several factors; rainfall, soil erodibility, cover management, slope length and slope steepness.

The equation states:  $A = R * K * L * S * C$

$A$  = Annual soil loss (tons/acre)

$R$  = Rainfall - Runoff Erosivity factor

*K= Soil erodability factor.*

*L/S= Slope length/ Steepness factor.*

*C = Cover management factor.*

Each of the aforementioned factors were computed in GIS and a map showing erosion potential of the site generated. The total soil loss was calculated by the use of the map algebra function in Arc GIS to determine the soil loss for the area.

### **K= Soil Erodibility Factor**

The Soil Erodibility Factor is a measure of the susceptibility of soil particles to detachment and transport by runoff. The K factor is related to the integrated effects of rainfall runoff and infiltration on soil loss accounting for the influence of soil properties on soil loss during storm events (Renard et al., 1997). Within this study, the K factor is estimated through a purely experimental approach outlined by Wischmeier and Smith (1978). This model is based on soil properties such as the composition of sand, silt and clay percentages, organic matter content, soil structure, and the permeability of the soil.

Information pertaining to the properties of the various soil types was determined by the use of existing soil data collected from the Rural Agricultural Development Authority, Rural and Physical Planning Agency and additional site observation.

This data was used to determine the K value; a numerical value measured between 0-1, the smaller value represents a lower erodability and vice versa. The K-Factors ranged from 0.01 for very low erodibility to 0.65 for highly erodible. Once the soil data is collected the K value is determined by the use of a published soil erodibility nomograph (Figure 5.3.15). The values derived for the K-factors are then used to create a raster map.



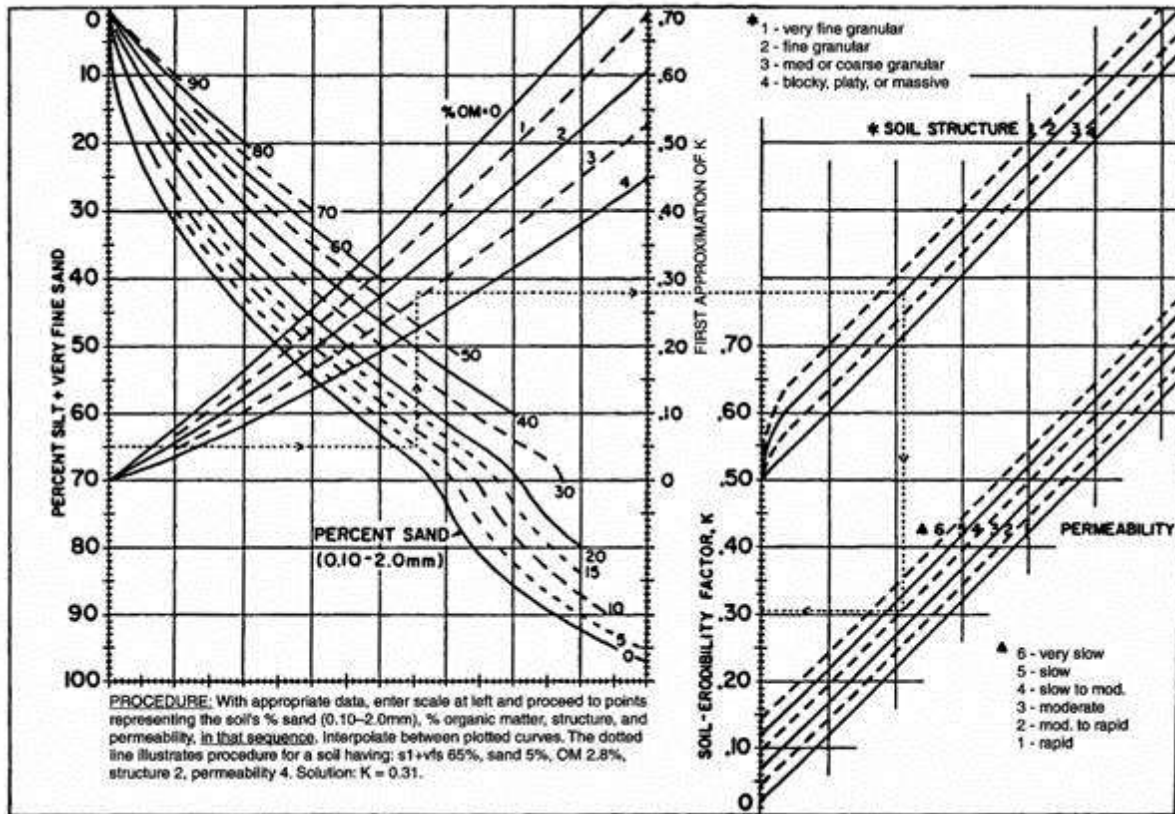


Figure 5.3.15: Soil erodability nomograph (Wischmeier and Smith 1978, Renard et al. 1997).

### **R= Rainfall - Runoff Erosivity Factor.**

This factor measures the effect of rainfall on erosion based on rainfall intensity and duration. Hence, the greater the duration and intensity of a rainfall event the higher the potential for soil erosion. For the purpose of study however, rainfall intensity data was not available and was substituted for by the annual rainfall data. Hence, average annual precipitation was used to determine the R factor, using Renard and Freimund (1994) regression equation:

$$R = 0.0483 \times P^{1.61}$$

The annual average rainfall data for Falmouth and its environs, were collected from the Meteorological office and inserted into the regression equation in order to determine the R factor.

In the equation:  $R = 0.0483 \times P^{1.61}$



**R=** Rainfall Erosivity Index,

**P=** is the annual average rainfall in mm/yr.

The raster calculator function in Arc GIS was then used to create an R-factor raster file.

**L/S= Slope length/ Steepness factor.**

The effect of topography on soil erosion is described by the LS factor in the Universal Soil Loss Equation. Hence, the Slope/Length Factor is used to quantify the combined impact of slope length and slope steepness on the rate of soil erosion. Based on the size of the study area the Arc GIS methodology was used to determine the LS Factor.

The slope length raster is calculated from the original DEM by proceeding through the hydrogeology tools in Arc GIS until a flow accumulation grid is created. The Slope map is also generated from the existing DEM after which the raster calculator tool is finally used to compute the LS-factor using the equation:

$$L = (Flow\ Accum * Cellsize / Slope\ Length)^m * (Sin([S] * 0.01745))^m$$

**S: slope steepness (%)**,

**L: slope length (m)**,

**m = Slope length exponent**

### **Vegetation Cover Factor**

The Vegetation Cover Factor determines the effectiveness of vegetation cover in preventing soil loss. The Cover Factor for the Coral Spring area was determined using land use data acquired from the National Land Agency (NLA). A multivariate analysis was further carried out in Arc GIS using the most current Google imagery of the study area to determine existing land use patterns. Additional fieldwork was also done to verify existing land use data.

The Final Erosion Map was created using Map Algebra Tool in GIS and the Formula;  $A = R \times K \times C \times LS$ .

### 5.3.3.2.2 Erosion Potential

The Erosion Map of Coral Spring (Figure 5.3.16) depicts the spatial variation in soil erosion rates across the study area. For the purpose of study, the Universal Soil Loss Equation (USLE) was used to estimate the soil erosion potential with the aid of remote sensing and GIS.

Approximately 70% of the site displays low or slight erosion potential. This area includes the central and southern section of the site which forms a plateau at an elevation of approximately 80m. Such low erosion rates are due to an increase in cover management factor, and relatively low soil erodibility due to the presence of hard rocky ground with very thin soil cover. Erosion rates were generally moderate to moderately high along the coastal areas. Such moderate to moderately high erodibility may be due to the lack in vegetation cover allowing rain to splash directly on the soil surface and detach soil particles. In addition, the Soil Erodibility Factor is high in this area, as the soil type is predominantly a loose medium-fine sand. High erosion rates were exhibited along an East-West trending fault bounded escarpment towards the southern section of the site. This may be due to the effect of the topography factor (slope length/steepness) on soil erosion as described by the LS factor in the Universal Soil Loss Equation.

*Table 5.3.2: Erosion Potential Zones*

<b>Erosion Potential</b>	<b>Erosion Rates (tons/ha/yr)</b>
Low/slight	<0.5
Moderate	0.5-1
Moderately High	1-5
High	>5

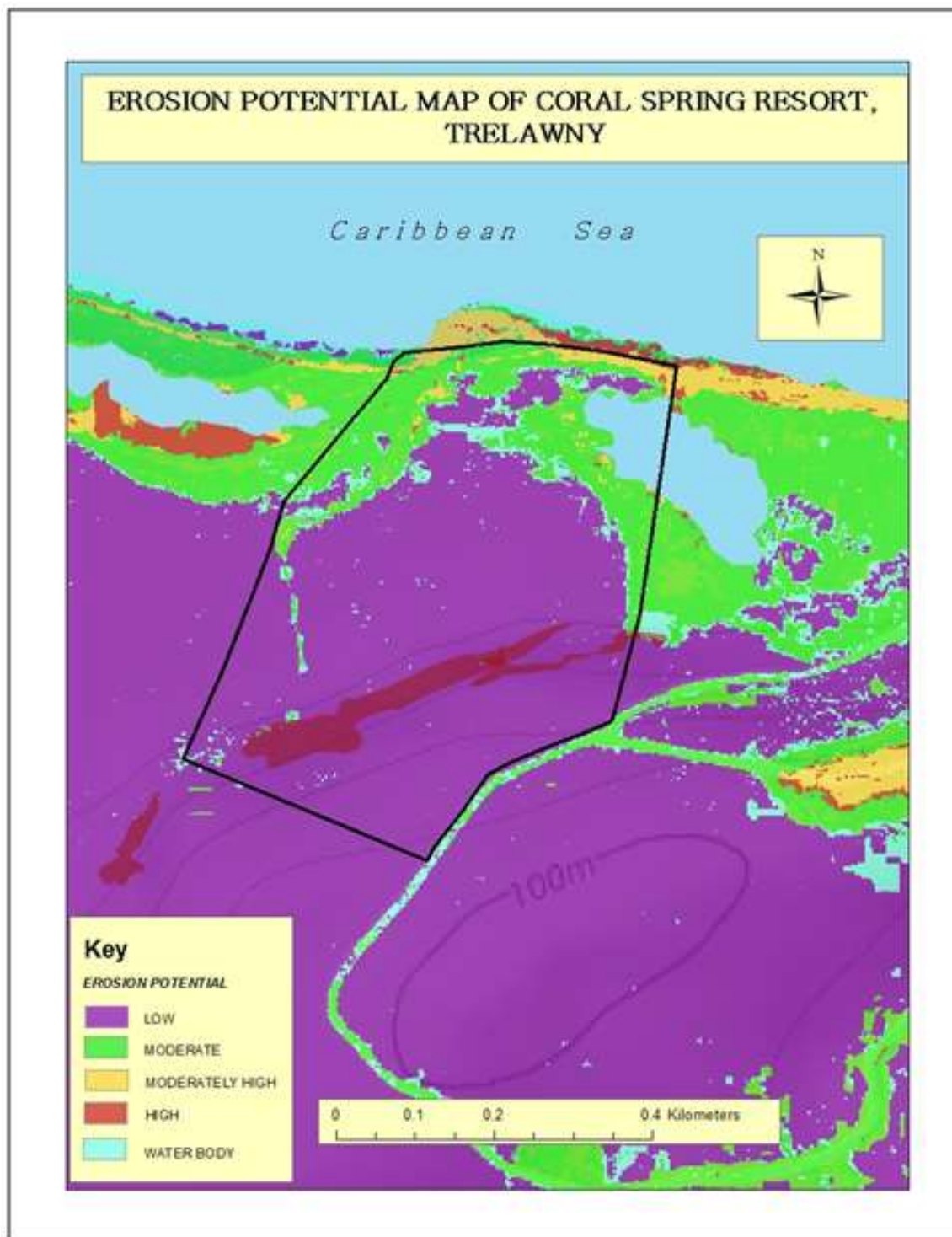


Figure 5.3.16: Erosion Map of Coral Spring Hotel Site

#### 5.3.3.2.3 Limitations

While the Universal Soil Loss Equation (USLE) has its merits, there are limitations as the computations represents estimates and not precise measurements. Therefore, it is recommended that the erosion map be used more so as a tool to indicate trends or to identify spatial variation in erodibility rather than to quantify precise soil loss. In addition, the map shows potential soil loss for the pre-construction phase and does not take into account potential site modifications which occur in the post-construction phase and how they impact the potential soil loss on site.

### 5.3.4 Earthquake Hazards

#### 5.3.4.1 Regional and Local Seismicity

From a regional perspective, Jamaica is located in the north-central Caribbean on the Gonave Microplate, a tectonic sub-block of the Caribbean plate. The Gonave Micro plate has a spreading rate of 13mm/year of plate motion. It consists of the Oriental Fracture Zone (OFZ) which is located to the north, the Cayman Spreading Zone or Trench (CT) to the west and the Enriquillo Fracture Zone also known as the Enriquillo –Plantain Garden Fault passes through the eastern part of Jamaica. Earthquakes which are generated along these major fault zones tend to generate moderate to large earthquakes in the Caribbean (Figure 5.3.17).

One of the major fault zones on the northern side of Jamaica is the Duanvale Fault (dv) which is approximately 9 km south of the Coral Spring Hotel site (Figure 5.3.18). Information from the Earthquake Unit of Jamaica website indicates that the seismicity on the Duanvale Fault is low compared to the major faults in the east where seismic activity is highest on the island.



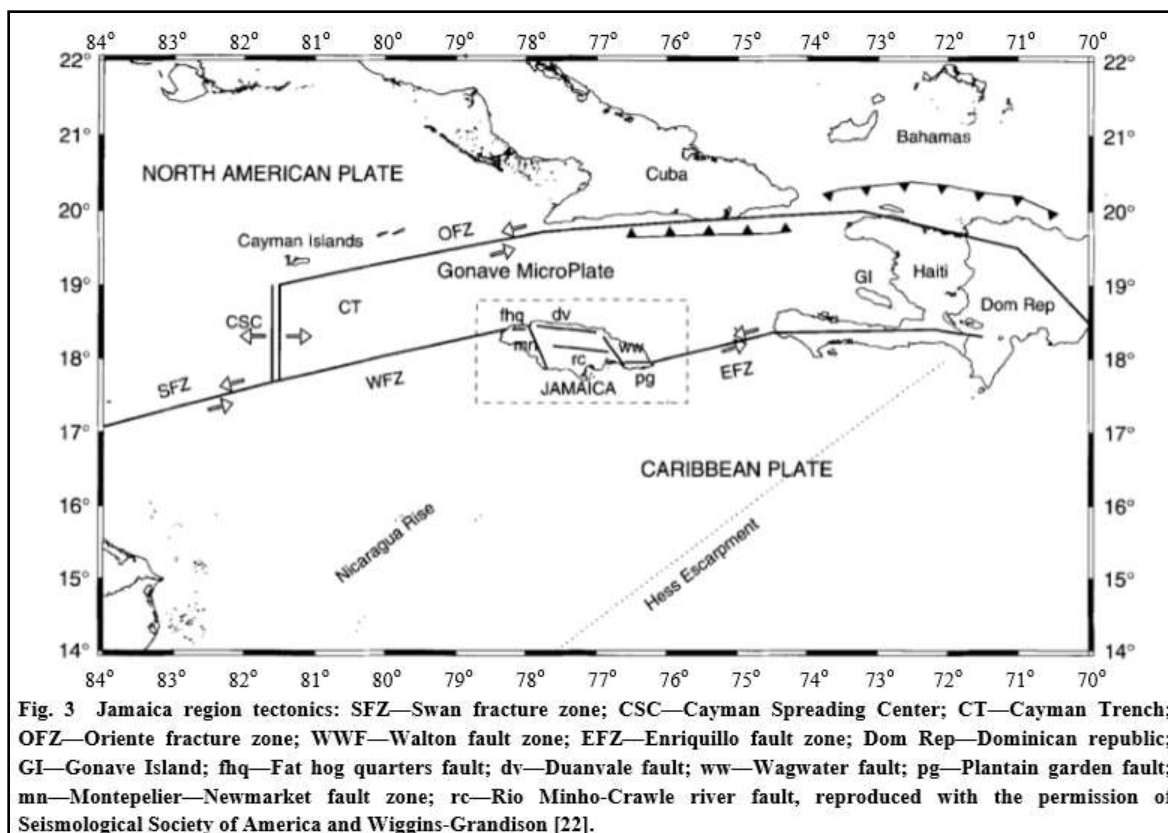


Figure 5.3.17: Regional seismo-tectonic activity in the Caribbean

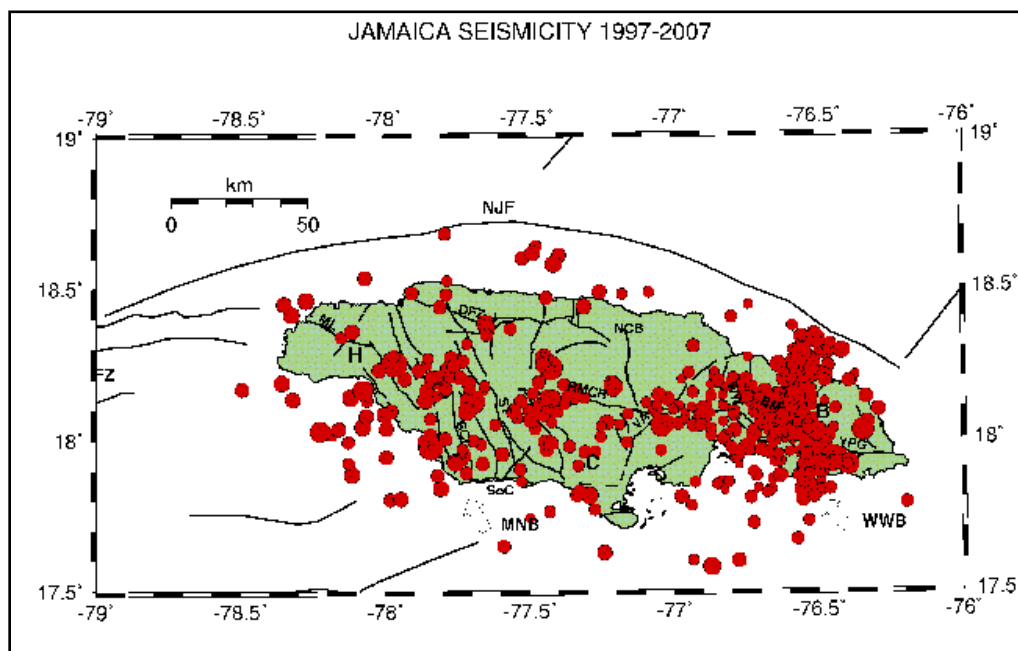


Figure 5.3.18: Local seismicity of Jamaica between 1997 and 2007

### 5.3.4.2 Earthquake History

Table 5.3.3 shows data taken from the Earthquake Unit of Jamaica website which shows that the north-western and western sections of Jamaica have relatively low levels of damaging earthquakes based on seismic occurrences. It shows that only 3 damaging earthquakes have affected Jamaica between 1839 and 1957.

*Table 5.3.3: History of Most Damaging Earthquakes affecting Jamaica*

Year	Date	Maximum Intensity (EMS) *	Places Affected	Observed Damage
1667	-	VIII	-	Landslide
1688	March 1	VII	Port Royal	Houses and ships damaged
1692	June 7	X	Port Royal, Kingston, Vere Plains. Also felt strongly island-wide	3,000 dead; buildings collapsed; liquefaction, subsidence, landslides and water ejected
1771	Sept 3	VII	Port Royal, Kingston	Damage to structures, felt on boats in port.
1812	November 11	VIII	Kingston	Several people killed; walls fell, buildings damaged
1824	April 10	VII	Kingston; Spanish Town, St. Catherine; Old Harbour, Clarendon	Loud noise accompanied shock; some houses fell
1839	November 5	VII	Montego Bay, St. James	Government buildings declared unsafe due to damage
1907	Jan 14	IX	Kingston, Port Royal	1,000 dead; fire over 56 acres; most buildings collapsed; water mains broken; landslides and slumps; localized tsunami; statues rotated; near total destruction of damage - est. 2 million pounds sterling in damage
1914	August 3	VII	Eastern Jamaica	Buildings cracked, doors and windows out of plumb; clocks stopped; stocks in drug stores broken
1943	July 15	VII	St. Elizabeth	Landslides; many homeless; breakages of merchandise in shops
1957	March 1	VIII	Montego Bay, St. James and felt island-wide	4 dead; landslides; bridges damaged; rotation of spires and monuments; springs increased flow and muddied ; utility poles and lines broken; breakages of items off shelves
1993	Jan 13	VII	Kingston and St. Andrew. Also felt island-wide	2 dead; items thrown off shelves and broke; most were frightened; heavy furniture shifted; water splashed out of containers and pools; much non-structural damage; few cases of structural damage
2005	June 12	VII	Central Jamaica - Felt strongest at Aenon Town and Top Alston in Clarendon; Silent Hill, Manchester; Wait-a-bit and Lemon Walk, Trelawny	Moderate to heavy structural damage on most vulnerable structures; some people had to be dug out of collapsed dwelling; minor injuries from falling objects

(EMS)\* - European Macroseismic Scale

NB: Dates highlighted in red are earthquakes affecting western Jamaica

#### 5.3.4.3 Probabilistic Ground Motion Model

Shepherd and Aspinall (1999) conducted seismic studies for Jamaica and placed the Coral Spring site and surrounding areas as having a peak ground acceleration of 19.5 percent of gravity with a 10 percent probability of exceedence in 50 years (Figure 5.3.19). The earthquake source areas for this study were based on off-shore sources capable of generating large earthquakes.

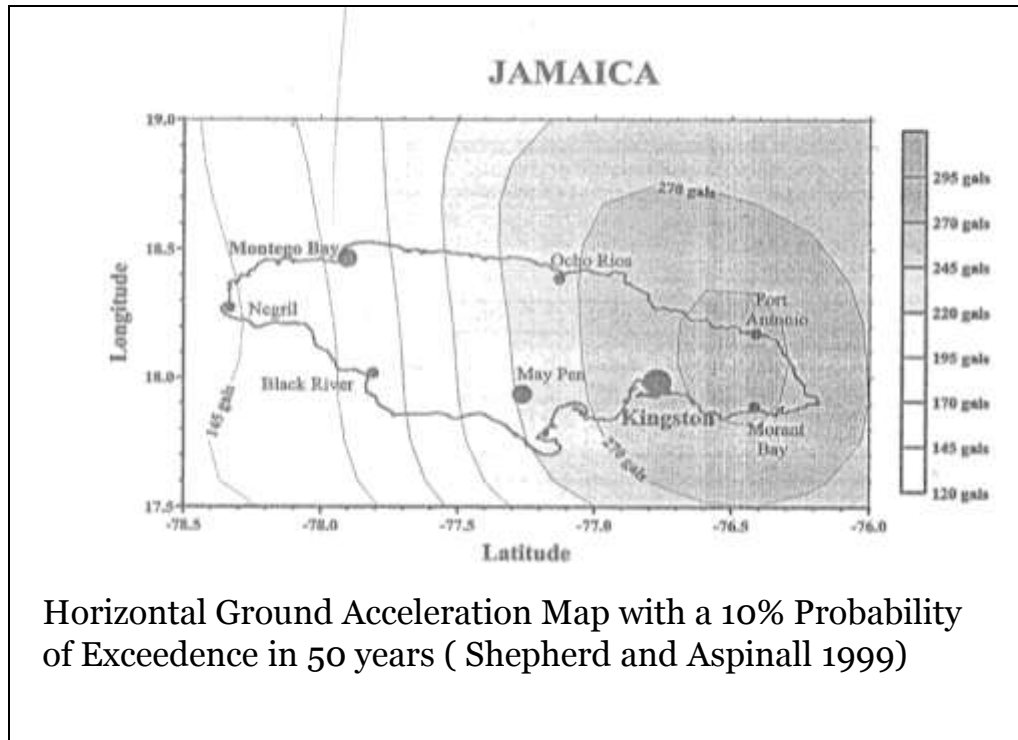


Figure 5.3.19: Horizontal ground acceleration map for Jamaica

#### 5.3.4.4 Spectral Site Response

Response spectra are typically used to illustrate the characteristics of an earthquake and are usually plots of ground acceleration against a range of natural periods measured in seconds. With respect to its application, response spectra are normally used as input data in dynamic analysis of elastic systems such as building structures.

The International Building Code (IBC) adopted for Jamaica recommends that the Peak Spectral Site Response Acceleration for the project site and surrounding areas is 50 % of gravity for 0.2s short period waves and 20% of gravity for 1.0s long period waves with a 2% probability (2,475 yr Return Period) of exceedence in a 50 yr period (Figure 5.3.20).

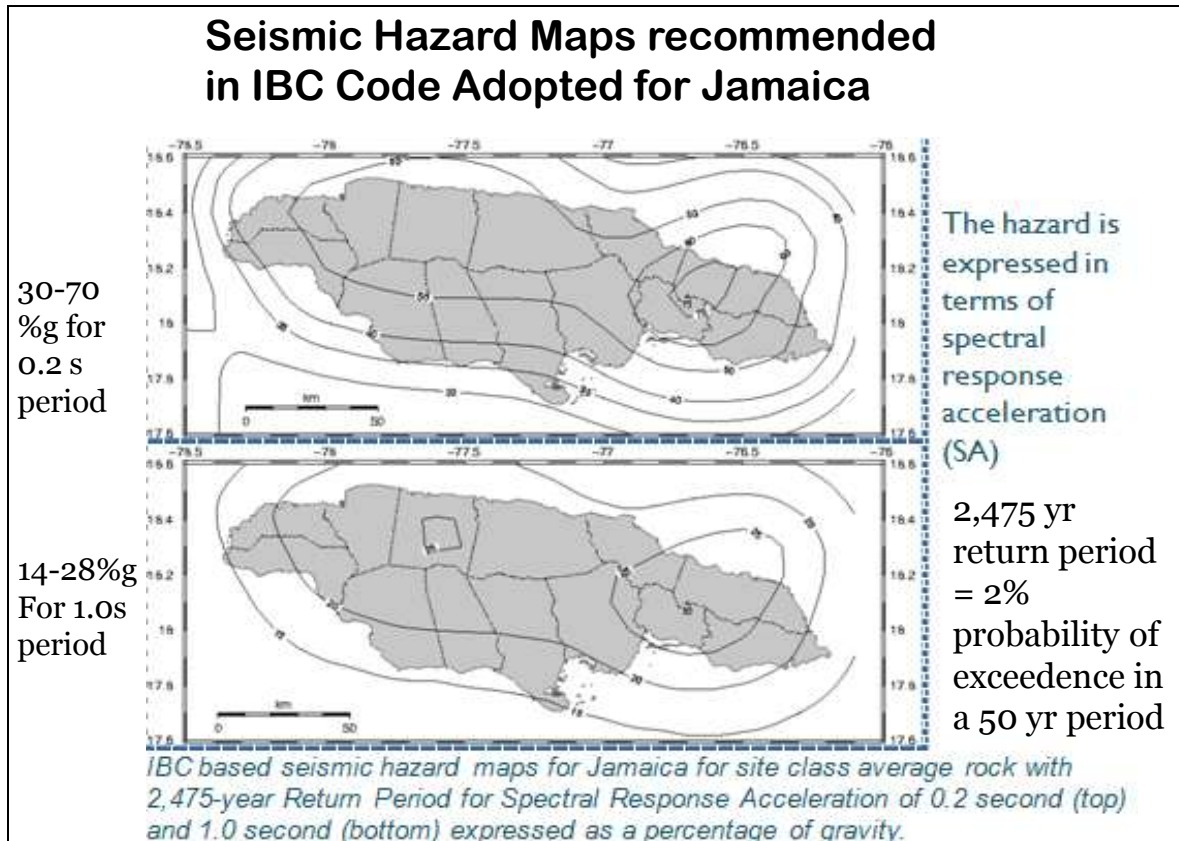


Figure 5.3.20: Site Spectral Response map for 0.2s short period and 1.0s long period waves (Source: Earthquake Unit, UWI).

### 5.3.5 Hurricanes and Tropical Storms

Jamaica is located in the northern Caribbean region between latitude 18° 36' N 175° S and longitude 76° 15' E and 78° 22' W. It is also within the North Atlantic Hurricane Belt and therefore in the path of tropical storms and hurricanes. Over the past 2 decades, tropical storms and hurricanes have done extensive damage to coastal and inland infrastructure. During the period, approximately seven severe weather systems have caused significant economic damage to the country. These include Hurricane Allen (1980), Hurricane Ivan (2004), Hurricane Dean (2007), Hurricane Sandy (2012), Tropical Storm Gustav (2008), Tropical Storm Nicole (2010). Severe tropical storms systems tend to cause flooding in low lying areas, while hurricane damage is generally caused by sea surges (coastal flooding) and wind.

A history of hurricanes tracks from 1856 to 2005 that pass in close proximity to the island is shown in Figure 5.3.21. Recent hurricanes that have directly affected Jamaica from 1980 to 2008 are presented in Figure 5.3.22.





## 5.4 Biological Environment

### 5.4.1 Terrestrial Environment

Please note that additional information regarding the terrestrial environment is presented in section 4.2, *Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica* (submitted by CL Environmental Co. Ltd, January 2017).

#### 5.4.1.1 Vegetation

Vegetation on the flat terrain near the coastline changes progressively inland, from sparse grass to low shrubs, to dense high shrub land and small trees further inland at an estimated distance of 35m-40m inland from the shoreline. Further south, the land rises to the upland region of the property where the vegetation can be described as dense, slender trees, typical of dry limestone forest.

##### 5.4.1.1.1 Methodologies

The following methods were employed for the assessments of the biological environment of the site proposed for the development of the hotel/resort:

#### Literature Review:

Literature related to the expected forest types to be found within the project area were examined as a means of establishing a general description the various types of floral assemblages and fauna that could be found at the sites. Camirand and Evelyn (2004<sup>5</sup>) and Forestry Department <sup>6</sup>, <sup>7</sup> references were valuable in establishing this general description.

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<sup>5</sup> Roland Camirand and Owen B. Evelyn – National Forest Inventory Report 2003 Volume 1 of 2 – Main Report and Appendices I-V 2004.

<sup>6</sup>Forestry Department Min of Agriculture Photo Interpretation Manual – June 2002

<sup>7</sup> Forestry Department - Forest Inventories in Natural Forests [UNDP/FAO, 1972; Swedforest Consulting, 1981; FIDCO, 1982-83; TFT Project, 1998-99]

Further technical guidance was obtained from H. Raffaele (2003)<sup>8</sup>, Sutton and Downer (2009)<sup>9</sup>, Peter Vogel<sup>10</sup> and other butterfly/insect references and gastropod references sourced on the internet. From these references, visual identification keys were generated for use in the identification of flora and fauna species observed in the field, with special attention being placed on the identification of species that are known to be endemic to the environment or otherwise threatened or endangered.

Finally, the proposed location is in close proximity to two major developments – the Gore Developments Ltd’s Coral Springs Housing Development immediately to the south of the development area and the Amaterra Hotel and Villas development to the east. Both developments were the subject of Environmental Impact Assessments (EIAs- submitted in July 2012<sup>11</sup> and December 2007<sup>12</sup> respectively). Data presented in these documents were used for comparison with that obtained for the present study area, since the terrain and floral assemblages present within the previously studied areas were contiguous with that of the proposed area.

#### Aerial Imagery/Geographical Information Systems Assessments – land use/Flora:

Google Earth images of the location dated 2015<sup>13</sup> were referenced to the JAD2001 coordinate system using a Geographical Information System software<sup>14</sup>. After referencing, the Google Earth images were then used for the broad-scale characterization of land use and floral spatial coverage on the site. A higher resolution aerial image data set was captured for near-shore areas of the property using a DJI Phantom II Quadcopter remotely operated camera system flown at an elevation of 200 meters.

Additional spatial data, specifically topography, elevation, soil type and any floral/faunal ground truthing data obtained in the field were inputted into a geographical information

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<sup>8</sup> Birds of the West Indies by Herbert Raffaele, James Wiley, Orlando Garrido, Allan Keith and Janis Raffaele - 2003

<sup>9</sup> Ann Haynes-Sutton, Audrey Downer, Robert Sutton and Yves-Jacques Rey-Millet: A Photographic Guide to the Birds of Jamaica - 2009

<sup>10</sup> [www.jpat-jm.com/pdfs/Amphibians](http://www.jpat-jm.com/pdfs/Amphibians)

<sup>11</sup> Final Environmental Impact Assessment for Coral Springs Residential Development – Prepared by Environmental Solutions Ltd July 2012.

<sup>12</sup> Environmental Impact Assessment Report Golf Course: Amaterra Jamaica Ltd – Prepared by Enviroconja December 2007.

<sup>13</sup> Representing the most recent imagery available

<sup>14</sup> [www.mapmaker.com](http://www.mapmaker.com)

systems software to be used to help further analyze and illustrate any spatial variations that could be detected at the site.

Positional data for field information was collected with a Garmin GPS Map 60CSx hand held global positioning system (GPS), with waypoint and track information being managed through Garmin Map Source software.

Floral Assessments –Ground Truthing:

Two types of floral assessment methods were employed to verify interpretations made from aerial image analysis. These methods are described below:

Walk-Through Surveys:

The primary methodology employed to assess the flora of the study area consisted of a series of walk-through exercises. Figure 5.4.1 illustrates pathways used as a line along which the assessments were carried out. One of these pathways was an access road through the development site forest.

In this method, features of floral aggregations existing along these routes were assessed, with observations being made along a vertical arc extending from the ground towards any forest canopy existing to one side of the pathway (Figure 5.4.2).



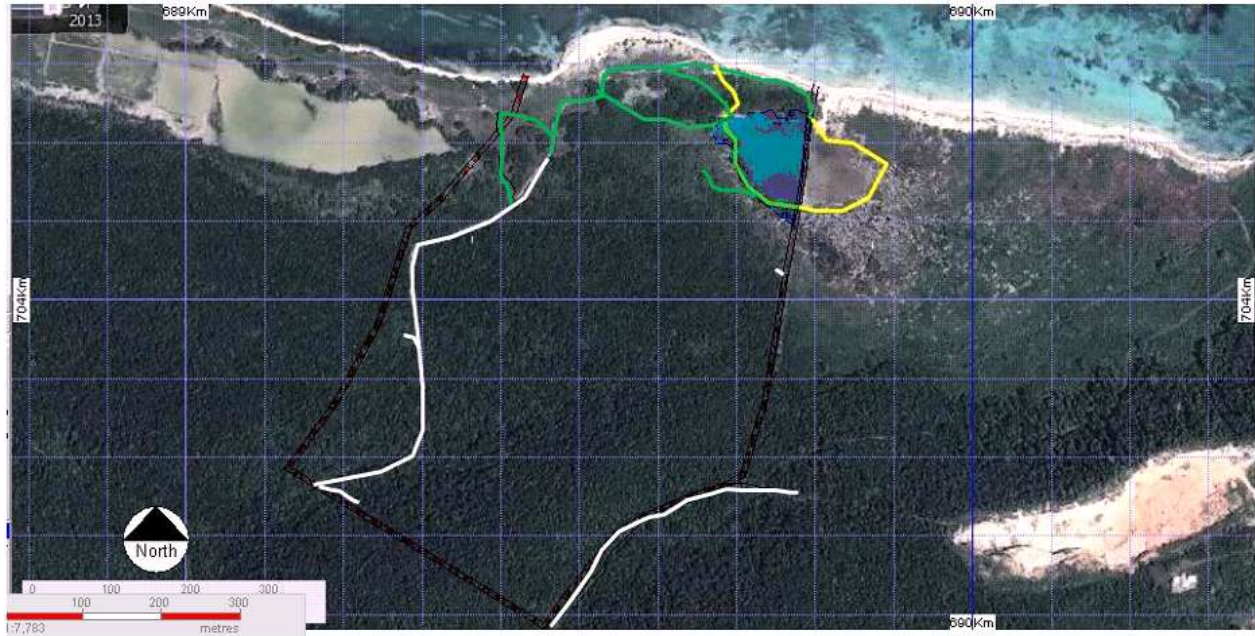


Figure 5.4.1: Vehicle/Pedestrian Paths in Natural Vegetation at the Proposed Development Site Used as walk-through routes in the Study Area (white – limestone area, green – beach area, yellow – wetland area)

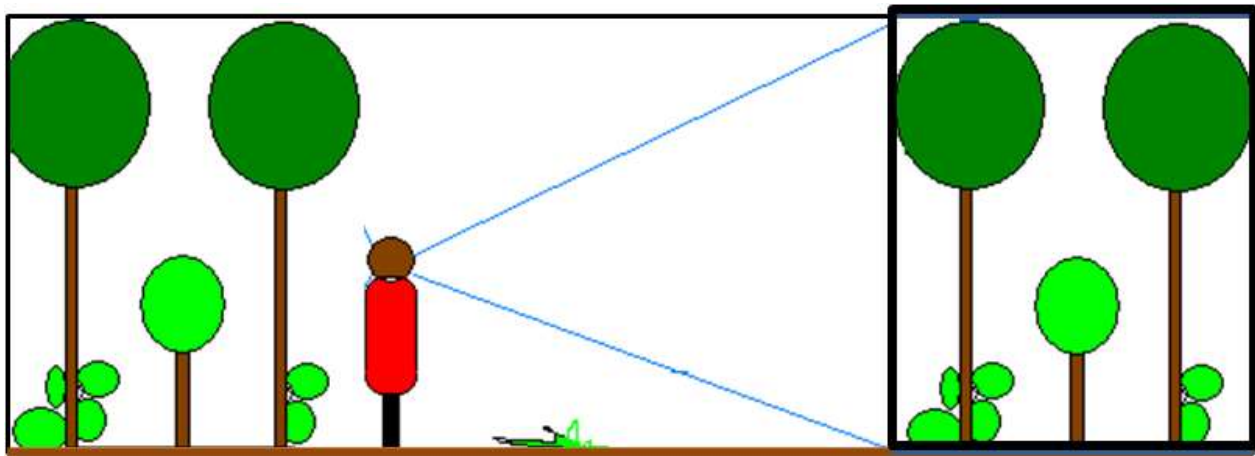


Figure 5.4.2: Schematic View of the Surveyed Areas Observed Along the Transects.

The rationale for using walk-throughs for qualitative observations was for the following reasons:

1. Convenience - The existing pathways, for the most part, were already present and no vegetation cutting would have been necessary to facilitate access. Additionally, the lay of the land and the density of vegetation present on the location made incursions into undisturbed areas difficult to impossible.

2. The pre-existing pathways were also rationalized as being representative of what would be observed on the site as one made a geographical transition between higher elevations to the south of the property across to lower elevations at the north of the property.
3. Aerial image photo-interpretation of the vegetative cover present within the property's boundaries, as well as examination of literature related to the type of vegetation assemblage present, lead to the opinion that the homogeneity in cover would be present. Changes in vegetation character that might have been influenced by changes in elevation or topography (specifically shading) would have been represented to an extent by the pathway present.

The floral data collected was primarily used for the generation of a species list. Furthermore, an indication of relative prevalence of forest vegetation observed was estimated using the **DAFOR** scale syst<sup>15</sup> defined below. In this instance, the DAFOR scale was used to approximate percentage covers as follows:

- D - Dominant = >75%
- A - Abundant = 75 – 51%
- F - Frequent = 50 – 26%
- O - Occasional = 25 – 11%
- R - Rare 10 – 1 %

#### Photo-quadrat Method:

An experimental attempt at providing meaningful percentage composition and diversity information for the surveyed floral assemblage was conducted with the use of photo-quadrats for the estimation of species composition and cover. A quadrat is a tool used to isolate a standardized area for study. Quadrats can vary in size, however, the standard shape is that of a square or rectangle.

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<sup>15</sup> <http://www.surreyflora.org.uk/newnotes.php>

Quadrat sizes were varied in accordance with the vegetation type being studied. Table below suggests the sizes appropriate for various forms. The highlighted columns represent quadrat dimensions used in the course of the survey.

*Table : Quadrat Sizes for Different Floral Lifeforms*

<b>Suggested Quadrat Sizes for Different Floral Lifeforms<sup>16</sup></b>					
Lifeform	Mosses	Low Herbs	Tall Herbs/Low Shrubs	Tall Shrubs	Trees
Quadrat Area (m2)	0.01-0.1	1-2	4	16	100

Either vertically or horizontally oriented photoquadrats were used depending on the type of floral lifeforms being evaluated. In either case, the camera being used to capture imagery was oriented perpendicularly to the floral assemblage being captured<sup>17/18</sup>.

A Sony DSC V3 7 megapixel digital camera was used for photoquadrat data capture. Sensor size for the camera was 7.144mm x 5.358mm and, set for maximum resolution, generated an image of dimensions 3072 x 2304 pixels.

The camera's lens was set for wide angle viewing and held at a standard height of 1.7 meters for quadrats taken from a vertical orientation for low herbs and 3 meters horizontal distance for tall shrubs and near trees. The images captured thus represented an image width which corresponded with that highlighted in Table .

Photoquadrats were taken along sets of transects deployed over the study area, illustrated on Figure 5.4.3 Nineteen photo-quadrat stations were established across the accessible areas of the site at locations illustrated on Figure 5.4.3 and a total of 30 photo-quadrats were captured. The locations of the stations from which photographs were taken were obtained simply by walking for a timed interval, starting from the point at which the pathway entered into the boundary of the study area to the south and progressing towards the north. Information was recorded when the set time interval expired. The latitude-

<sup>16</sup> Cain, S.A and G.M De O Castro 1959. Manual of Vegetation Analysis. Harper, NY pp 325

<sup>17</sup> USGS-WERC Vegetation Transects and Survey Plot Standard Operating Procedures 2011

<sup>18</sup> Mathews, N.A 2008. Aerial and Close-Range Photogrammetric Technology Technical Note 428. US Department of the Interior Denver, Colorado 42pp



Longitude positions of these points were then recorded by a handheld Garmin GPS Map 60CSx global positioning system (GPS).

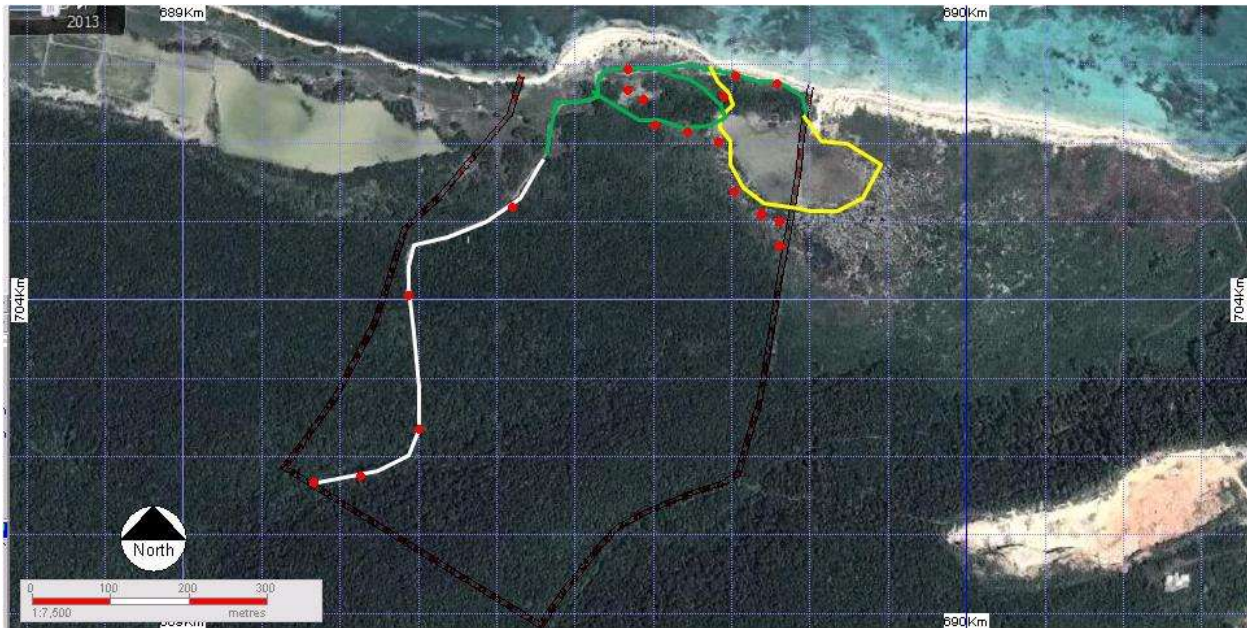


Figure 5.4.3: Photoquadrat Locations Distributed Over Study Area (**red dots**).

#### Limitations – Photo-quadrat Method:

The primary limitation of the photo-quadrat method used during the survey was the inability to resolve image details greater than 3 meters away from the subject. Thus, while the method worked fairly well for/was biased towards the capturing of floral assemblages near to the photographer, it was limited in its ability to examine distant forest assemblages.

As a result of these limitations, both species richness (number of species recorded) and species percentage covers appeared to have been underrepresented. Therefore, a subsequent, more thorough, floral sortie was conducted (see *Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica*, CL Environmental Co. Ltd, January 2017) in order to arrive at a more accurate inventory of the community. Nonetheless, the data collected and subsequent inferences made remain herein for reference.



#### 5.4.1.1.2 Observation

##### Spatial Extent

Literature reviews, as well as the identification of characteristic flora within the vegetation assemblages found surrounding the proposed development site lead to the characterization of the property into three distinct zones, namely:

1. Tall, Open, Dry Forest<sup>19</sup> occupying limestone elevated areas.
2. Beach/beach hinterland area vegetation occupying marine sand deposits on land.
3. Wetland vegetation on clayey soil types.
4. Figure 5.4.4 illustrates the spatial extent of the three floral types found on the proposed development site

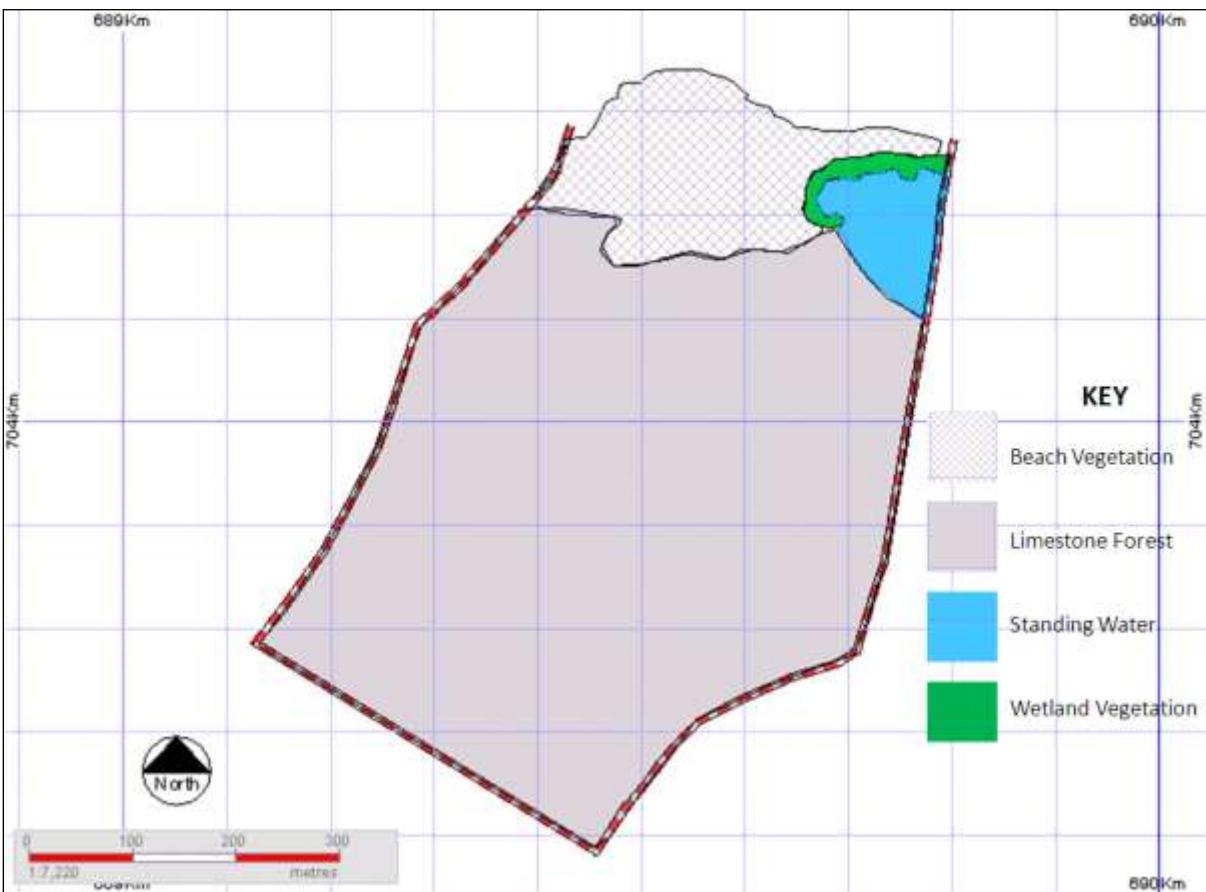


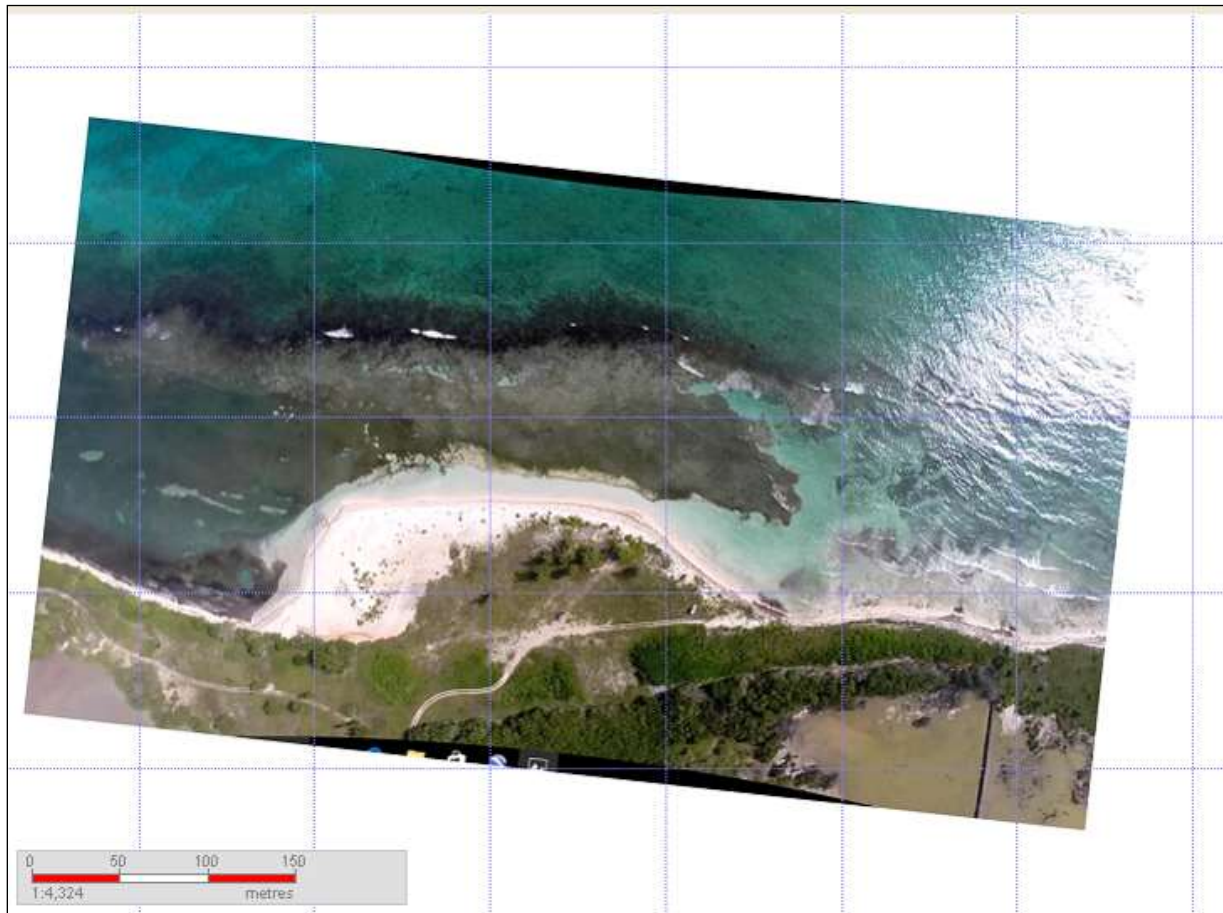
Figure 5.4.4: Extent of Natural Vegetation Disturbance at the Study Site.

<sup>19</sup> A Tall Open Dry Forest is an open natural woodland or forest with trees at least 5m tall and crown not in contact, in drier part of Jamaica with species indicators such as Red Birch Tree (*Bursera simaruba*) - Forestry Department Min of Agriculture Photo Interpretation Manual – June 2002

The following areas were estimated based on aerial image interpretations (confirmed with site observation):

1. Tall, Open, Dry Forest<sup>20</sup> occupying limestone elevated areas – 24.7 hectares.
2. Beach/beach hinterland area vegetation occupying sandy areas – 3.9 hectares
3. Wetland vegetation – 0.3 hectares
4. Standing water associated with wetlands -1.1 hectares

Figure 5.4.5 and Figure 5.4.6 illustrate an interpretation of the floral characteristics distribution found within the coastal area of the proposed development site, 50-100 meters landward of the shoreline.



*Figure 5.4.5: DJI Phantom II-Aided Aerial Image of Proposed Development Site, 50-100 Meters Landward of the Shoreline*

<sup>20</sup> A Tall Open Dry Forest is an open natural woodland or forest with trees at least 5m tall and crown not in contact, in drier part of Jamaica with species indicators such as Red Birch Tree (*Bursera simaruba*) - Forestry Department Min of Agriculture Photo Interpretation Manual – June 2002

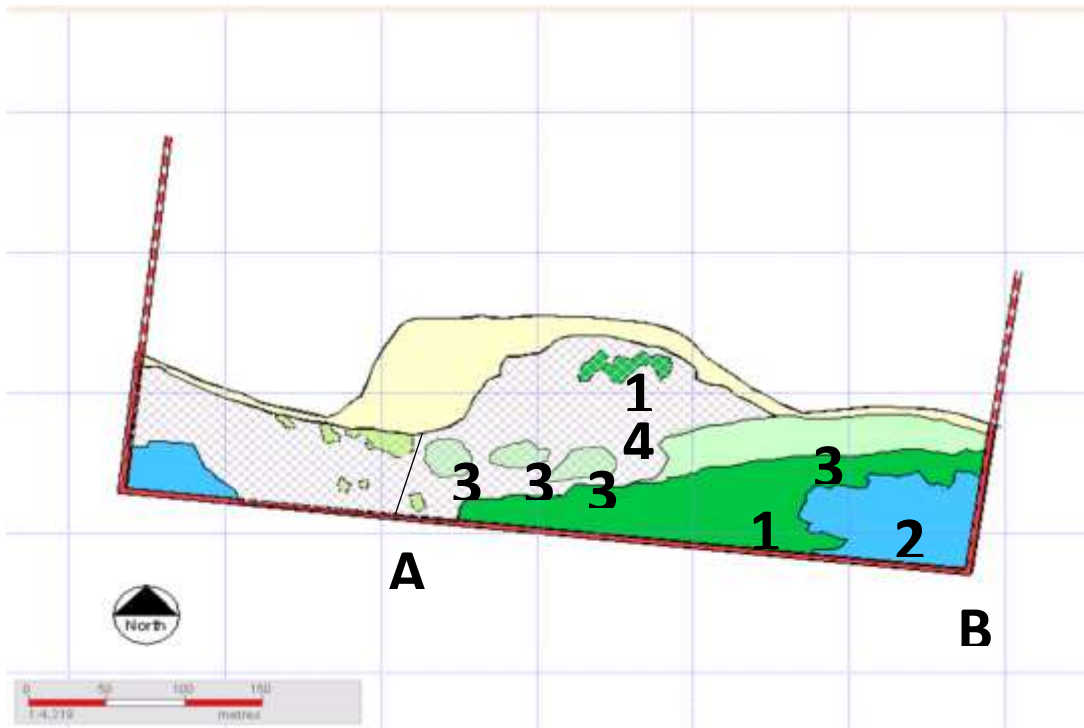


Figure 5.4.6: Floral Distribution Within 50-100 Meters Landward of the Shoreline at the Development Site (A and B = western and eastern property boundaries, 1-trees, 2-standing water, 3 – low shrubs, 4-grass).

### Vegetation

Floral species observed were initially categorized based on the floral zone within which they were found, then further categorized into floral types - namely **trees**<sup>21</sup>, **Shrubs**<sup>22</sup>, **vines**<sup>23</sup>, **bromeliads**<sup>24</sup>, **herbs**<sup>25</sup> and **grasses**<sup>26</sup>. Table 5.4.1 lists the floral species observed on the proposed development site, along with their DAFOR descriptions.

<sup>21</sup> Tree – A woody perennial plant, typically having a single stem or trunk growing to a considerable height and bearing lateral branches at some distance from the ground - Wikipedia.org

<sup>22</sup> A Shrub is a

<sup>23</sup> Vine – A climbing or trailing woody-stemmed plant.

<sup>24</sup> Bromeliad- A plant of tropical and subtropical America typically having short stems with rosettes of stiff, spiny leaves. Some kinds are epiphytic.

<sup>25</sup> Herb – Any seed-bearing plant which does not have a woody stem and dies down to the ground after flowering - google definition

<sup>26</sup> Grass –Vegetation consisting of typically short plants with long, narrow leaves growing wild or cultivated on lawns.

Table 5.4.1: Tree Shrub, Herb, Vine and Bromeliad Species List – Divided in Accordance With Floral Zones and Floral Types Observed Within Each Zone. (red highlighted = endemic, threatened)

LIMESTONE FOREST AREA	
Trees	
Scientific Name	Common Name
<i>Acacia sp</i>	Acacia
-	Fiddlewood
<i>Piscidia piscipula</i>	Dogwood
<i>Leucaena leucocephala</i>	Lead Tree
<i>Guazuma ulmifolia</i>	Bastard Cedar
<i>Cordia gerascanthus</i>	Spanish Elm
<i>Metopium brownie</i>	Burnwood
<i>Melicicus bijugatus</i>	Guinep
<i>Cassia emarginata</i>	Candlewood
<i>Bursera simaruba</i>	Red Birch
<i>Terminalia catappa</i>	Almond
<i>Aeschrion excels</i>	Bitter Wood
<i>Brosimum alicastrum</i>	Breadnut
<i>Juniperus bermudiana</i>	Cedar
<i>Albizia lebbbeck</i>	Woman Tongue
<i>Cecropia peltata</i>	Trumpet Tree
<i>Nectarandia coriaca</i>	Sweetwood
<i>Ficus sp</i>	Strangler Fig
<i>Morinda citrifolia</i>	Noni
<i>Haemotoxylum campechianum</i>	Logwood
<i>Thrinax parviflora</i>	Broom Thatch Palm
-	Herringwood
<i>Acacia tortuosa</i>	Wild Pompanax
Shrubs	
<i>Passiflora suberosa</i>	-
<i>Pisonia aculeate</i>	Cockspur
<i>Commelina diffusa</i>	-
<i>Centrosema virginianum</i>	-
<i>SP-4</i>	-
<i>Lasiacis divaricata</i>	Bamboo Grass
<i>SP-3</i>	-
<i>SP-2</i>	-
<i>Tecoma stans</i>	Torchwood
<i>Melochia nodiflora</i>	-
<i>Thespesia populinea</i>	Seaside Mahoe
<i>Lantana sp.</i>	Lantana



**Grasses**

<i>Eleusine indica</i>	Yard Grass
<i>Panicum maximum</i>	Guinea Grass
<i>Sporobolus sp</i>	-

**Bromeliads**

<i>Broughtonia sanguinea</i>	Purple bromeliad
<i>Hylocereus triangularis</i>	God Okra
<i>Hohenbergia sp</i>	Tank Bromeliad
<i>Agave sobolifera</i>	Century Plant

**Vines/Runners**

Snake Withe

**BEACH AREA**

**Trees**

<i>Casuarina equisetifolia</i>	Willow Tree
<i>Leucaena leucocephala</i>	Lead Tree

**Shrubs**

<i>Sesuvium sp</i>	-
<i>Ipomoea pes caprae</i>	-
<i>Canavalia maritima</i>	-
<i>Thespesia populinea</i>	-
<i>SP-5</i>	-
<i>SP-1</i>	-

**Grasses**

<i>Xerophyllum tenax</i>	Bear Grass
<i>Cenchrus incertus</i>	Sand Spur
<i>Sporobolus virginicus</i>	Beach Grass
<i>Zoysia sp</i>	Zoysia

**WETLAND**

**Trees**

<i>Conocarpus erectus</i>	Button Mangrove
<i>Avicennia germinans</i>	Black Mangrove

**Bromeliads**

<i>Broughtonia sanguinea</i>	Jamaican Orchid	Purple
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### 5.4.1.1.3 Flora Percentage Cover

#### Limestone Area

Analysis of the 16 photoquadrats captured at the limestone area revealed that the most commonly occurring plant species types were as listed in Table 5.4.2 and Figure 5.4.7.

Table 5.4.2: Percentage Cover for Flora: Limestone Areas

LIMESTONE AREAS		
FLORA		%
Species Name	Common Name	
<i>Thespesia populinea</i>		1.6
-	Fiddlewood	1.6
<i>Piscidia piscipula</i>	Dogwood	0.5
<i>Leucaena leucocephala</i>	Lead Tree	1.1
<i>Sporobolus sp</i>		4.2
<i>Guazuma ulmifolia</i>	Bastard Cedar	3.7
<i>Passiflora suberosa</i>		1.1
<i>Eleusine indica</i>	Yard Grass	0.5
<i>Hylocereus triangularis</i>	God Okra	0.5
-	Snake With	0.5
	Cockspur	4.7
<i>Commelina diffusa</i>	-	2.6
<i>Centrosema virginianum</i>	-	0.5
SP-4	-	1.6
<i>Cordia gerascanthus</i>	Spanish Elm	5.3
<i>Metopium brownie</i>	Burnwood	1.6
<i>Melicicus bijugatus</i>	Guinep	3.2
<i>Thrinax parviflora</i>		4.7
<i>Lasiacis divaricata</i>	Bamboo Grass	2.1
<i>Bursera simaruba</i>	Red Birch	4.7
SP-3		1.1
-	Herringwood	7.9
SP-2		0.5
<i>Tecoma stans</i>	Torchwood	1.1
<i>Melochia nodiflora</i>	-	3.7
<i>Panicum maximum</i>	Guinea Grass	3.2
<i>Cassia emarginata</i>	Candlewood	0.5
Non Vegetation (shadow, soil etc.)	-	35.8

### Beach/Wetland Area

Analysis of the 14 photoquadrats captured within the Beach and Wetland area revealed that the most commonly occurring plant species types observed were as listed in Table 5.4.3 and Figure 5.4.8.

Table 5.4.3: Percentage Cover for Analyzed Flora: Beach/Wetland Areas

BEACH/WETLAND AREAS		
Species Name	Common Name	%
<i>Conocarpus erectus</i>	Button Mangrove	0.4
<i>Avicennia germinans</i>	Black Mangrove	13.8
<i>Thespesia populnea</i>	Seaside Mahoe	22.3
<i>Sesuvium sp</i>		15.4
<i>Ipomoea pes caprae</i>		1.5
<i>canavalia maritima</i>		0.4
SP-5		3.1
<i>Zoysia sp</i>	Zoysia	2.7
SP-1		1.2
<i>Leucaena leucocephala</i>	Lead Tree	1.9
<i>Xerophyllum tenax</i>	Bear Grass	30.8
Non Vegetation (shadow, soil etc)		6.5

#### 5.4.1.1.4 Floral Species Diversity

Figure 5.4.9 illustrates Shannon Wiener indices results for the species sampled from the photoquadrats taken at the study site. The sums of the values represented here, or the diversity indices (**H**) are:

1. Index of 3.96 for the Limestone Forest area, suggesting a floral population of relatively **high species richness and relative un-evenness in abundance.**
2. Index of 1.66 for the Beach/Wetland area, suggesting a floral population of relatively **moderate species richness and some element of bias in abundance.**

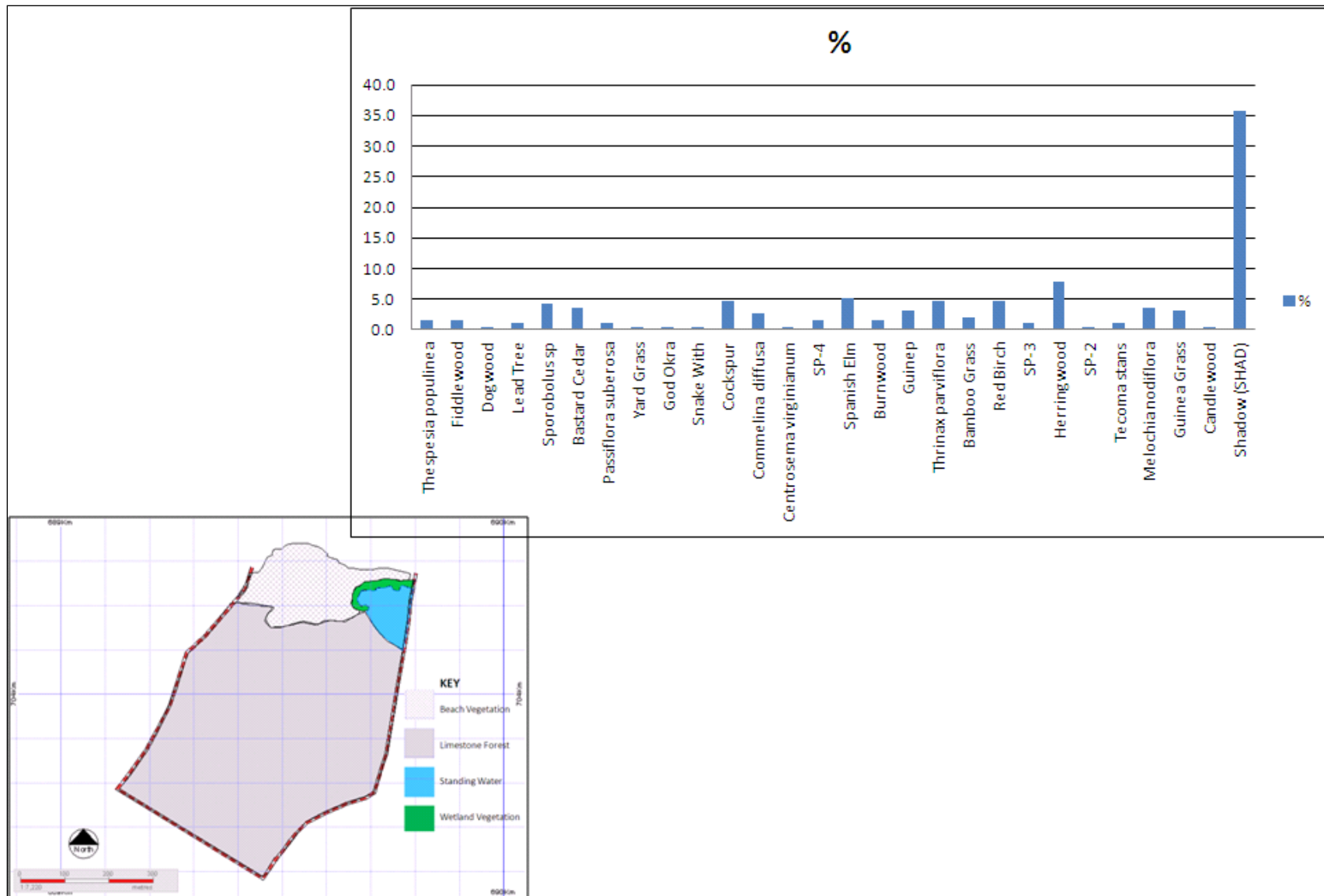


Figure 5.4.7: Representation of Percentage Cover Flora in Limestone Areas.



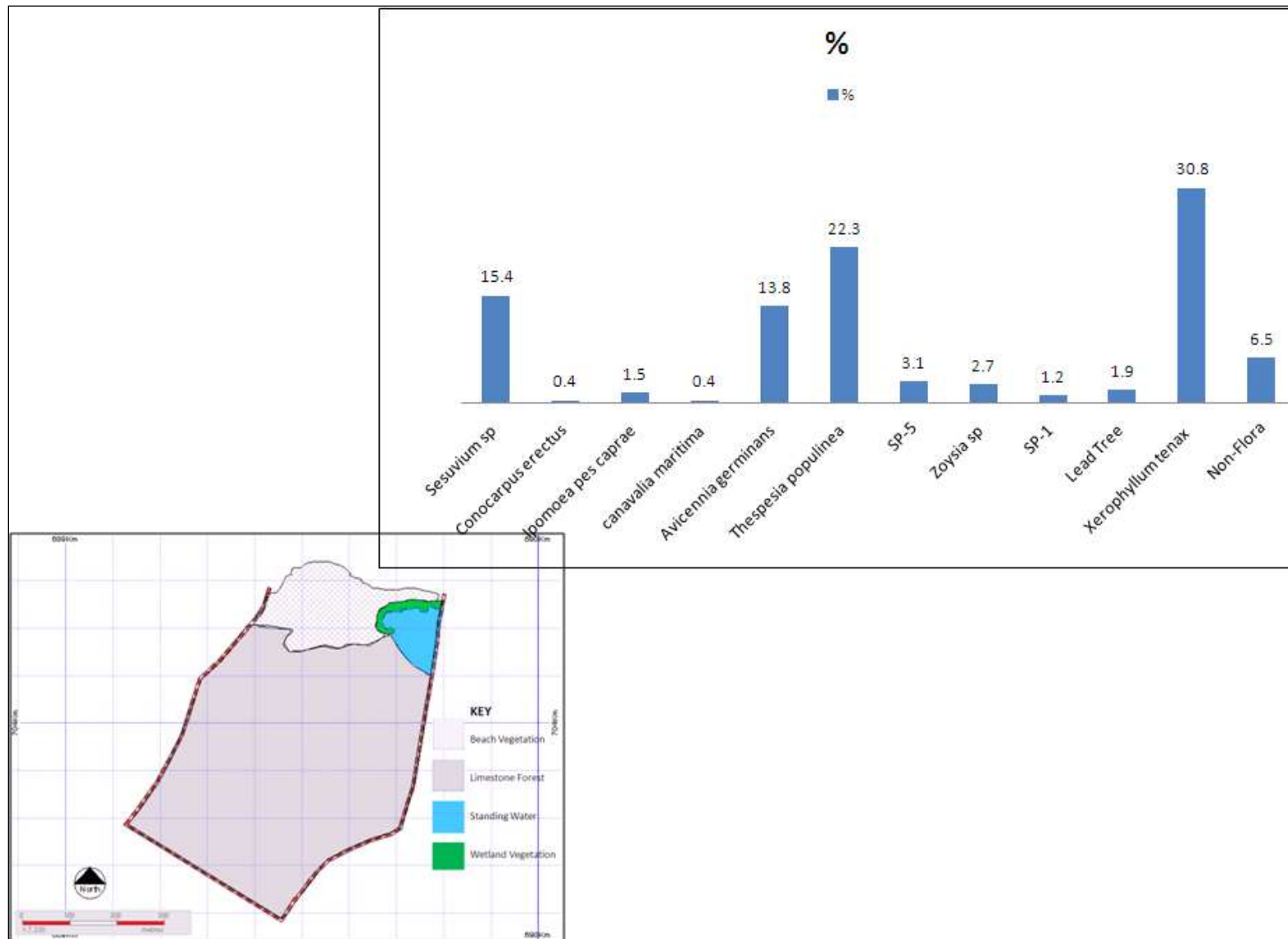


Figure 5.4.8: Representation of Percentage Cover Flora in Beach/Wetland Areas

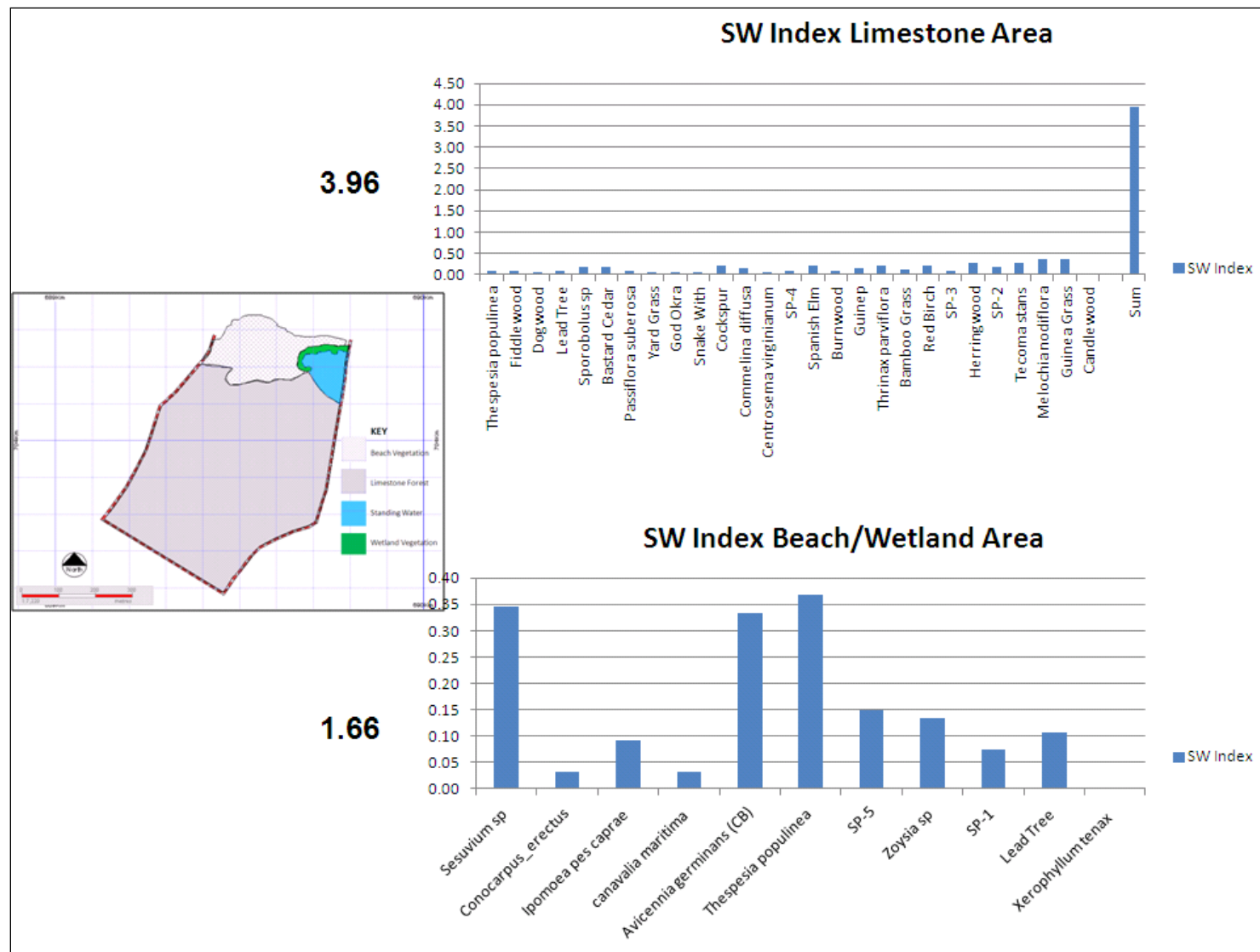


Figure 5.4.9: Floral Species Diversity

#### 5.4.1.2 Fauna Assessment

Please note that additional information regarding the Faunal assessment is presented in the addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica (submitted by CL Environmental Co. Ltd, January 2017).

The literature review identified several groups of animals which likely use the project site. These include:

1. Avi-fauna (Birds)
2. Herpetofauna (Lizards)
3. Insects (Butterflies and Moths)
4. Gastropods (snails)
5. Mammals (Bats, Mongooses)
6. Frogs

##### 5.4.1.2.1 Methodologies

###### Faunal Walk Through/ Line Transect Methods:

Presence/absence visual surveys along the transects traversed for the floral surveys, with observations being made in accordance with the space depicted on Figure 5.4.1. The assessment was similar to the vegetation walk through.

An attempt was made to stage the surveys at times that would facilitate most successful observations.

These timings are listed below:

1. Day bird/insect observations: 5:30am – 8am
2. Reptiles: 5:30am – 8am
3. Night bird/insect observations: 5:30pm – 8pm
4. Bat observations 5:45pm – 6:45m
5. During the course of the day for any birds or other animals that might be either observed flying or disturbed during the course of the vegetation surveys.

A species list was generated.

### Faunal Photoquadrat:

Photoquadrats taken during the flora survey were examined for the presence of any fauna. This was done to further supplement the observations that were made as traverses were conducted along the transects.

### Bird /Insect Line Transects:

#### *Birds*

The line transects survey method for birds were conducted. Visual observations of birds were made while walking along transects (in accordance with Bibby et al. 2000<sup>27</sup>). Where birds were heard or seen while traverses were being made, audio recordings were made and photographs taken while remaining stationary for 5-10 minutes (mirroring techniques used for Bird Point Count methods – Bibby et al 2000). Birds in excess of 50 meters from the observer could therefore be heard and identified. Figure 5.4.3 above also represented the location of the stops for audio recordings.

A critical assumption of this line transect method was that all birds on the transect centerline, as well as ranging into the foliage for the dimensions of the observation area were detected. Thus, birds distant from the transect centerline may have been missed, and thus, the proportions missed.

This assumption was deemed to be important because the interpretation of the observations was based on numbers of sightings/hearings (assuming no repeat observations) in relation to the length and cross sectional area of the footprint surveyed.

#### *Insects*

Emphasis was placed on the observation and identification of flying insects – specifically butterflies flying across the path of the transect being surveyed. This was done because it was opined that flying insects play an important role both as plant pollinators and as a food source for forest avi-fauna. It was anticipated that survey time allotments would not

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<sup>27</sup>Bibby, C.J, Burgess, N.D., Hill, D.A., and Mustoe, S.H (2000). *Bird Census Techniques*, 2<sup>nd</sup> ed. Academic Press London.

allow for actual numbers to be determined. Therefore, an indication of relative prevalence was given, as defined using the DAFOR scale system<sup>28</sup> defined below:

D - Dominant

A - Abundant

F - Frequent

O - Occasional

R - Rare

In this case, the DAFOR scale was based on estimates of numbers of different species seen during the traverse along the transect with Dominant = >75 individuals, Abundant = 75 – 51 individuals, Frequent = 50 – 26 individuals, Occasional = 25 – 11%, Rare 10 – 1.

#### Species Diversity <sup>29</sup>:

Species diversity, biodiversity or the measure of how varied the species composition is within an area, has traditionally been one of the primary interests of Ecologists. It is said that the more diverse an area is, the healthier it is.

Species diversity can be regarded as having two separate components, namely:

The number of species present – termed **Species Richness**

The relative abundance of the species present – termed **Dominance or Evenness**.

With this complexity in mind, many different measures or indices of species diversity have been developed.

The **Shannon Wiener** index (**H**) was used for the determination of biodiversity information, which is calculated in the formula  $H = -\sum[(p_i) * \log(p_i)]$ <sup>30</sup> where  $p_i$  = Number of individuals of species  $i$ .  $P_i$  can be estimated as  $p_i = n_i/N$ , where  $n_i$  is the number of individuals in species  $i$  and  $N$  is the total number of individuals in the community.

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<sup>28</sup> <http://www.surreyflora.org.uk/newnotes.php>

<sup>29</sup> Biology.kenyon.edu>courses.biol229

<sup>30</sup> [www.easycalculation.com/statistics/learn-shannon-wiener-diversity.php](http://www.easycalculation.com/statistics/learn-shannon-wiener-diversity.php)



The interpretation of the index results is based on the fact that typical summation values will be between 1.5 and 3.5 in most ecological studies, with 4.0 being the extreme upper end.

The index increases in value as both the richness and the evenness of the community increases – thus pointing to the fact that this index incorporates both biodiversity description components. High values would be representative of more diverse communities – meaning that there is variety in the types of species represented and that their population numbers are evenly distributed.

Concluding Assumptions:

The field methods described above were conducted over the period **2016-06-12, 16 and 20**. Considering the timeframe outlined for the collection of data, as well as terrain, access, vegetation density and safety considerations, the following data collection assumptions were made:

- A. Data records were made along defined pathways or roadways found constructed over the proposed site, being limited by the ability to penetrate into the vegetation stands existing at the site.
- B. Further to the above, no attempt was made to cut through vegetation so as to minimize impacts that the data collectors could make on the environment. In short, all the data collection methods were non-destructive in their nature.
- C. Quantitative assessments were attempted for:
  - Floral percentage cover
  - Floral diversity
  - Bird population numbers and diversity
- D. Quantitative assessments were not made for:
  - Bats and other mammals
  - Insects (day and night), though a qualitative assessment of population numbers was done for daytime flying insects.
  - Reptiles
  - Amphibians
- E. Species lists were generated for all flora/fauna observed, with importance (endemism, rarity, threatened status, migratory status etc) being highlighted.

#### 5.4.1.2.2 Results

Birds, pollinating insects (Butterflies and Bees), Lizards, Gastropods and Crustaceans were the predominant faunal types observed within/above the study site (refer to survey areas represented on Figure 5.4.10 below). These are described below:

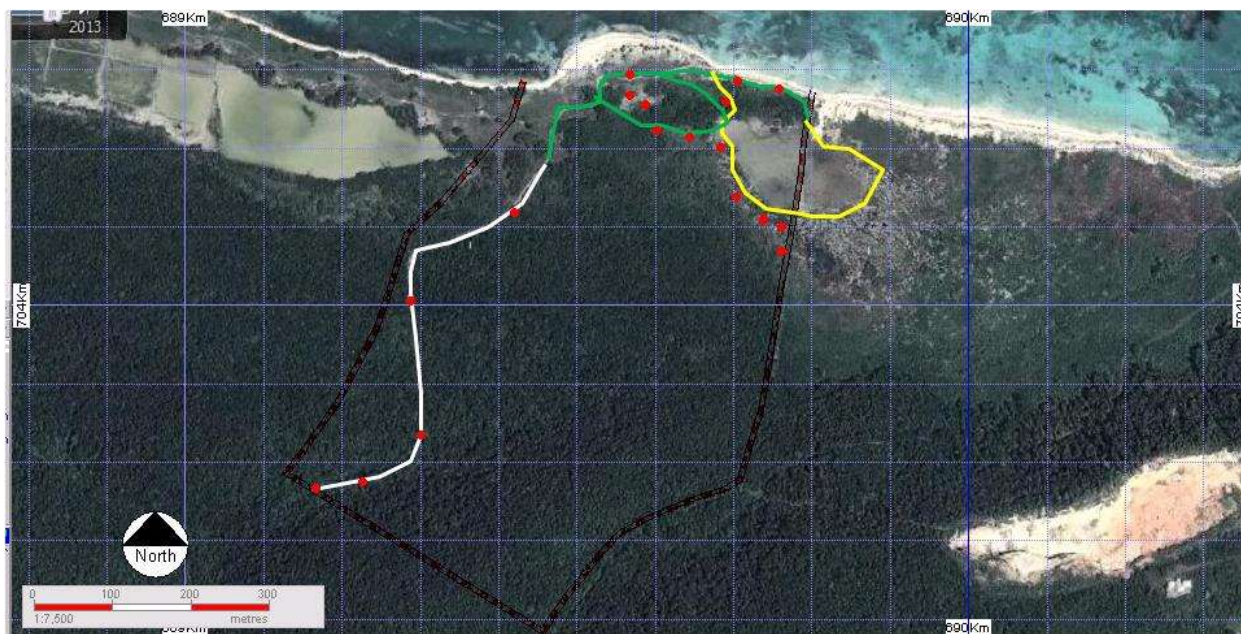


Figure 5.4.10: Accessible Survey Areas Examined for Birds and Butterflies at Halberstadt (refer to key)

#### Birds

Table 5.4.4 lists the types of birds that were detected (seen and heard) within or above the survey transects. This table is supported by Plate 5.4.1 and Plate 5.4.2. Twenty one varieties were observed:

Table 5.4.4: List of the Types of Birds Observed at the Site (red highlighted = endemic)

COMMON NAME	SCIENTIFIC NAME	NUMBERS OBSERVED
1 American Kestrel	<i>Falco sparverius</i>	1
2 Zenaida Dove	<i>Zenaida aurita</i>	3
3 Yellow-faced Grassquit	<i>Tiaris olivacea</i>	9
4 Turkey Vulture	<i>Cathartes aura</i>	3
5 Killdeer	<i>Charadrius vociferus</i>	4
6 Northern Mockingbird	<i>Mimus polyglottos</i>	2
7 Grey Kingbird	<i>Tyrannus caudifasciatus</i>	6
8 Dusky Capped Flycatcher	<i>Myiarchus tuberculifer</i>	5

COMMON NAME	SCIENTIFIC NAME	NUMBERS OBSERVED
9 Common Ground Dove	<i>Columbina passerina</i>	12
10 Osprey	<i>Pandion haliaetus</i>	1
11 Black Whiskered Vireo	<i>Vireo altiloquus</i>	7
12 Black-necked Stilt	<i>Himantopus mexicanus</i>	5
13 Bald Pate	<i>Patagioenas leucocephala</i>	2
14 Jamaican Woodpecker	<i>Melanerpes radiolatus</i>	4
15 Bananaquit	<i>Coereba flaveola</i>	1
16 Mangrove Cuckoo	<i>Coccyzus minor</i>	4
17 Barn Owl	<i>Tyto alba</i>	1
18 Antillean Nighthawk	<i>Chordeiles gundlachii</i>	2
19 Olive Throated Parakeet	<i>Aratinga nana</i>	3
20 Smooth Billed Ani	<i>Crotophaga ani</i>	6
21 Yellow Warbler	<i>Setophaga petechia</i>	1



Plate 5.4.1: Bird Species Observed at the Study Site (relate to Table 5.4.4)



*Plate 5.4.2: Bird Species Observed at the Study Site (relate to Table 5.4.4)*

A total of 82 birds were observed in the study area surveyed. Figure 5.4.11 illustrates percentage abundance (by numbers observed) and Shannon Wiener index results for the species sampled from the transect survey taken at the study site. The sum of the values represented here, or the diversity index (**H**) is 2.5, suggesting a bird population of relatively **moderate species richness and relative un-evenness in abundance.**



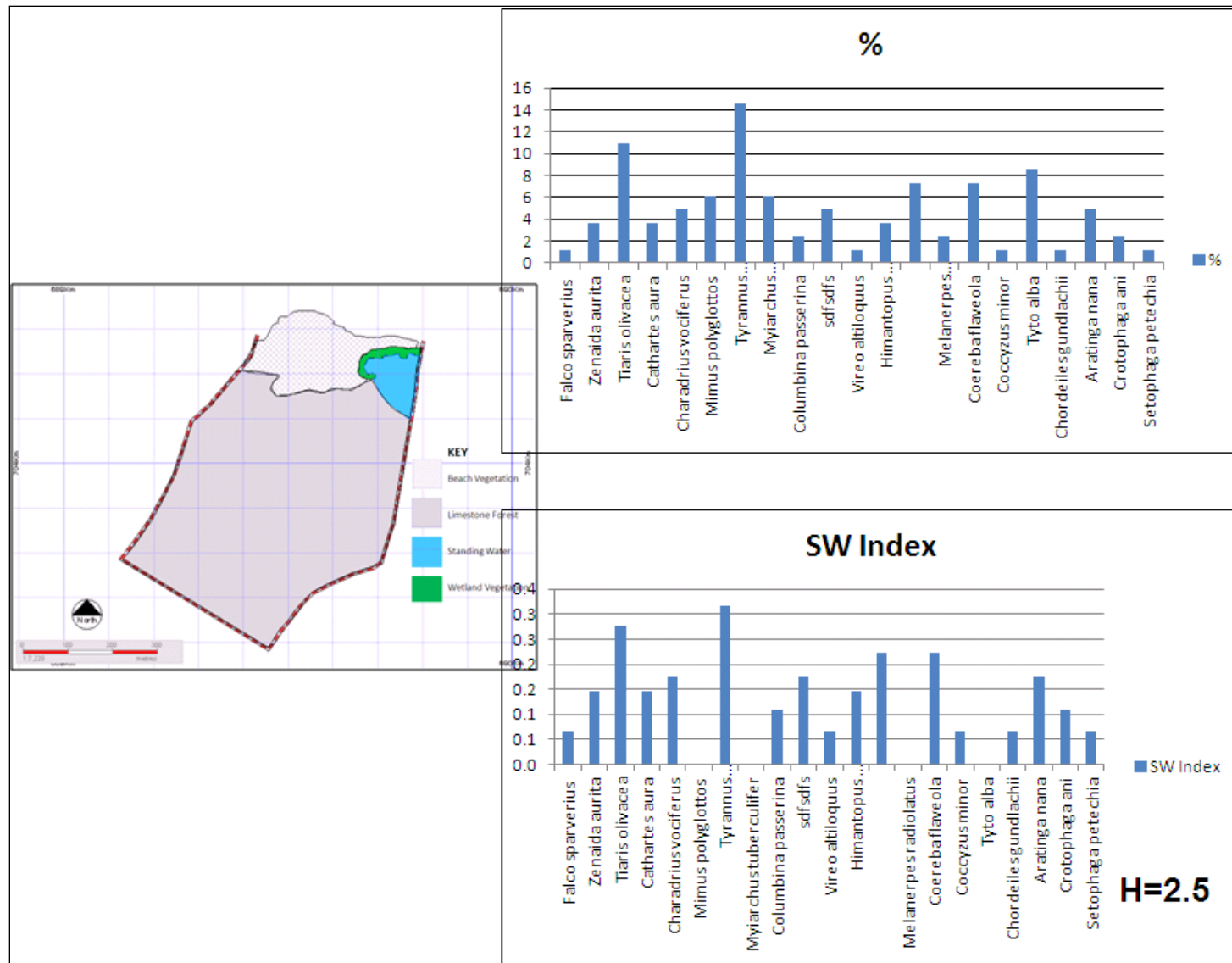


Figure 5.4.11: Percentage Abundance and Shannon Wiener Index Results for Bird Species Sampled from Transect surveys at Coral Spring.

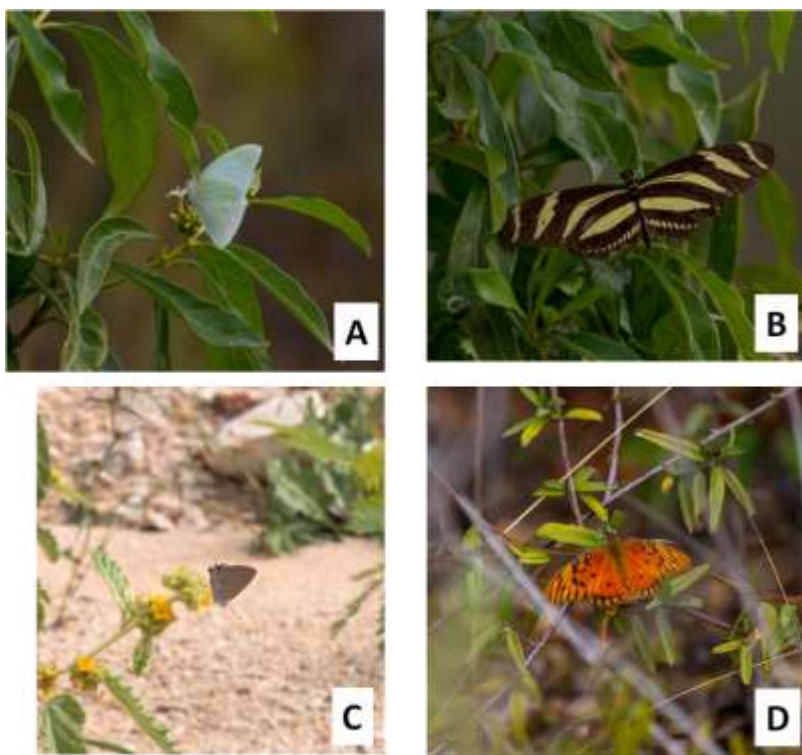


### Insects (Flying)

Nine varieties of flying insects and were observed at the development site, with five being butterflies. Table 5.4.5 lists the flying insects observed along with their DAFOR ratings for population estimates.

*Table 5.4.5: List of the Types of Insects Observed During Surveys Conducted at the Site*

COMMON NAME	SCIENTIFIC NAME	
<b>A - Lignum Vitae Butterfly</b>	<i>Krigonia lyside</i>	O
<b>B - Zebra Longwing</b>	<i>Heliconius charitonius simulator</i>	O
<b>C - Tropical Buckeye</b>	<i>Precis evarete zonalis</i>	O
<b>D - Tropical Silverspot</b>	<i>Dione vanilla insularis</i>	O
<b>E - Honey Bee</b>	<i>Apis sp.</i>	F
<b>F – West Indian Buckeye</b>	<i>Precis evarete zonalis</i>	O
<b>G – Carpenter Bee</b>	<i>Xylocopa sp</i>	O
<b>H –Dragonfly</b>	-	O
<b>I – Unnamed Beetle</b>	-	R



*Plate 5.4.331: Flying Insects Observed at the Development Site – refer to Table 5.4.5*

<sup>31</sup> Images plates taken from Cement Company Ltd Limestone Quarry Site

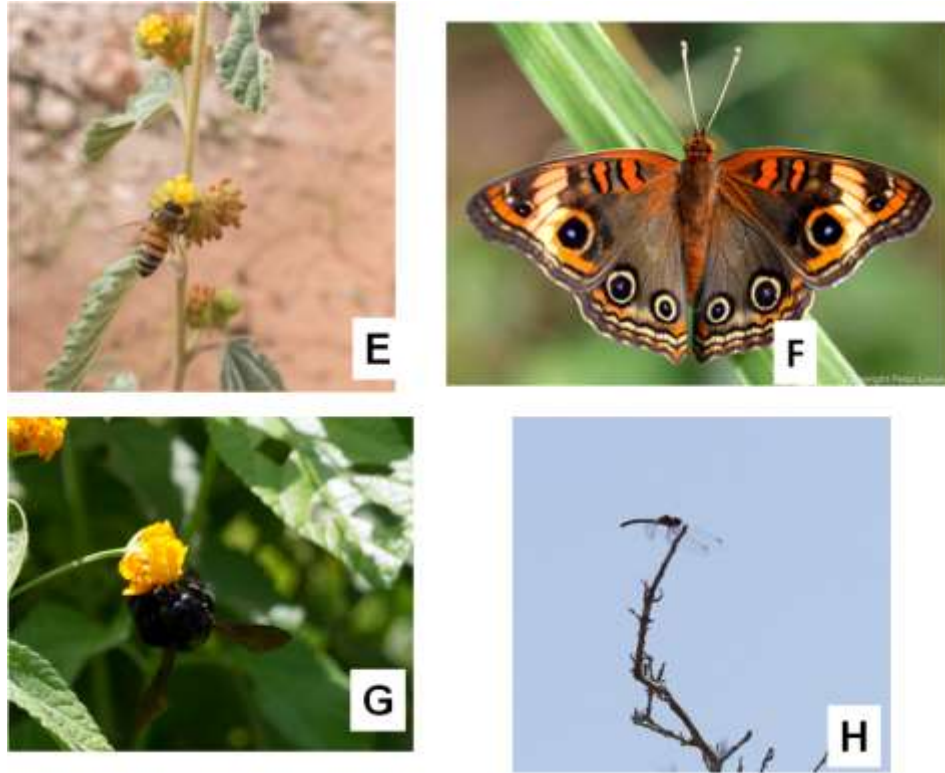


Figure 5.4.12: Flying Insects Observed at the Development Site – refer to Table 5.4.5



Figure 5.4.13: Unnamed Beetle Observed at the Development Site – refer to Table 5.4.5

### Lizards

Anoles *opalinus*, was observed during daytime traverses in the proposed development area. During dusk and night periods, Croaking Lizard were heard, however no species identification was possible.

### Gastropods (snails)

The gastropod *Pleurodonte peracutissima* was the only variety of gastropod observed during traverses conducted at the site.



Figure 5.4.14: Ground Gastropod *Pleurodonte peracutissima*

### **5.4.2 Marine Environment**

Please note that additional information regarding the marine environment is presented in section 3, *Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica* (submitted by CL Environmental Co. Ltd, January 2017).

#### **5.4.2.1 Coral Reefs**

Coral reefs form a linear, shallow underwater structure composed of skeletons of corals which are marine invertebrate animals. The reefs are located approximately 68m-150 m from the northern coastline and are aligned parallel/near-parallel to the shoreline (Figure 5.4.15). These coral reefs tend to thrive in tropical waters because they extract calcium carbonate from the sea water to create a hard exoskeleton to protect their soft sac-like bodies ([www.livesciences.com/40276-coral-reefs](http://www.livesciences.com/40276-coral-reefs)). Coral reefs provided a variety of ecosystems services, including tourism, fisheries and shoreline protection. They are

however, under threat from both natural and anthropogenic sources: sea temperature rise, pollution, coastal modification and agricultural run-off, for example.



Figure 5.4.15: Coral reefs in the shallow sea water near to the northern coastline

The following methods were employed for environmental assessments conducted at the site which, considering the time period allotted for the study, will be regarded as a **Rapid Assessment**:

#### 5.4.2.2 Aerial Imagery/Geographical Information Systems Assessments – Seafloor Lifeforms and Substrates:

Google Earth images of the location dated 2015<sup>32</sup> were referenced to the JAD2001 coordinate system using a Geographical Information System software<sup>33</sup>. After referencing, the Google Earth images were then used for the broad-scale seafloor lifeforms and substrates adjoining the site.

<sup>32</sup> Representing the most recent imagery available

<sup>33</sup> www.mapmaker.com



A higher resolution aerial image data set was captured for near-shore areas of the property using a DJI Phantom II Quadcopter remotely operated camera system flown at an elevation of 200 meters.

Positional data for field information was collected with a Garmin GPS Map 60CSx hand held global positioning system (GPS), with waypoint and track information being managed through Garmin MapSource software.

#### 5.4.2.3 Marine Ground Truthing

##### 5.4.2.3.1 Line Intercept Method

A line intercept <sup>34</sup> method was employed at the site. Figure 5.4.16 illustrates the position of transect lines surveyed at the site. The transect line was defined using a weighted 50 meter long fiberglass tape measure laid out on the seafloor.

The transect line served as a reference point along which depth, as well as photographic information was collected. For the latter, a Gopro Hero 3+ Black video camera with underwater housing was used for image data capture.

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<sup>34</sup> [www.wikipedia.org](http://www.wikipedia.org) – Line Intercept method





Figure 5.4.16: Position of Marine Transect Lines in the Study Area (white lines)

Video recordings taken along each of the transects deployed were then used to confirm spatial characterizations interpreted for marine substrates and benthic lifeforms within a 100 meter distance from the shoreline of the proposed site. Additionally, presence/absence descriptions of all fauna observed within the area were also recoded. **No interpretations of lifeform population statistics or diversities were attempted.** Assessments were confined to a representation of what was spatially interpreted from the aerial images and what was seen and identified during transect surveys.

#### 5.4.2.4 Observations

##### 5.4.2.4.1 Marine Substrates Spatial Extent

Figure 5.4.17 shows an interpretation of the marine substrates existing within the boundary of the 2016 aerial image of the site (refer to Figure 5.4.16 above)

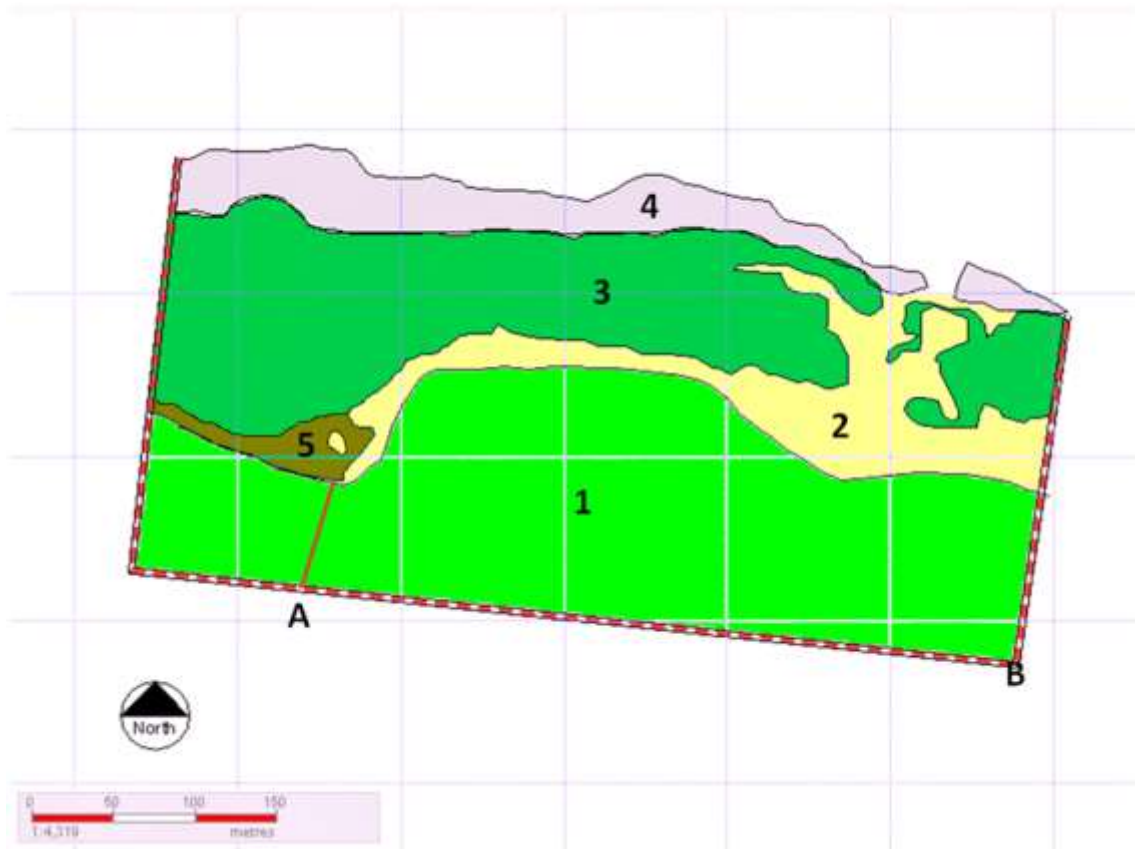


Figure 5.4.17: Spatial Representation of Marine Substrates Existing Within 100 meters of the Development Site Shoreline (A-B = property coastline boundaries, 1= Mainland, 2= Exposed Submerged Marine Sand with no benthic attached lifeforms, 3= submerged marine sand with benthic attached lifeforms, 4=hard calcareous substrate (reef), 5: marine silt/mud with benthic attached lifeforms.

Sediments observed at **location 5** on Figure 5.4.17 above were a combination of silts and organic muds that extended downwards from the seafloor for a depth in excess of a meter.

#### 5.4.2.4.2 Depths

Figure 5.4.18 shows a spatial representation of depths existing immediately offshore of the proposed development site.

The depths showed progressive deepening from shore seaward along both the eastern and western boundaries of the property, until a reef was encountered. Towards the central portions of the shoreline, consistent shallowing occurred until the reef area was encountered.

This shallow area, combined with the nearshore reef, has created a breakwater-like condition immediately offshore of the beach area on the mainland, providing a measure of shoreline protection.

On the other hand, the depths at the eastern section of the property (which are the deepest within the entire study area boundary) suggest an area where wave action can channel itself in towards the shoreline.



Figure 5.4.18: Spatial Representation of Depths Existing Within 100 meters of the Development Site

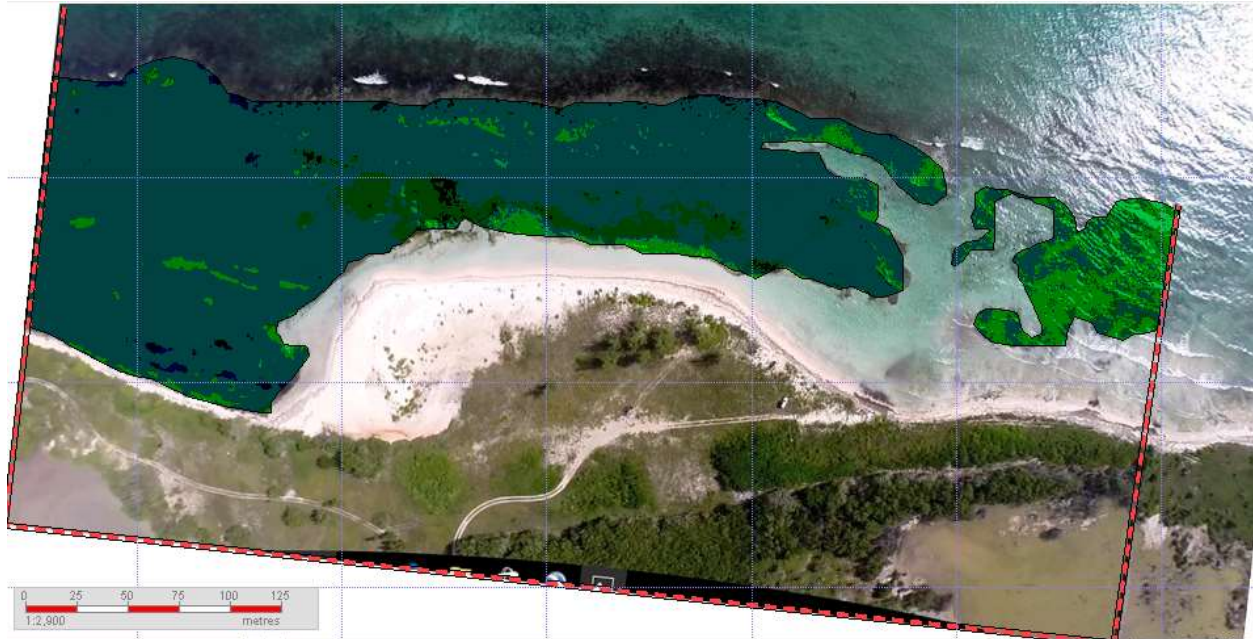
#### 5.4.2.5 Marine Community

##### 5.4.2.5.1 Attached Benthic Lifeforms – Seagrass Spatial Distribution

Ground truthing observations conducted along transects defined on Figure 5.4.16 revealed that the majority of the area defined as being sand/silt overlain with benthic species in and around the seagrasses – specifically Turtle Grass (*Thalassia testudinum*). Sparse distributions of Shoal Grass – (*Halodule wrightii*), were also observed at or near to leeward seagrass margins.



Figure 5.4.19 illustrates this distribution. Within the confines of the boundary illustrated on Figure 5.4.16, it is estimated that approximately **4.9 hectares** of Turtle Grass resources are present.



*Figure 5.4.19: Spatial Representation of Depths Existing Within 100 meters of the Development Site (dark green polygon – light green areas within polygon represent sparse distribution of seagrasses).*

The seagrass resources present within the study area are further illustrated on Figure 5.4.20 through to Figure 5.4.23. Prominent features observed within the seagrass area were:

1. Dense and long seagrass blade development (in excess of 20 centimeters) for seagrasses present over most of the southern and central portions of the seagrass beds
2. Absence of significant epiphytic<sup>35</sup> growth on the seagrass blades
3. Erosion margins within the sandy substrates present along the southern margins of the seagrass beds, which terminated the growth of the seagrass bed (see Figure 5.4.23 item 2).

<sup>35</sup> Epiphytic growths are growths that occur on other plants that do not interfere with or harm the supporting plant – wikipedia.org

4. A blow-out<sup>36</sup> erosional feature observed towards the western boundary of the marine study area (see Figure 5.4.21).
5. Growth limitation in the seagrass resources towards the northern boundary of the seagrass bed due to shallow water/intense light exposure and mixed sand/hard bottom substrates.

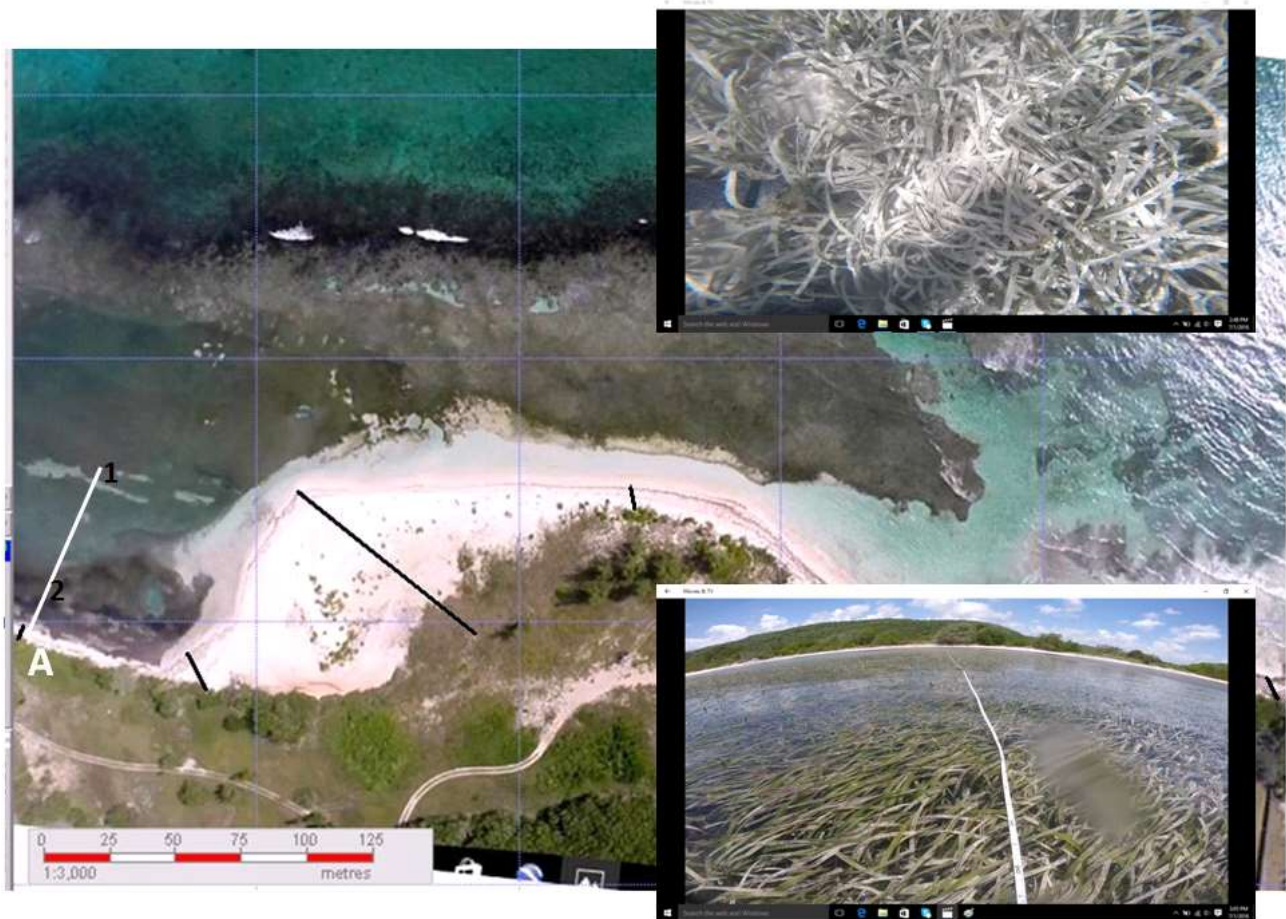


Figure 5.4.20: Illustration of Seagrass Resources Present Along Study Transects. (1 –seagrass on sand, 2 –seagrass on silt/mud)

<sup>36</sup> Seagrass blow-outs are erosional features that occur within seagrass beds. An erosive event, such as a grounded vessel or storm wave action results in the removal of seagrass from an area of a seagrass bed. The loss of stabilizing roots leaves the underlying sand/silt vulnerable to further erosion, resulting in the creation of a pit in the bed.



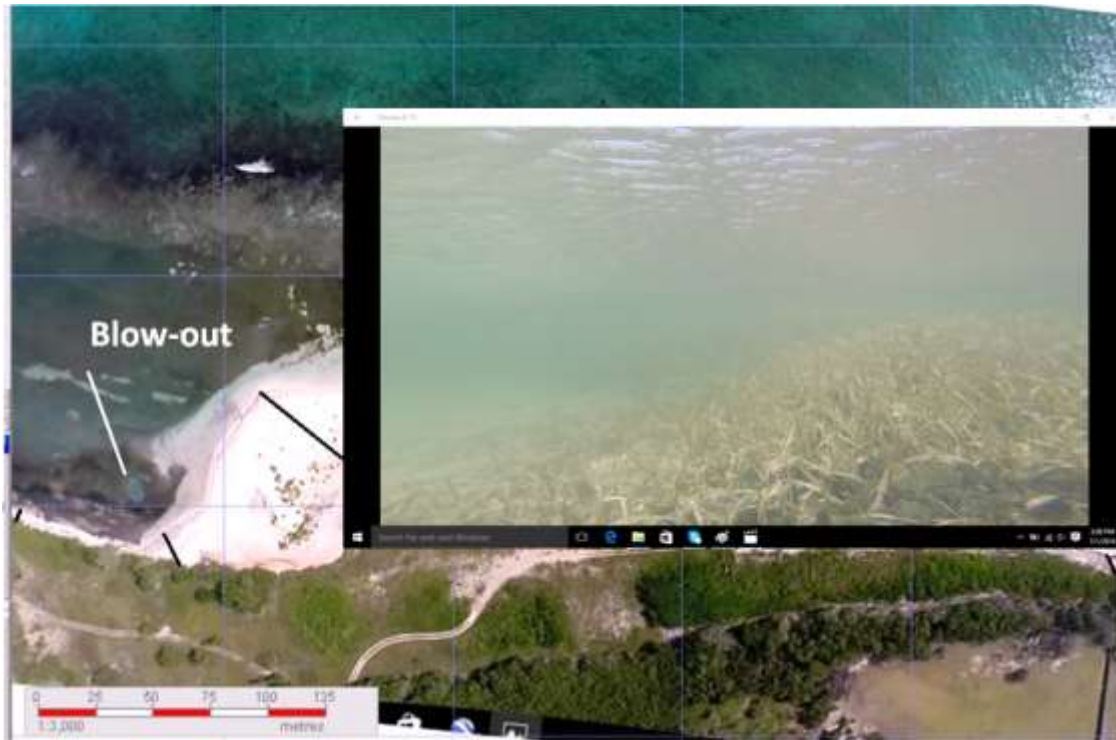


Figure 5.4.21: Illustration of Seagrass Resources Present Along Study Transects – Description of Blow-out Feature

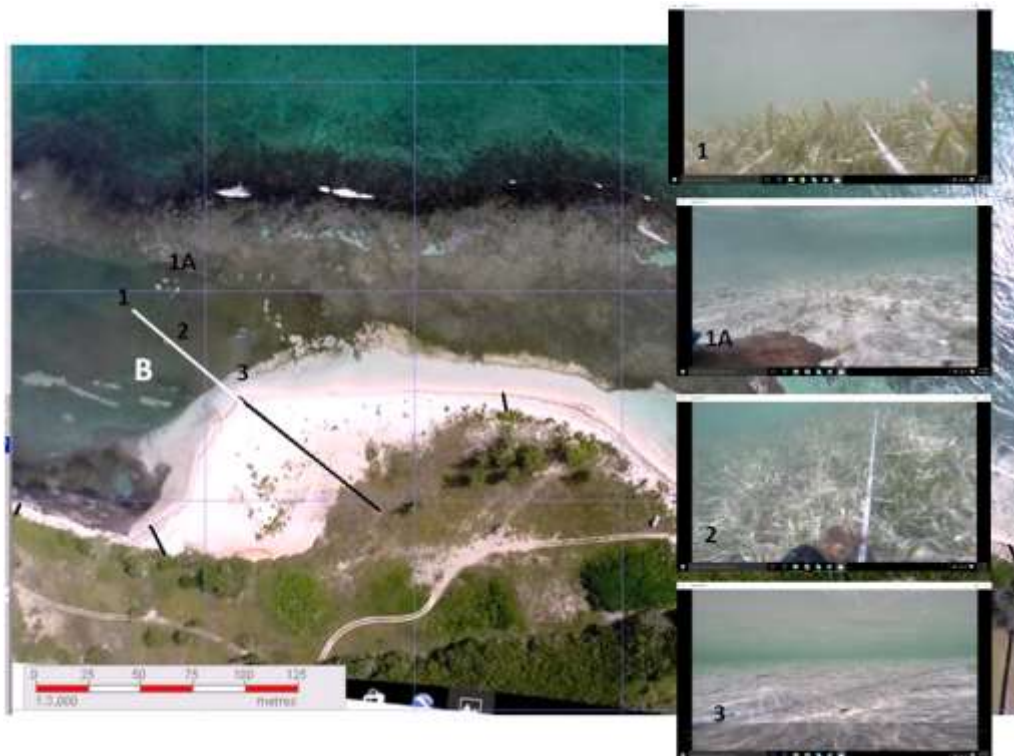


Figure 5.4.22: Illustration of Seagrass Resources Present Along Study Transects (1 –seagrass, 1A –area of hard bottom with algae, 2-seagrass, 3 sand bottom with no seagrass.



Figure 5.4.23: Illustration of Seagrass Resources Present Along Study Transects (1 –seagrass on sand/hard bottom substrate, 2- seagrass on sand/growth limited by erosion feature.

#### 5.4.2.5.2 Attached Benthic Lifeforms – Reef Spatial Distribution

Figure 5.4.24 illustrates the spatial distribution of reef resources within the study area. A detailed evaluation of the status of the reef resources present on the windward side (outside of the 100 meter seaward boundary) of the study area was not done. However, an indication of the status of reef resources on the leeward side was obtained during an examination of the eastern most study transect, as well as the northern extents of the other transects surveyed.

For the most part, reef resources observed at the northern extent of the transect surveyed (see Figure 5.4.25 below) were devoid of excessive macro-algae growth. Coral resources were sparsely distributed within the area surveyed and were comprised primarily of small (less than 15cm in diameter) heads of Smooth Starlet Coral (*Siderastrea radians* – see Figure 5.4.25: insert 2 below) and Fire Coral (*Millepora sp*).





Figure 5.4.24: Location of Reef Resources Present Within the Study Area (black/grey polygon).



Figure 5.4.25: Seagrass and Reef Resources Present Within the Study Area.

#### 5.4.2.5.3 Benthic Lifeform Spatial Change Over Time

Figure 5.4.26 (below) shows a comparison between the shoreline present in 2013 (as interpreted from Google Earth images) and that present in 2016. It strongly suggests that there has been a significant alteration of the position of the shoreline over the period. A corresponding change has also occurred in the spatial extent of seagrass resources over the period 2013-2016, which is represented on Figure 5.4.27. It is estimated that in 2013, 5.9 hectares of seagrass resources existed within the area studied. Thus, over the period 2013-2016, approximately 1 hectare of seagrass resources was affected by changing shoreline/sand distribution over the site.

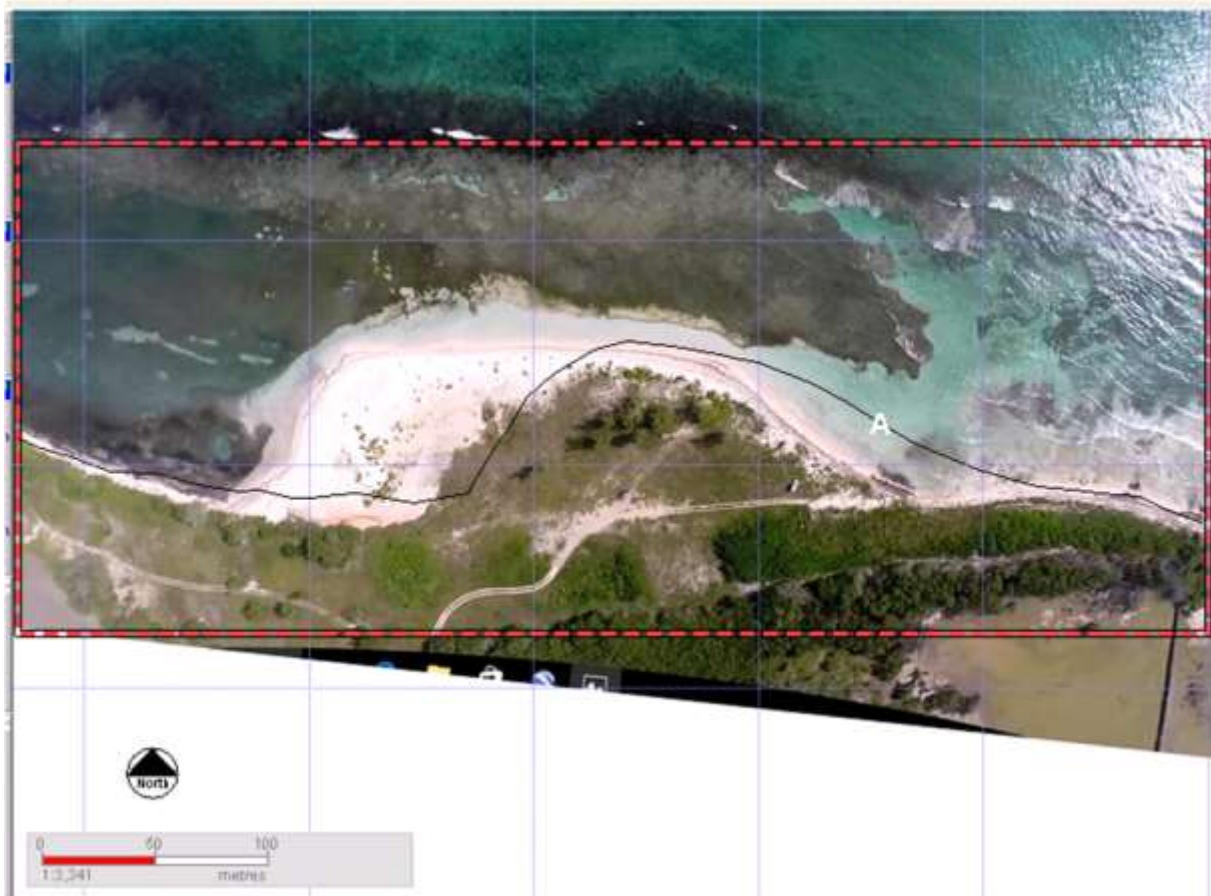


Figure 5.4.26: Shoreline Change Experienced Over the Study Area Over the Period 2013-2016 (A-shoreline position in 2013).



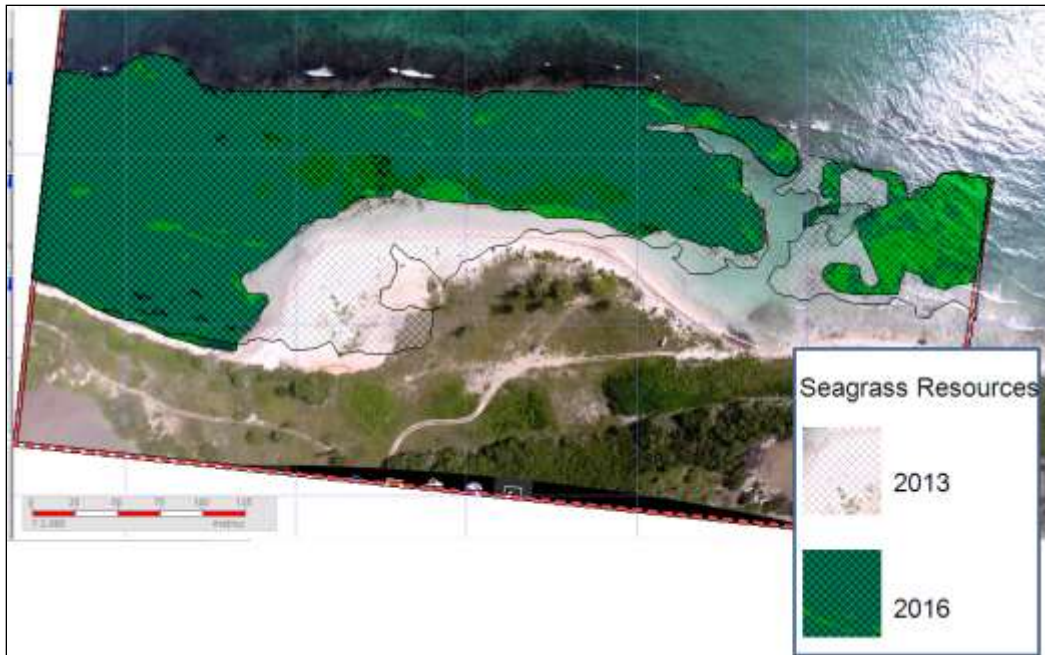


Figure 5.4.27: Seagrass Resources Change Experienced Over the Study Area Over the Period 2013-2016

#### 5.4.2.5.4 Marine Fauna

Several different species were seen along the eroded margins of the seagrass bed, in particular, juvenile fish. Figure 5.4.28 illustrates a school of juvenile Lane Snappers (*Lutjanus griseus*), the most frequently seen fish type observed within the study area.





*Figure 5.4.28: School of Juvenile Lane Snappers (Lutjanus griseus) Swimming at Edge of Seagrass Blowout (white square)*

An examination of the same seagrass margins also revealed the presence of attached benthic fauna, including a Sea Anemone observed at the edge of the blow out (see Figure 5.4.29 below).



*Figure 5.4.29: Sea Anemone Observed at Edge of Seagrass Blowout (white square).*

Finally, the shallow northern sections of the seagrass beds within the study area were populated with moderately dense populations of Sea Urchins, in particular, the West Indian Sea Urchin (*Tripneustes ventricosus*). An example of the Urchin observed in the area is illustrated on Figure 5.4.30 below.



Figure 5.4.30: Example of The West Indian Sea Urchin (*Tripneustes ventricosus*) Observed Within the Study Area Seagrass Bed.

Marine ecological resources observed within the seafloor study area are presented in Tables below:

Table 5.4.6: Benthic Attached Marine Ecological Resources Identified Within Study Area (Relate to Figure 5.4.29 above)

SUBMERGED MARINE SAND – ATTACHED BENTHIC LIFEFORMS	
Scientific Name	Common Name
<i>Thalassia testudinum</i>	Turtle Grass (dominant)
<i>Halodule wrightii</i>	Shoal Grass (occasional)
-	Anemone (rare)
MARINE SILT/MUD WITH BENTHIC LIFEFORMS ATTACHED	
<i>Thalassia testudinum</i>	Turtle Grass (dominant)
<i>Halodule wrightii</i>	Shoal Grass (occasional)

HARD CALCAREOUS SUBSTRATE (REEF)	
<i>Siderastrea radians</i>	Starlet Coral (Occasional)
<i>Millepora complanata</i>	Blade Fire Coral (Occasional)

Table 5.4.7: Benthic Mobile Marine Ecological Resources Identified Within Study Area (Relate to Figure 5.4.30 above)

SUBMERGED MARINE SAND WITH ATTACHED BENTHIC LIFEFORMS	
Scientific Name	Common Name
<i>Tripneustes Ventricosus</i>	West Indian Urchin (Frequent)
MARINE SILT/MUD WITH BENTHIC LIFEFORMS ATTACHED	
NIL	
HARD CALCAREOUS SUBSTRATE (REEF)	
<i>Diadema antillarum</i>	Black Spiny Urchin (Frequent)
<i>Tripneustes Ventricosus</i>	West Indian Urchin (Occasional)

Table 5.4.8: Free-swimming Mobile Marine Ecological Resources Identified Within Study Area (Relate to Figure 5.4.28 above)

SUBMERGED MARINE SAND WITH ATTACHED BENTHIC LIFEFORMS	
Scientific Name	Common Name
<i>Lutjanus synagris</i>	Lane Snapper (Frequent)
MARINE SILT/MUD WITH BENTHIC LIFEFORMS ATTACHED	
<i>Lutjanus synagris</i>	Lane Snapper (Frequent)
HARD CALCAREOUS SUBSTRATE (REEF)	
NIL	

## 5.5 Heritage

### 5.5.1 Regional Setting

The parish of Trelawny was formed by an act of the Assembly of Jamaica in 1770, and Sir William Trelawney, the then governor, signed the momentous act on December 29 that

year. To demonstrate their gratitude, the parishioners named Trelawny after the governor. At the time of its formation, Trelawny measured approximately 304 square miles and this made it the fifth largest parish in Jamaica. Martha Brae Village, not Falmouth, was the first capital of Trelawny. It was chosen shortly after 1770, and its appeal was based on its history and location. In 1790 lands that were known then as Barrett Estate was selected as the new capital and was renamed Falmouth after the governor's birthplace in Cornwall County, southwestern England.

The story of Falmouth, Trelawny after 1790 was one of prosperity. Falmouth became one of the first areas in the island to enjoy piped water, which was pumped from the centre of the town up until 1950, at a place appropriately named Water Square. Falmouth enjoyed piped water before the citizens of New York City did, though this was probably less significant than it is today. Later on, a Sea Tank, which operated until the mid-nineteenth century, was built a few miles offshore to supply ships with water.

Falmouth was operating as a free port in the early 1800's. This meant that it was exempted from charging certain types of tariffs collected at other ports throughout the island. This encouraged many ships to dock at Falmouth Harbour. As a missionary, Knibb had the opportunity to observe many areas in the island, and Falmouth impressed him enough to record his opinion of it in 1830. According to him, Falmouth was "a pleasant, fashionable seaport town with from 2,000 to 3,000 inhabitants."

Steamboats began to arrive in Jamaica in the 1830's, and it signaled the end of Falmouth as a major port town. These bulky vessels needed deeper waters to dock, and Falmouth Harbour was not deep enough. Several attempts were made to deepen the harbour, but Falmouth never regained its former glory. Railway transportation was introduced into Western Jamaica in the 1890's, and because Falmouth could not handle steamboats, the town was bypassed for Montego Bay.

Under the Jamaica National Heritage Trust Act of 1985, a section of Falmouth, recognized as rich architectural and archeological heritage, was declared as a National Monument on September 5, 1996.

In the last one and a half decade most of the coastal region of the parish of Trelawny has experienced a rebirth in development and many investments primarily in the area of



tourism and housing have been implemented with many more at various stage of planning. This development boom in the area is facilitated by the following infrastructure:

1. North coast Highway:

The North Coast Highway Improvement Project (NCHIP) (LO-972/OC-JA) was developed and designed between 1994 – 1996 against the socio-economic backdrop of a contracting Jamaican economy which was largely dependent on bauxite, alumina and tourism. To address this economic decline, the Government of Jamaica (GOJ) sensibly embarked on a response strategy of revitalizing the tourism sector and commissioned the elaboration of a Tourism Action Plan (TAP) with the objective of diagnosing the gaps in the sector impeding sustained growth.

A slew of North Coast (tourism belt) Improvement infrastructure Projects that would engender high tourism productivity growth, were born out of this process of which the development of the NCHIP from Negril to Port Antonio (Figure 5.5.1) was identified as an important first step as it directly impacted the lives of approximately 500,000 individuals.

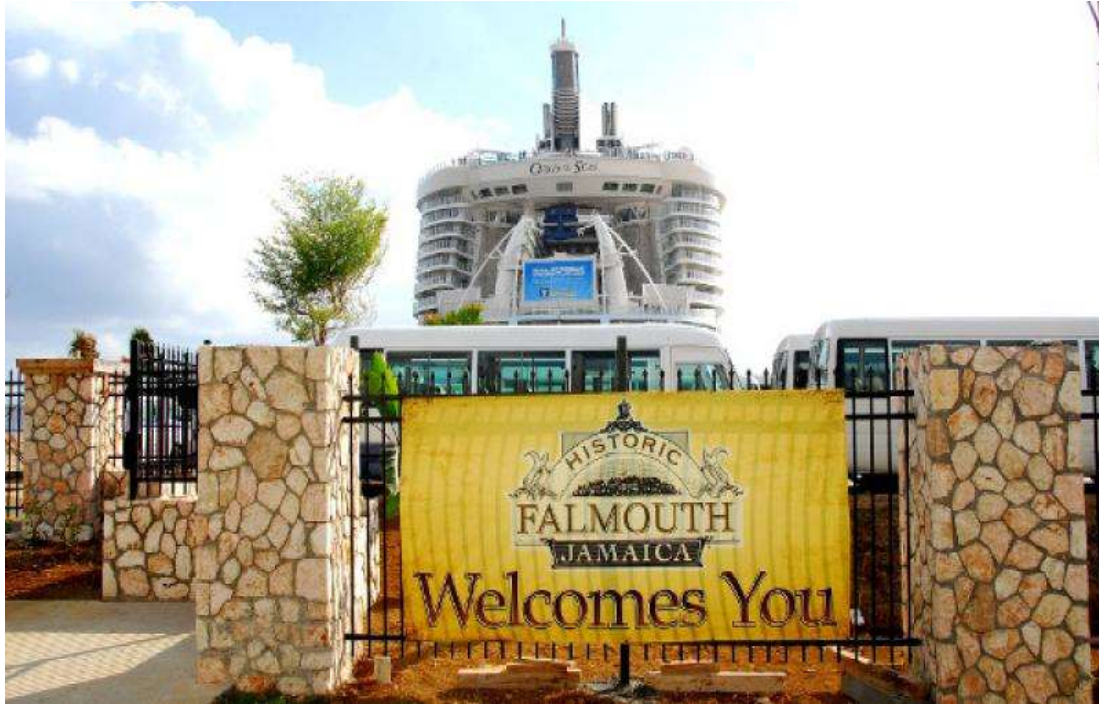
The North Coast Highway Improvement Project was essentially a five year program of investments in civil works to rationalize and improve 97km of coastal road together with investments to sustainably maintain the road and to minimize the negative environmental and social impacts. The overall objective of the NCHIP was to reduce overall road transportation costs along the route, improve vehicular and pedestrian safety, and alleviate congestion. By so doing, it would contribute towards attaining one of the country's primary objectives – to provide the physical infrastructure to diversify Jamaica's economy through tourism promotion and thereby provide foreign exchange reserves required to support economic development. The Project was also expected to ensure maintenance of the local socio-economic and ecological balance.



*Figure 5.5.1: Section of the North Coast Highway Improvement Project (NCHIP)*



*Figure 5.5.2: Falmouth Re-development Project*



*Figure 5.5.3: Falmouth Cruise Ship Pier*

### **5.5.2 History of Project Site**

The site proposed for the development of the hotel was once a part of the Stewart Castle Estate. In 1754, James Stewart of Scotland acquired the 167 acres estate and built an impressive cut-stone mansion with fortified towers which was designed to be a fortress; the remains of which stands today as the Stewart Castle Ruins (Figure 5.5.4). By 1799, Stewart Castle had expanded to 1200 acres, including quarters for 300 African slaves who keep the sugar works in operation. In 1912 the Stewart Castle estate ceased to operate as a sugar plantation and switched to cattle grazing and mixed cultivation.



*Figure 5.5.4: J.B. Kidd's Stewart Castle 1835*

Stewart Castle remained in the Stewart family for three generations. It passed to Stewart's son, also named James, who established Stewart Town, a community in Trelawny, and became custos of the parish in 1812. The estate changed hands several more times before Kaiser Bauxite Company bought it in 1930 and turned over the Castle, in ruins, in 1960, to the Jamaica National Heritage Trust Company.

In 1897, curator of the Natural History Museum of the Institute of Jamaica, James Edwin Duerden reported that Taino kitchen middens occupied a small section (about 7 acres) of the Stewart Castle Estate. Locally this section of the estate is known as Indian Town

The closest heritage feature to the project site is the ruins of the Stewart Castle which is located approximately 0.5 km north (Figure 5.5.5).





*Figure 5.5.5: Stewart Castle*

Contact was established with the Jamaica National Heritage Trust (JNHT) and information on the proposed project presented to the Trust. In response, the JNHT (Appendix 8) proposed that an Archaeological Impact Assessment (AIA) be carried out to ensure that any heritage which may be present on the project site is identified and mitigation measures implemented in advance of the development. Arrangements have been concluded with the JNHT for the AIA.

## 5.6 Socio-economic Environment

### 5.6.1 Zone of Immediate Influence

Given the nature and magnitude of the proposed development, over USD \$ 200M, its socio-economic influence can be expected to on a national level. The impact will no doubt extend from as far as Montego Bay in the West, Stewart Town and Clarks Town in the South and back to St Ann Bay in the East. At this stage of the development however, it is difficult to determine the projects impact on this much wider region.

For the purpose of this assessment the zone of socio-economic impact will focus on the geographical areas which are within a 2 km radius of the project site. There are no residential communities within 1 km of the project and the communities within the 2 km sphere of influence are; Coral Spring, Stewart Castle and Carey Park (Figure 5.6.1). Other communities which although not within the 2 km zone but was included in the assessment are Coopers Pen, Retreat Heights and Duncans.



Figure 5.6.1: 2 km Zone of Immediate Influence

#### 5.6.1.1 Coral Spring

This community is the closest to the site proposed for the Coral Springs Hotel Resort development (~1km). It is a recent development by Gore Development Limited of a high density sub-division comprising mainly two bedroom dwelling houses (Figure 5.6.2) the first phase of which has been completed and the second phase in a very advance state. When this development is complete there will be a total of about 500 units



*Figure 5.6.2: Typical two bedroom house which is signature style of Gore Developments Ltd.*

A substantial subdivision of the Coral Spring property was proposed and approved in the 1970's. This housing scheme failed and the existing subdivision comprising just over twenty built up and a few vacant lots. Residences are well appointed and of sound construction with those on Beach Road being noticeable for their landscaping. There are no actively used recreational facilities within the community, although an area with a tennis court is marked out and an empty swimming pool exists. This small community characterizes itself as comprising mainly returning residents and retirees. Some of the houses are vacant and their owners reported as being overseas.

#### 5.6.1.2 Stewart Castle and Carey Park

Both communities have a common heritage and interest in that continuum that links Stewart Castle Sugar Plantation in the 18<sup>th</sup> century through the work of William Knibb, emancipation and the free village system. The communities have a commonality in that they are unplanned residential areas, middle and lower income in economic terms, and each evidencing signs of growth in housing stock, which ranges from poor construction to fairly substantial architecturally designed houses.

The ruins of Stewart Castle which is a National Heritage site is located on the north western edge of these communities. The main entrance to the proposed hotel development will also access the highway through the Stewart Castle community.

#### 5.6.1.3 Retreat Heights

Retreat Heights is a large upscale residential community which lies opposite to Coral Springs, but with its main entrance located closer to the Royalton White Sands Hotel. Developed as a build on own lot subdivision circa 1995, this community has grown steadily since inception to now comprise over 100 high income homes.

#### 5.6.1.4 Coopers Pen

Coopers Pen is a seaside village located along the old north coast road adjacent to the Royalton White Sands Hotel and about 4 miles west of the Project site. The population could number about 300 including the neighboring unplanned settlement. Coopers Pen is a relatively infrastructure poor, lower income coastal community, with a high proportion of youth and female headed households. This demographic profile is generally representative of the coastal communities found in the Parish. The main land use is residential. Land use density within the community is dominated by Royalton White Sands Resort, with both community residences and the much smaller fishing beach accounting for the remainder. A striking contrast is the co-existence of the hotel property and the surrounding substandard residential housing. Coopers Pen itself comprises an older, sea-fronting section which includes a fishing beach and a newer unplanned community on land, edging the new north coast highway. Livelihoods inside the community come mainly from a mix of poorly constructed corner shops, entertainment venues and eateries. From observation, the viability and vitality of the township has been severely compromised since the main road through it was replaced by the Northern Coastal Highway. Some amount of vitality which may be short lived has returned with the expansion of Royalton which commenced in 2015 and is scheduled to be terminated at the end of 2016. Unemployment is reported as being very high. Those finding permanent employment do so largely in tourism. The presence of the Royalton Resort provides an important source of income for the community, as tourism spending filters down through food vending and transportation.



### 5.6.2 Demography and Regional Setting

Information on demography, regional setting and existing infrastructure was obtained primarily from recent EIA/EIS which were conducted for projects within the same general area. These include; - *Environmental Impact Assessment for Coral Springs Residential Development* by Gore Development Ltd, prepared by Environmental Solutions Ltd; - *Environmental Impact Statement of the Proposed Luxury Villas at White Bay, Trelawny* by White Bay Ltd, prepared by C.L. Environmental; - *Environmental Impact Assessment, Treasures of Trelawny Resort Development* by Treasures of Trelawny, prepared by Conrad Douglas & Associates Limited. Information from these sources was verified and checks conducted to determine if updated data were available and where this was so it was used as is the case for the STATIN 2011 census.

Jamaica's population grew from 2,607,632 (2.608 million) persons in 2001 to 2,697,983 (2.698 million) in 2011. This represents a 3.5% increase in the total population size over the period (2001 – 2011). The Falmouth area, within which the proposed Coral Springs development is situated, has grown modestly over the period 2001 to 2011. STATIN 2011 data reflects an overall population of 75,164 which represent an increase of 2.87% during this 10 year period. The growth rate was 1.85% for the previous 10 year period of 1991 to 2001. Within 2km of the project area, the population was estimated to be 848 persons in 2011 (based on STATIN 2011 census).

Commercial trading activity, tourism and to a lesser extent agriculture have been important economic generators in the regional setting. Light manufacturing which was in the 1980s an important source of employment in some communities (for example garment manufacturing in Hague) has largely been replaced by trading and tourism. More recently, the completion of the Northern Coastal Highway, the Greenfield Sports Stadium, Falmouth Cruise Ship Port, acquisition and expansion of the former Starfish Hotel and the Coral Springs Housing development facility are seen as important infrastructure developments.

Land use in the study area is mainly commercial, fishing, residential, recreational and some agriculture.

### 5.6.3 Existing Infrastructure

#### 5.6.3.1 Transportation

The site for the proposed development is located approximately 10 km east of Falmouth and approximately 39 km east of Sangster International Airport (Montego Bay).

The road network serving the zone of impact allows for the orderly flow of traffic between the communities of interest. The Northern Coastal Highway is the arterial road which connects the communities and also provides for hassle free transit to the towns and cities both east and west of the development. Local Traffic Authority reports that Falmouth to Duncans road is generally not a congested area, except when events are held at the Greenfield Stadium. The speed limit on the highway is 50 Km in the vicinity of the entrance to the Project (Stewart Castle). Transportation within the study area is provided by a fleet of taxis, “robot taxis” (unlicensed), buses and private cars.

#### 5.6.3.2 Utilities

##### 5.6.3.2.1 Water

With the exception of Coral Springs, the communities in the zone of influence are supplied water by NWC and the service is generally considered to be adequate. The area is served by two NWC treatment plants; Old Treatment Plant #1 (as it is referred to) located at Hague and is responsible for supplying treated water to several communities in the Falmouth area. The main plant is referred to as the New Treatment Plant and is located on the Martha Brea to Perth Town Road. It has the capacity to produce 6 Million Gals per day. More than half of which is sent along the coast into St. James and St Ann with the balance serving the environs of Falmouth area. It is the current source of treated water to the Greenfield Stadium and neighbouring housing developments and to the communities of interest, with the exception of Coral Springs which receives its own supply from a spring.

Table 5.6.1: Water yield and demand for Martha Brae and R. Bueno Water Management Units

Water Management Units	Reliable Surface Yield	Safe Ground Water Yield	Total Supply	Water Demand (10 <sup>6</sup> m <sup>3</sup> /Year)				Total Demand	Avg. Water Balance	Surplus Projected to 2025
				Munic.	Irrg.	Industr.	Env.			
Martha Brae	149.8	89.4	239.2	4.9	6.6	0.0	44.8	56.3	182.9	175.3
R.Bueno/White River	237.1	368.7	641.8	20.4	3.2	6.2	129.6	159.4	482.4	466.3
<b>Total</b>	<b>386.9</b>	<b>458.1</b>	<b>881</b>	<b>25.3</b>	<b>9.8</b>	<b>6.2</b>	<b>174.2</b>	<b>215.7</b>	<b>665.3</b>	<b>641.6</b>

Source: A National Water Resources Master Plan for Jamaica 2<sup>nd</sup> Draft 2005 (Water Resources Authority).

#### 5.6.3.2.2 Electricity

All communities in the zone of influence have access to electricity from the JPS grid with the primary line running along the highway.

#### 5.6.3.2.3 Telecommunication

The parish of Trelawny and the study area are served with landlines provided by Flow Jamaica Limited. Wireless communication (cellular/internet) is provided by Flow and Digicel.

#### 5.6.3.2.4 Public Health and Safety

Persons within the study area obtain their health care at a number of health centres and private doctors. The closest hospital to the proposed site is located in Falmouth. It is a Type C Public Hospital, located at approximately 10 km from the proposed site. This Hospital has approximately three hundred and twenty (320) beds and provides the following services; General medicine, General surgery, Paediatric surgery, Paediatric medicine, Obstetrics, Maternity services, Tubal Ligation, Other gynaecological services, X – Ray, Physiotherapy and a Pharmacy.

The health centres within proximity to the proposed site are the Duncans/Dewars Health Centre which provides the following services; Maternal, Antenatal, Postnatal, Child Health, Immunization and Family Planning. The other is the Falmouth Health Centre which provides services in; Maternal, Antenatal, Postnatal, Child Health, Immunization, Family Planning and Food Handlers permits.

#### 5.6.3.3 Emergency/Fire Service

The fire station that would respond to an emergency at the proposed site is located within Falmouth, some 8 km from the proposed development site. The station was officially reopened in 2007 after a \$100m upgrading. (Figure 5.6.3) The proposed development will have its own designed fire control system, with a series of fire hydrants and fire extinguishers. It is not anticipated that there will be any problems as it relates to fire fighting and a fire event at the proposed development.



*Figure 5.6.3: Falmouth Fire Station*

#### 5.6.3.4 Police Station

The Falmouth police station (Figure 5.6.4) is responsible for policing the area in proximity to the proposed development site. They have reported that incidence of major crimes are low if not non-existent. Crime is not expected to be a major problem in proximity to the proposed site.



*Figure 5.6.4: Falmouth Police Station*



#### 5.6.4 Land Use

The main land use in the more limited zone studied is agriculture and settlement followed by commercial activity and tourism. Agriculture is mainly market, gardening and pen keeping. This is reflected from the community membership's perception of land use in the project area as reflected in Figure 5.6.5 below. Consistent with observation, the main land use identified was residential (45%), followed by agricultural (36%) and commercial activity (18%).

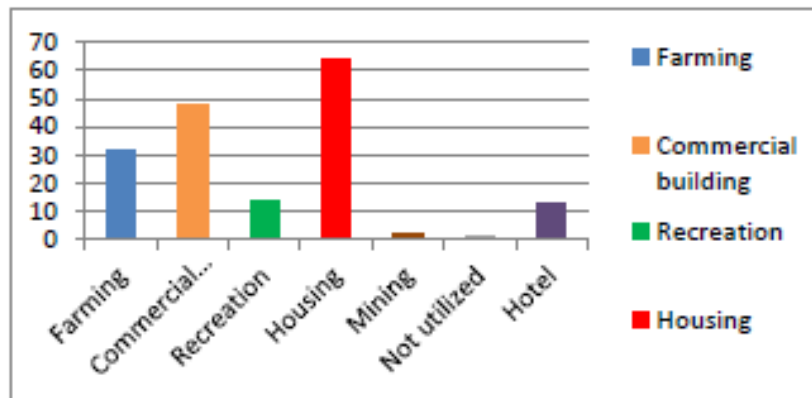


Figure 5.6.5: Land Use in surrounding communities of the proposed site (Extracted from EIA for Coral Springs Residential Development for Gore Development Ltd – Final Report – June 2012)

On the coastal strip several tourism establishments are in various planning stages such as the 1,800 room Oyster Bay Hotel development (currently halted). Expansion of Royalton Resorts now underway with plans for further expansion in the near future. White Bay Luxury Villas proposed for White Bay. Treasures of Trelawny proposed 112 rooms in a Five Star development at Duncans Bay. The 25,000 seat Greenfield Stadium complex which still remains at the center of the Government's interest in promoting sports tourism. Centered near Martha Brae is the important rafting attraction along the Martha Brae River.

The Falmouth Cruise Terminal, a project of the Port Authority of Jamaica includes berthing and other landside facilities to accommodate two mega line size cruise ships in the Genesis class. It is currently in operation with weekly visits by Carnival Cruise Lines. This major tourism development is an important compliment to the landside expansion of the existing tourism hotel infrastructure.

Agriculture is most intense in the sugar belt extending through the Queen of Spain's Valley. Fishing takes place in the Falmouth harbor and along the coast. The nearest NEPA licensed

fishing beach to the project is at Rock. It should also be mentioned that the Jamaica Salt Works<sup>37</sup> is approximately 100m to the west of the project site, however operations from the evaporation process at the pond has ceased and is inactive (Figure 5.6.6).



Figure 5.6.6: Google map showing mineral resource locations in relation to Coral Spring Hotel site

### 5.6.5 Community Opinion of the Proposed Development

A rapid survey of community residents and business owners as well as persons occupying leadership positions within the community was undertaken. The survey was focused on the three communities within the 2 km zone of influence since these are the communities which would have greatest interaction with the project their responses ought to give a very good indication of opinion on the project. It is to be noted that other communities outside the 2 km zone such as Retreat Heights, Duncans, Refuge and Coopers Pen will be invited to participate in the public presentation of the EIA.

<sup>37</sup> Natural Salt that is formed from evaporation of sea water by the sun or wind in an open pond is normally referred to as solar salt.

The survey sample size was determined primarily by the estimated size of the population and proximity to the project site. The number of respondents are broken down by communities as follows:

- Coral Spring                -        62
- Stewart Castle           -        28
- Carey Park                -        24

The survey was conducted during the week of August 7, 2016 and September 19, 2016 by the EIA Team. The survey form is shown in Appendix 6. The results of the survey (Table 5.6.2 and Table 5.6.3) indicated that the majority of the residents are looking forward to the project and see it as a means providing job opportunities and increasing the socio-economic quality of their lives.

In addition to the general survey, several telephone discussions and exchange of information via emails were held with the president of the Coral Spring and Stewart Castle Citizen Association. Appendix 7 shows an example of the letters which were sent to the community's citizen associations as well as other stakeholders such as the Member of Parliament, Councilor, Mayor and the Police in charge of the area.

*Table 5.6.2: Community Survey Results*

<b>Coral Spring – 62 Respondents</b>				<b>Stewart Castle - 28 Respondents</b>			
<b>Questions</b>	<b>Yes</b>	<b>No</b>	<b>No Ans.</b>	<b>Questions</b>	<b>Yes</b>	<b>No</b>	<b>No Ans.</b>
Aware of the hotel project	38	24	0	Aware of the H10 hotel project	14	11	3
Aware of other development	45	16	1	Aware of other development	18	10	0
Project will provide jobs	57	0	5	Project will provide jobs	26	0	2
Attract other to live in area	50	9	3	Attract other to live in area	21	0	7
Destroy the environment	36	20	6	Destroy the environment	11	11	6
Cause/contribute to flooding	2	36	24	Cause/contribute to flooding	5	17	6
Have no significant impact	16	32	14	Have no significant impact	8	16	4
Create dust & noise nuisance	42	6	14	Create dust & noise nuisance	17	7	4
Cause traffic problem	24	28	10	Cause traffic problem	17	3	8
Socio-economic improvement	53	2	7	Socio-economic improvement	22	1	5
Do support of the hotel project	48	4	10	Do support of the hotel project	22	1	5
<b>Carey Park – 24 Respondents</b>				<b>Total – 114 Respondents</b>			
<b>Questions</b>	<b>Yes</b>	<b>No</b>	<b>No Ans.</b>	<b>Questions</b>	<b>Yes</b>	<b>No</b>	<b>No Ans.</b>
Aware of the H10 hotel project	7	15	2	Aware of the H10 hotel project	59	50	5
Aware of other development	16	5	3	Aware of other development	79	31	4
Project will provide jobs	20	2	2	Project will provide jobs	103	2	9
Attract other to live in area	18	1	5	Attract other to live in area	89	10	15
Destroy the environment	4	16	4	Destroy the environment	51	47	16
Cause/contribute to flooding	2	12	10	Cause/contribute to flooding	9	65	40
Have no significant impact	5	15	4	Have no significant impact	29	63	22
Create dust & noise nuisance	12	8	4	Create dust & noise nuisance	71	21	22
Cause traffic problem	5	14	5	Cause traffic problem	46	45	23
Socio-economic improvement	18	2	4	Socio-economic improvement	93	5	16
Do support of the hotel project	19	1	4	Do support of the hotel project	89	6	19

*Table 5.6.3: Community Survey Results - Concern for the Project*

<b>Area of Concerns</b>	<b>Coral Spring</b>	<b>Stewart Castle</b>	<b>Carey Park</b>	<b>Total</b>
Squatting	44	13	6	63
Crime	48	14	8	70
Air/Noise Pollution	24	11	1	36
Water Shortage	0	8	13	21
Do not know	6	9	6	21



The community was asked if they are in support of the development of the hotel at the proposed site and the following response was given (Figure 5.6.7):

- Support the hotel project - 78%
- Not sure/No answer - 17%
- Do not support the hotel project - 6%

Those supporting the project expect job opportunities and improved socio-economic conditions. Those not supporting the project was concern about crime, squatting and dust and noise nuisance mainly from trucks travelling through the community during construction.

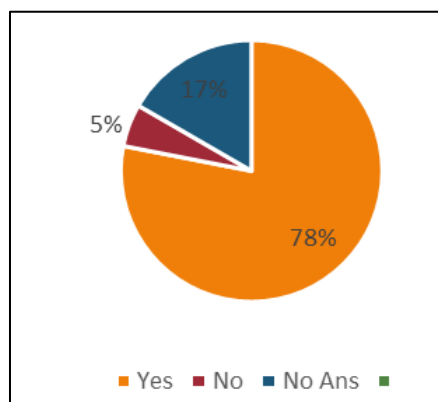


Figure 5.6.7: Response of interviewees regarding support for project

When asked what was their major of concern as it relates to the hotel project, the response was as follows (Figure 5.3.8): Squatting - 32%; Crime - 36%; Air/Noise Pollution - 18%; and Water Shortage – 11%. The concerns for squatting and crime related more to the construction period.

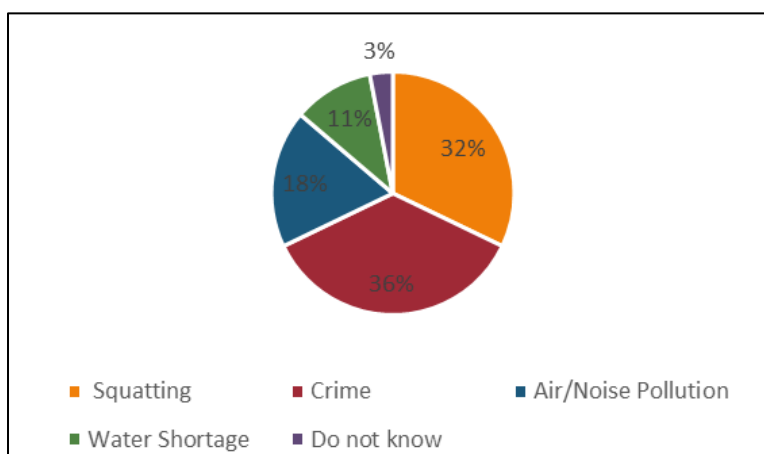


Figure 5.6.8: Response of interviewees regarding areas of concern

## 6 Public Participation

A survey of the communities within the 2 km zone of influence was conducted during the week of August 7, 2016 and September 19, 2016. The details of the survey are presented in section 5.6.5 above as well as the other methods utilized to obtain feedback from the community. Key stakeholders such as the president of the Coral Spring and Stewart Castle Citizen Association, the Member of Parliament, the Mayor and Councilor were contacted by letter/email/telephone.

The Draft EIA will be presented at a public meeting which is to be organized in the community and will be done in accordance with NEPA Guidelines for conducting public presentation of EIA. Feedback received during and after the meeting will be incorporated in the final document.

## 7 Impact Identification and Analysis

### 7.1 Introduction

The proposed Coral Springs resort development has the potential to create a variety of impacts when it is implemented, during both construction and operation phases. These potential impacts can be either positive or negative depending on the receptors involved and other parameters such as magnitude, duration, project management and the mitigation measures employed.

The significance of a potential impact is assessed primarily based on the magnitude, frequency, likelihood/probability of occurrence and duration. Each parameter identified 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
- ❖ 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

Potential impacts identified as being associated with the implementation of the project are divided into the following categories:

- ❖ Physical environment
- ❖ Natural Hazards
- ❖ Biological
- ❖ Heritage
- ❖ Human/Social/Cultural
- ❖ Public Health

An assessment of the identified potential impacts are presented below.

## 7.2 Impact Assessment & Mitigation

Table 7.2.1: Assessment of the identified potential impacts for the construction phase

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
<b>Physical</b>				
Site Clearance and erection of concrete structures	- Fugitive Dust impacting air quality	· Minimize the size of cleared area; period wetting; wearing of PPE on site (N95 respirators).	Short term/Reversible	Minor/Negative
		· Wetting of exposed areas every 4 - 6 hours to minimize dust generation		
		· Fencing and hoarding the site		
		· Replace grass on exposed soils and other suitable cover		
	-Soil erosion	· Control exposed soil run-off through barriers and control flows from heavy runoff areas that threaten to erode or result in substantial turbid surface runoff to adjacent marine waters.	Short term/Reversible	Major/Negative
	-Increased turbidity in marine waters	Fortnightly water quality monitoring for TSS, turbidity, BOD, nitrate, phosphate and faecal coliform	Short term/Reversible	Major/Negative
		· Monitor areas of exposed soil during periods of heavy rainfall to ensure erosion can be addressed where necessary. Use of sediment ponds, sediment basins and turbidity barriers		
Construction Materials transported and stored for use on site	-Spillage to the environment and Fugitive Dust	· Stockpiles of material to be covered or wetted to prevent wind erosion	Short term/Reversible	Major/Negative
		· Wet Access Roads and exposed soils		
		· Trucks with earth materials will be covered to prevent fugitive dust emissions		
		· Immediate clean up of spilled material		
		Fine grained materials (sand, marl, etc.) will be stockpiled away from drainage channels		
		Equipment should be stored on impermeable hard stands surrounded by berms to contain any accidental surface runoff		
		Bulk storage of fuels and oils should be in clearly marked containers (tanks/drums etc.) indicating the type and quantity being stored.		
		Raw material should be placed on hardstands surrounded by berms.		
		Paths of the planned roadways should be used, rather than creating temporary pathways just for equipment access		
		· Trucks must not be overloaded to prevent spillage to the environment		
	-Materials received from illegal quarrying	· Materials to be sourced only from Licenced quarries and suppliers. Checks will be made by management team of sources of all materials used	Short term/Reversible	Minor/Negative
	Traffic congestion due to slow moving trucks	· Delivery of materials that require larger haulage trucks to be scheduled during low traffic hours as much as is practical	Short term/Reversible	Minor/Negative
		Adequate and appropriate road signs should be erected to warn road users of the construction activities.		



Activities	Potential Impact	Mitigation	Duration/Nature	Significance
		Paths of the planned roadways should be used, rather than creating temporary pathways just for equipment access		
		· Employ Flag men to help ensure road safety and regulate traffic		
Heavy Equipment Operation	- Air pollution from vehicular emissions.	· Proper maintenance of vehicle and equipment.	Short term/Reversible	Minor/Negative
	Greenhouse gas emission	· Use fuel efficient and properly maintained vehicle and heavy equipment	Long term Irreversible	Minor/Negative
		· Fuel and other onsite oil storage facilities will be properly banded and maintained.		
		· Chemicals will be properly stored in suitable containers with their contents labelled with required safety signs placed on storage areas		
	-Soil and water contamination from oil and other Chemical use	· Proper work procedures will be employed to prevent spillages during dispensing.	Short term/Reversible	Major/Negative
		· Emergency and Spill Response plans will be drafted for use		
	-Noise from excavating, Pile driving and general construction activities	Daily monitoring of vehicle refuelling and repair should be undertaken to ensure that these exercises are carried out on hardstands. This is to reduce the potential of soil/sand contamination from spills		
		· Restrict pile driving and noisier activities to normal working hours	Short term/Reversible	Minor/Negative
		Use equipment that has low noise emissions as stated by the manufacturers		
		Use equipment that is properly fitted with noise reduction devices such as mufflers		
		Operate noise-generating equipment during regular working hours (e.g. 7 am – 7 pm)		
		Construction workers operating equipment that generates noise should be equipped with noise protection		
		· Inform residents to be potentially affected of the pending activities		
		· Conduct noise monitoring during noisy operations to ensure stipulated Noise levels are not exceeded off site		
Workers on Site	- Generation of solid waste	· Establish proper garbage receptacle and disposal.	Short term/Reversible	Minor/Negative
		Skips and bins should be strategically placed within the campsite and construction site		
		The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour		
		· Proper temporary sanitary facility with good servicing. A ratio of approximately 25 workers per chemical toilet should be used.		
	- Human waste generation	· Proposed training of workers on site on proper solid waste management and use of bins		
	Vending and Food Hygiene	Provision of adequate supply of potable water	Short term/Reversible	Minor/Negative
		The monitoring of the various ‘cook shops’ by public health authorities, and with the monitoring of the construction management team, to ensure proper hygiene is being followed.		
		The provision of areas to adequately wash hands and utensils		

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
<b>Biological</b>				
Site Clearance	<b>TERRESTRIAL</b>	<ul style="list-style-type: none"> <li>Reserve as much trees as possible; replant vegetation</li> </ul>	Long term/Irreversible	Major/Negative
	Loss of vegetation, Loss of Habitat, Habitat fragmentation and Loss of species diversity and abundance (reduced Biodiversity)	<ul style="list-style-type: none"> <li>Establish aesthetically pleasing in green area.</li> </ul>	Long term/Irreversible	Major/Positive
	Species which may be impacted; Avifauna, invertebrates, reptiles and amphibians	<ul style="list-style-type: none"> <li>Limit Site clearance to working footprints so as to retain as much of the original vegetation, including trees, as practical considering the proposed layout of the buildings.</li> </ul>	Long term/Irreversible	Minor/Negative
		<ul style="list-style-type: none"> <li>Submit a landscape plan prior to commencement of site clearance for approval that would seek to preserve habitats as best as practical, which are favourable to the existing avi fauna, by identifying the existing trees that it would be possible to protect,.</li> </ul>	Short term/Reversible	Minor/Negative
	<b>MARINE</b>		Long term/Irreversible	Major/Negative
	Loss of seagrass, Loss of Habitat, Habitat fragmentation and Loss of species diversity and abundance (reduced Biodiversity)	Erect barrier in natural storm water channels. Reduce sedimentation to the marine environment		
	Loss of seagrass, Loss of Habitat, Habitat fragmentation and Loss of species diversity and abundance (reduced Biodiversity)	Limit coastal modification in particular the removal of seagrass, hard corals, soft corals and sponges		
	Loss of reef community including hard and soft corals, sponges and benthic species. Loss of Habitat, Habitat fragmentation and Loss of species diversity and abundance (reduced Biodiversity)			
<b>Socio- Economic</b>				
Site Clearance and construction activities	- Employment of skilled labourers and construction workers	No mitigation required	Short term	Major/positive
	Influx of workers may lead to illegal settling in the area	Coordination with parish council to prevent informal settling of workers	Long term/Irreversible	Major/Negative
Site Clearance and construction activities	Decreased Aesthetic appeal	Skips and bins should be strategically placed within the campsite and construction site	Short term/Reversible	Minor/Negative
		The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour		

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
Site Clearance and construction activities	Emergency Response and Accidental Injury	A lead person should be identified and appointed to be responsible for emergencies occurring on the site.	Long term/Irreversible	Major/Negative
		The construction management team should have onsite first aid kits and make arrangements for the nurse and doctor at the Falmouth Hospital to be on call. Prior arrangements should be made with health care facilities/clinics to accommodate any eventualities.		
		Material Safety Data Sheets (MSDS) should be stored onsite.		
Cultural				
Site Clearance	- Possible damage of cultural artefacts	JNHT survey to determine likelihood of finding artefacts in the area	Long term/Irreversible	Minor/negative
		· Site clearance to be done keeping a keen eye out for potential artefacts, which if found will be secured by Site manager	Short Term/Irreversible	Major/Positive

*Table 7.2.2: Assessment of the identified potential impacts for the operation phase*

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
<b>Physical</b>				
Use of utilities (electricity, water)	- increased demand for water	· Employ water conservation strategies, including low water usage fixtures.	Long term/Irreversible	Major/Negative
		· Reuse treated effluent from Wastewater treatment facility for land scaping		
		· Rainwater harvesting through installation of roof gutters for rainwater capture		
		Do not leave the tap running while cleaning, using buckets for holding water instead		
		Hotel guests can be given politely written cards as to how to conserve water in their bathrooms		
		Purchase and use water-saving equipment always		
		Establish an effective employee training program about water conservation		
		Make reglar checks on plumbing ssytem for leaks or failures		
		Report immediately any leaking and dripping faucet		
	- increased demand for electricity	· Energy Saving devices and fixtures to be employed throughout the development		
Solid Waste generation	Solid waste not properly managed affecting the marine environment and resulting in decreased Aesthetic appeal	Develop solid waste management system for use which will include, solid waste segregation/separation and minimization.	Long term/Irreversible	Major/Negative
		Provision of solid waste storage bins and skips.		
		Provision of adequately designed bins and skips to prevent access by vermin		
		Monitor beach garbage		
		· Ensure proper disposal of solid waste at an approved disposal site (Retirement Landfill) as required by NSWMA	Long term Irreversible	Minor/Negative

Activities	Potential Impact	Mitigation	Duration/Nature	Significance
Wastewater generation	- Soil, Groundwater, and marine environment contamination	· Construct wastewater treatment facility for treatment of all wastewater generated, treated to meet the required standards.	Long term/Irreversible	Major/Negative
		· Treated effluent will be used for landscaping of green areas on site, preventing discharge to the marine environment		
		· Irrigation storage tank to be installed to hold treated effluent during periods of heavy rainfall to prevent sheet flow of treated effluent to the environment		
		· Irrigation rate to be limited to prevent soil saturation		
		Quarterly marine water quality monitoring for TSS, turbidity, BOD, nitrate, phosphate and faecal coliform		
Hotel Operations	Increased Surface runoff due to increase in hard surfaces to the marine waters	Drainage plan as presented for the approval of NWA, to ensure protection of the marine environment and the foreshore	Long term/Irreversible	Major/Negative
Biological				
Hotel Operations	TERRESTRIAL	No mitigation needed	Long term/Irreversible	Major/Negative
	MARINE			
	Diving and snorkelling activities lead to degradation of the benthic community including seagrass, hard corals and invertebrates due to physical damage and/or removal	· Monitor to ensure corals are not removed by patrons		
		· Sensitize swimmers to the importance of protecting the reef		
		· Provide mooring points for boats etc. that does not affect the reefs		
Socio- Economic				
Hotel operations	- Employment of individuals	No mitigation needed	Long term	Major/positive
	-skills development through staff training			
Hotel Operations	Emergency Response and Accidental Injury	Have first aid kits located in various sections of the hotel	Long term/ Reversible or Irreversible	Major or minor / Negative
		Make prior arrangements with health care facilities to accommodate any eventualities		
		Arrange with other health practitioners to be on call or have an in house physician/nurse		
		Design and implement an emergency response plan		
		Staff should be trained in CPR		
		Coordinate with mutual aid organisations/agencies such as with the local fire brigade		
Cultural				
Hotel operations	- Cultural exchange by tourist from all over the world with locals.	No mitigation needed	Long term	Major/positive/negative

## 7.3 Site Preparation and Construction

### 7.3.1 Overview of Activities and Impacts

#### 7.3.1.1 Site Preparation

Construction of Phase 1 is planned for the north-western side of the hotel property, followed by Phase 2 construction on the north-eastern side and finally, phase 3 to be constructed on the southern section in the hilly terrain. Phases 1 and 2 are located closest to the northern coastline and will consist of the construction of 11 blocks of 5-storey buildings.

Site preparation for phase 1 will include excavation works for sewer and water mains, waste water and storm drainage facilities as well as swimming pools. Additionally, fill for landscaping purposes and backfilling operations will also be conducted. This will involve the use of hammer drills with compressors, pneumatic drills, excavators and bulldozers for land clearance and hard digging. Heavy duty trucks (trailers) for transporting construction material and equipment to the site will be an integral part of site preparation activity.

Similar earthworks construction will be conducted for phase 2; however, there will be additional activities, as the pond will be modified to facilitate construction. Draining, cleaning, backfilling and compacting will take place as part of ground modification on the north-eastern section of the site. This will require the use of construction and other equipment such as water pumps, dumper trucks, loaders, scrapers and compactors.

Also, construction on the moderate to steep slope also includes the clearing of land and the excavation of rock for the construction of villas and access roads.

Main impact will be noise from equipment, fugitive dust, and alteration of topography, waste generation and water quality.

#### 7.3.1.2 Building Construction Phase

During building construction, heavy duty equipment such as excavators, loaders, compactors, cranes, rollers and pavers as well as pneumatic drilling equipment will be used. During phase 1 operation, waste and construction material will be stored at phase 2



pre-construction site and during phase 2 operation, construction material will be stored near the SE boundary of the site.

Phase 3 (villas) will take a different approach, since it is the final phase of development following the completion of Phases 1 and 2 and will be located on the moderate to steep slope overlooking phases 1 and 2 and the Caribbean Sea. Heavy duty equipment such as excavators, bulldozers for excavation of earth material, removal of woodland vegetation and loaders for loading and removing material off/on-site will be conducted.

### **7.3.2 Physical Impacts**

#### **7.3.2.1 Coastline Modification**

Modification of the coastline will be done to facilitate recreational activities such as swimming and water sports. This involves excavation of partly submerged rocks which is to be replaced with beach sand, removal of approximately 0.2 hectare of seagrass and the dredging of soft mud and silt on the seafloor on the eastern and western side of the shoreline respectively.

#### **7.3.2.2 Impact of Earth Works and Building Construction Activities**

##### **7.3.2.2.1 Backfilling of Pond**

Backfilling the shallow pond within the property boundary will result in migration of brackish water further to the south east on the adjoining property. However, if the backfill is not adequately compacted, ground settlement could occur in the medium term.

##### **7.3.2.2.2 Phase 3 Construction**

Phase 3 construction will follow the completion of Phases 1 and 2. Noise and dust nuisance, site clearance and earthworks activity during construction of Phase 3 will have a negative impact on the operations of Phases 1 and 2. There is the potential for rockfall during site clearance and earthworks on the moderate to steep hillside areas, which could cause serious injury to operators of equipment and other workers on site. If hotels 1 and 2 are operational during development of phase 3, then this could impact the operational activities at the hotel with respect to noise nuisance and excessive dust emissions.

#### 7.3.2.3 Run Off and Marine Water Quality

During construction, the immediate areas around the project site will have the potential to have reduced marine water quality. The storage of material and any construction debris will have the potential to generate turbidity and result in sedimentation.

#### 7.3.2.4 Storage of Raw Material and Equipment

Any raw materials used in construction will be stored onsite. There will be a potential for them to become air or waterborne. Stored fuels and the repair of construction equipment has the potential to leak hydraulic fuels, oils etc.

#### 7.3.2.5 Water Supply

NWC is willing to provide water service to the proposed project (Appendix 9).

#### 7.3.2.6 Construction Waste

Construction waste and other loose sediments, if not properly stored and managed on site will be washed down to the sea, pollute the waters in the near-shore marine environment and could have a negative impact on marine life as well as damage to the coral reefs in the shallow sea.

Diesel and other petrochemicals will be used on site for the operation of equipment and machinery for construction purposes. Building construction will be intensive during phases 1 and 2 and it is expected that machinery and equipment operation will be in full use during this period. Oil spills from accidents on site and from improper storage could occur, leading to pollution of the marine environment.

#### 7.3.2.7 Solid Waste and Sewage

All solid waste generated during construction will be recycled/reused on site and where this is not practical removed and disposed of at an approved disposal site. The Retirement Landfill in St. James is the closest disposal site to the project.

During this construction phase of the proposed project, solid waste generation may occur mainly from:

- From the construction campsite.
- From construction activities such as site clearance and excavation (vegetative debris).

- Construction materials packaging (cardboard, plastics, fencing material, wooden pallets, containers etc.)
- Earth materials from grading, roadway construction etc.

In addition, with every construction campsite comes the need to provide construction workers with showers and sanitary conveniences. The disposal of the wastewater generated at the construction campsite has the potential to have a minor negative on the surrounding environs.

#### 7.3.2.8 Transportation

The transportation and use of heavy equipment and trucks is required during construction. Trucks will transport raw materials and heavy equipment. This has the potential to directly impact traffic flow along local roads.

#### 7.3.2.9 Air Quality

The site is heavily forested with the exception of the beach area along the coastline, is also surrounded by vegetation and is not in close proximity to potential sources of air pollutants; as such it is expected that the air quality would be of fairly high standard.

Site preparation has the potential to have a two-folded direct negative impact on air quality of the surroundings. The first impact is air pollution generated from the construction equipment and transportation. The second is from fugitive dust from the proposed construction areas and raw materials stored on site. Fugitive dust has the potential to affect the health of construction workers and the surrounding vegetation.

#### 7.3.2.10 Noise

The North Coast Highway is in excess of 2.0 km south of the proposed project site. Additionally, there is significant vegetation between the site and the highway. The impact of noise is therefore considered to be insignificant except for during construction when noise is expected from heavy equipment, this will be short term and will be mitigated by employing best construction noise management practices.

It should also be noted that the closest noise receptor is the Coral Springs housing development, situated approximately 1 km southwest of the proposed project. There is a potential for noise nuisance from construction activities during the construction of Phase 3.

#### 7.3.2.11 Vending and Food Hygiene

The establishment of a construction campsite may cause a proliferation of “cook shops” (food vendors) to provide the construction workers with meals. Improper food preparation and the failure to practice proper hygiene can result in certain pathogens entering the food supply and cause food borne illness. Food borne illness often presents itself as flu like symptoms such as nausea, vomiting, diarrhoea or fever. This will also have a negative visual effect on the proposed construction site.

### 7.3.3 Natural Hazards

#### 7.3.3.1 Erosion Potential Impacts (Hillside Area/Scarp Slope)

Removal of vegetation and construction activity on the hillside will result in disturbance of the slope, leading to mobilization of loose rocks to fall to the foot of the slope. This could result in injury to construction workers during development/construction stage. It was observed that some of the loose boulders were prevented from further movement because they were anchored to the trunks of trees.

Movement of small size limestone rocks (cobblestones) down slope will not have a major impact to life and property, but is sometimes seen as a nuisance as these may accumulate at the foot of the slope over a period of time. However, the small rocks (cobble and pebble stones) could enter and clog storm drainage structures if inadequately designed to prevent sedimentation of material and debris and could lead to blocked drains and possible flooding.

The other concern is the movement of large boulders loosely perched on the slope which can be easily mobilized following severe storm events. Equipment operators and other workmen could be at risk during construction phase.

#### 7.3.4 Biological Impacts

Development construction activities are anticipated to result in significant whole vegetation loss within the footprint of the construction areas and roadway areas. With the vegetation and soil layer removed, bulldozing and other heavy equipment movement and consequential building of hotel/villa facilities, there will be no supporting substrate

layers to facilitate type of natural re-growth of vegetation that would restore natural diversity at the disturbed site.

Further, it is very likely that landscaping activities will be conducted during the construction phase. Introduced vegetation (lawns, hedges and decorative trees) may not be able to replicate or simulate the pre-existing plant cover that supported wildlife prior to the modification of the site.

Vegetation removal will also negatively affect the faunal support that the forest area would have provided, with at least 4 endemic species of birds, 1 species of endemic lizard and 1 endemic species of snail being affected by the loss of flora.

Of the faunal species present within the proposed area, birds are likely to avoid the onset of forest removal by flying to areas removed from the disturbance. Nesting young birds, however, may not be as mobile and mortalities may occur during the deforestation process prior to construction. Other less mobile fauna (lizards, snails etc) may also be lost during site clearance.

At the beach area, the removal of shoreline vegetation for near-shore construction may have de-stabilizing effects on beach areas that have been determined to be dynamic in their stability nature<sup>38</sup>. Dredging will be required to achieve the required depths in the proposed wading area (0.54 hectares). It is estimated that approximately 4300 cubic meters of material will have to be removed and an estimated 0.23 hectares of seagrass resources being impacted by dredging activities, if mitigations are not implemented (Figure 4.4.2).

Due to the nature of the development, the impacts on the ecosystem as a whole will be irreversible in the short and long term.

Please note that additional information regarding the marine environment is presented in section 3, *Addendum to the Environmental Impact Assessment for the Proposed*

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Refer to technical document entitled **Shoreline Dynamics Descriptions Coral Spring Trelawny Hotel Development At Coral Spring, Trelawny,**

June 2016



*Development of a Hotel at Coral Springs Trelawny, Jamaica* (submitted by CL Environmental Co. Ltd, January 2017).

### **7.3.5 Heritage**

The site has been deemed by JNHT to be archaeologically sensitive (Appendix 8) although no feature of significance was observed during the traverse. It should also be noted that the densely forested southern section with very steep topography is very difficult to access. Artifacts/Structures of importance could be discovered or damage during site clearance and excavation. This could therefore be a negative or positive impact.

JNHT proposed that an Archaeological Impact Assessment (AIA) be carried out to ensure that any heritage which may be present on the project site is identified in advance of the development. Arrangements have been concluded with the JNHT for the AIA (Appendix 8).

### **7.3.6 Human/Social/Cultural**

Socio-economic project impacts on the neighbouring communities comprise both positive and negative impacts.

#### **7.3.6.1 Employment**

During construction, employment will be generated for several categories of workers including engineers, casual labourers, skilled and unskilled workers, as well as suppliers of goods and services.

#### **7.3.6.2 Aesthetics**

Improper solid waste management practices may have a potential negative visual impact on the surrounding campsite.

#### **7.3.6.3 Emergency Response**

Construction of the proposed hotel will involve an estimated 1,200 construction workers during peak period. The possibility of accidental injury is high. There may be either minor or major accidents.

## 7.4 Operation

### 7.4.1 Physical Impacts

#### 7.4.1.1 Storm Water Run-Off

The proposed post-development conditions show significant development of the flat coastal plain in the central and northern parts of the property. Development on the slope to the southern end of the property is however less significant (Figure 7.4.1). Most of the storm water that will impact the property will flow from the hill at its southern end. The minimal development of this section of the property will minimize the likely increase in runoff and reduce the impact developments within the flat coastal plain.



Figure 7.4.1: Map showing post-development conditions of the site

The post-development peak flows are presented in Table 7.4.1. A surcharge of 10% was included to account for possible climate change impacts.

*Table 7.4.1: Post-development peak flows*

Catchment Area	Area (ha)	Watershed Slope (m/m)	Runoff Coeff.	Runoff Coefficient Surface Type Description Table 2, HEC 12	Shallow Concentrated Flow Velocity (m/s)	Watercourse Length (m)	Time of Concentration (mins)	Intensity (mm/hr)	Design Discharge * (cms)
<b>Post-Development - 2 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	147	1.2
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	113	1.4
Project Site CA 3	36.0	0.10060	0.70	paved (flat)	0.243	1004	68.9	58	4.5
Project Site CA 4	14.0	0.39175	0.80	paved (flat/steep)	0.480	194	6.7	158	5.5
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	39	3.0
<b>Post-Development - 5 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	210	1.7
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	157	1.9
Project Site CA 3	36.0	0.10060	0.70	paved (flat)	0.243	1004	68.9	76	5.9
Project Site CA 4	14.0	0.39175	0.80	paved (flat/steep)	0.480	194	6.7	228	7.9
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	49	3.7
<b>Post-Development 10 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	256	2.1
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	190	2.3
Project Site CA 3	36.0	0.10060	0.70	paved (flat)	0.243	1004	68.9	90	7.0
Project Site CA 4	14.0	0.39175	0.80	paved (flat/steep)	0.480	194	6.7	279	9.6
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	57	4.3
<b>Post-Development - 25 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	315	2.6
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	232	2.8
Project Site CA 3	36.0	0.10060	0.70	paved (flat)	0.243	1004	68.9	107	8.3
Project Site CA 4	14.0	0.39175	0.80	paved (flat/steep)	0.480	194	6.7	345	11.9
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	68	5.1
<b>Post-Development - 50 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	359	3.0
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	263	3.2
Project Site CA 3	36.0	0.10060	0.70	paved (flat)	0.243	1004	68.9	120	9.3

Catchment Area	Area (ha)	Watershed Slope (m/m)	Runoff Coeff.	Runoff Coefficient Surface Type Description Table 2, HEC 12	Shallow Concentr ated Flow Velocity (m/s)	Waterc ourse Length (m)	Time of Concentr ation (mins)	Intensity (mm/hr)	Design Discharge * (cms)
Project Site CA 4	14.0	0.39175	0.80	paved (flat/steep)	0.480	194	6.7	393	13.5
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	75	5.7
<b>Post-Development - 100 Year Storm</b>									
Project Site CA 1	9.0	0.26812	0.30	woods (max. value)	0.397	276	11.6	401	3.3
Project Site CA 2	13.0	0.23364	0.30	woods (max. value)	0.371	428	19.2	293	3.5
Project Site CA 3	36.0	0.10060	0.70	paved (flat)	0.243	1004	68.9	133	10.3
Project Site CA 4	14.0	0.39175	0.80	paved (flat/steep)	0.480	194	6.7	439	15.1
Salt Water Works CA	165.0	0.04816	0.15	woods (max. value)	0.168	1495	148.3	83	6.3

Only Catchment Areas 3 and 4 on the Project site are affected by the development. Within Catchment Area 3, the impact was mostly seen in the flat coastal plains. Most of Catchment Area 4, which mostly lies on the hillside to the south of the property, was impacted by the development. Consequently, post-development conditions only affect Catchment Areas 3 and 4. Notwithstanding, design discharges were computed for the other catchment areas.

Given that the coastal plains are very flat and ponds storm runoff, adequate provisions should be made for drainage. For this reason, it is recommended that drainage infrastructure, particularly detention/retention ponds, be designed for the 100-year storm event.

Please note that additional information regarding run-off is presented in section 2, *Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica* (submitted by CL Environmental Co. Ltd, January 2017).

#### 7.4.1.2 Water Supply

NWC is willing to provide water service to the proposed project (Appendix 9).

#### 7.4.1.3 Sewage Treatment and Disposal

The proposed sewage treatment facility will treat the wastewater as a resource, ensuring it is reused for landscaping. It is proposed that the treated tertiary effluent will be stored in an effluent holding tank with at least a three (3) days retention for use for irrigation on the hotel's property. This method of disposal provides the most beneficial use for the treated effluent and is not expected to pose a public health risk.

#### 7.4.1.4 Solid Waste Management

The operation of the development has the potential of significantly increasing the solid waste generation. All solid waste generated during operation will be recycled/reused on site and where this is not practical removed and disposed of at an approved disposal site. The Retirement Landfill in St. James is the closest disposal site to the project.

#### 7.4.1.5 Utilities Consumption

There will be increased demand on electricity during operations of the proposed hotel. It is not anticipated that there will be any problems as it relates to the supply of electricity to the proposed development. Extension of the supply lines from the vicinity of Stewart Castle to the project site will be required.

#### 7.4.1.6 Telecommunication

There will be increased demand on telecommunication during operations. As mentioned previously, the study area is served with landlines provided by Flow Jamaica Limited. Wireless communication (cellular/internet) is provided by Flow and Digicel.

#### 7.4.1.7 Transportation

When the project commences operation, a traffic congestion problem is not envisaged by the authorities, but some measures may be necessary to curb the speeding on the highway.

### 7.4.2 Natural Hazards

#### 7.4.2.1 Storm Surge Potential Impacts (Including Climate Change)

Storm surge modeling conducted by Smith Warner International shows that for a 50-yr storm, surge heights will be 1.6 m and inundation levels up to 3.3m on the beach front. The coral reef offers a good protective barrier for high waves during storm events and is



suggested as one of the reasons for relatively low storm surge and inundation levels for storm events based on the study. It is however noted that field evidence indicates that the north-eastern section of the site consists of a storm bank which is attributable to an opening in the reef which runs parallel to the coastline.

The destroyed residential dwelling and the storm bank indicate that the project site has been impacted by storm surge in the past. The storm bank stretches inland from the shoreline (HWM) for a distance of 43m at its widest. If setbacks for the hotel development are inadequate, then the hotel structures closest to the shoreline could be negatively impacted by storm wave forces.

Additionally, the Inter-Government Panel on Climate Change (IPCC) in their latest report has predicted more intense hurricanes and tropical storms, which implies that coastal areas will become more vulnerable to sea surges from major hurricanes.

Please note that additional information regarding storm surge is presented in section 2.4, *Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica* (submitted by CL Environmental Co. Ltd, January 2017).

#### 7.4.2.2 Erosion Potential Impacts

##### 7.4.2.2.1 Beach Erosion

Beach area on the eastern side of the coastline will be lost over time due to erosion caused by wave action. Since the beach area will be used for recreational purposes and is an important part of the natural features of the coastline that has attracted development, more erosion is likely to occur resulting in the loss of an important coastal asset for the hotel.

##### 7.4.2.2.2 Hillside Area/Scarp Slope

Injury to workers/guests and damage to hotel property could result from erosion of large limestone material on the hillside.

#### 7.4.2.2.3 Erosion Map

It is important to note that the erosion map (Figure 5.3.16) only displays potential erosion rates in the preconstruction phase. Notwithstanding, the post-construction phase will involve significant site modifications which may increase the erosion potential significantly. Hence, the cutting of roads and land clearance for proposed resort infrastructure may increase the erosion potential across the site (particularly along the steep sided escarpment located towards the southern section of the site). As such, this particular area may require a comprehensive sediment or erosion control measures in order to minimise soil erosion, which if left uncontrolled may lead to slope failure.

#### 7.4.2.3 Earthquake Impact

##### 7.4.2.3.1 Rock Falls

In the event of an earthquake of similar magnitude or greater than the March 1, 1957 earthquake which affected western Jamaica, the potential for rock falls on the fault scarp of the project site is likely to be high if significant vegetation has been removed from the hillside. At present, the fault scarp on the southern section of the property contains large, loose boulders and partly detached rock on the steep slope. Ground shaking of the magnitude experienced in western Jamaica will result in loose rock being mobilized on the scarp slope.

##### 7.4.2.3.2 Ground modification

As part of the development plan for the hotel, the pond will be drained, shallow organic and inorganic soils removed and then replaced with approved limestone aggregate as fill. Assuming a thickness of 1m-1.5m of fill, it is estimated that 12,000m<sup>3</sup> -18,000m<sup>3</sup> of suitable aggregate will be placed and compacted to aid in construction.

Under seismic loading conditions, fill normally performs poorly if not engineered or is poorly engineered. If the pond is to be reclaimed, site grading specifications for the placement of fill will be an important consideration so that the impact on load bearing structures located in the fill would be minimized. This assumes the shallow foundations will be used in the construction of some of the building structures.

#### 7.4.2.4 Hurricanes and Tropical Storms

##### 7.4.2.4.1 Storm Surge (Coastal Flooding)

The Coral Spring Hotel site is in an uninhabited area and there is no available documented information specific to the site relating to hurricane impacts. The only documented information available are storm surge impacts for Silver Sands and Falmouth in Trelawny (Wilmot-Simpson et al MGD 1980) which are located at distances of 4.3km and 8.4km respectively. However, field and anecdotal evidence show that the Coral Spring Hotel site was affected by storm surge resulting in the development of a storm bank. Also, the destruction of a concrete dwelling following the passage of Hurricane Allen in 1980 is a confirmation that the site has been impacted by sea surges in the past.

Storm surge modeling for the project site conducted by Smith Warner International shows that surge heights of 1.6 m is expected during a 50-yr storm event.

Please note that additional information regarding storm surge is presented in section 2.4, *Addendum to the Environmental Impact Assessment for the Proposed Development of a Hotel at Coral Springs Trelawny, Jamaica* (CL Environmental Co. Ltd, January 2017).

##### 7.4.2.4.2 Hurricane Force Winds

Hurricane force winds from a major hurricane (Category 3 or greater) are expected to have a negative impact on the hotel development. The larger the hurricane, the greater the potential for damage as wind speed increases and barometric pressure decreases. This is reflected in the Saffir- Simpson Hurricane Classification (Table 7.4.2) which shows that damage can be extensive for a category 3 hurricane to catastrophic for a category 5 hurricane. Water sports equipment, gazebos and other light weight or small wooden structures, windows and doors of buildings will be most vulnerable to hurricane wind forces of all categories including hurricanes of lower strengths. Table 7.4.3 provides an indication of the types of damage that can be expected from hurricanes of different categories and wind speeds.

Table 7.4.2: Saffir-Simpson Hurricane Scale

Sustained Winds	Storm Surge	Damage
-----------------	-------------	--------

Hurricane Category Number	(km/h	(miles/h	Atmospheric Pressure in the Eye (mb)	metres	(feet)	
1	119 - 153	74 - 95	980	1.2 - 1.5	4.0 - 4.9	Low
2	154 - 177	96 - 110	965 - 979	1.8 - 2.4	5.9 - 7.9	Moderate
3	179 - 209	111 - 130	945 - 964	2.7 - 3.7	8.9 - 12.2	Extensive
4	211 - 249	131 - 155	920 - 944	4.0 - 5.5	13.0 - 18.0	Extreme
5	> 249	> 155	< 920	> 5.5	> 18.0	Catastrophic

(Source: Adapted from Oliver, J., and Fairbridge, R. The Encyclopedia of Climatology (New York: Van Nostrand Reinhold Co., Inc., 1987).

Table 7.4.3: Level of Damage expected from different categories of hurricanes

Minimal/Low	Moderate	Extensive	Extreme	Catastrpohic
Damage primarily to shrubbery, trees and foliage; some coastal flooding and possible minor damage to boats	Considerable damage to trees; some roof, window and door damage; coastal flooding requiring evacuation; damage to boats	Large trees blown down; structural damage to small buildings; serious flooding near coast; evacuation necessary; coastal structures damaged or destroyed	Extensive destruction of trees and buildings; large-scale flooding; major damage to low structures within about 450m of shore; possible evacuation from low ground within eight to 16km of shore.	Trees down; extensive building damage; coastal area below 3m flooded up to 10km inland; major damages to coastal structures; beaches eroded; massive evacuation near coast. damage primarily to shrubbery, trees and foliage; some coastal flooding and possible minor damage to boats.

### 7.4.3 Human/Social/Cultural

#### 7.4.3.1 Services and Employment

During the operation phase supplies of goods and services will be required and employment opportunities created. The site which has been the subject of illegal activities in the past will become a control environment and thereby prevent such future activities.

#### 7.4.3.2 Cultural Aspects

During operation, visitor to the hotel from different culture will result in the exchange of cultures with locals.

#### **7.4.3.3 Emergency Response and Accidental Injury**

The operation of the proposed hotel will involve workers and guests, who may become ill or have accidents. In addition, disasters such as earthquakes, floods, storm surge and fires are real possibilities.

### **7.5 Public Health Issues of Concern**

The construction and operation of the proposed Coral Spring Hotel Resort is not expected to have a negative impact on the health system within the study area as there will be medical staff on property during any eventualities during operations. Only emergencies are expected to impact on the Public health care system.

### **7.6 Risk Assessment**

Project Risk Assessment is presented in Table 7.6.1.



Table 7.6.1: Project Risk Assessment

Area	Project Activities	Potential Risk	Mitigation	Responsibility
Site clearing	Removal of trees	Unintended removal of trees	Flag trees which are to be retained	Contractor
Land environment	Road construction		Stockpile soil and debris in selected section of the site	
Land Environment	Site establishment	Pollution	Reduce fugitive dust by regular removal of spoils	Contractor
	Road construction	Flooding and siltation	Proper upkeep of the site will be done	
			Where possible re-use of stripped top-soil during site clearance	
			Establish drainage network and storm water detention area to prevent sheet flow to the marine environment and to eliminate erosion.	
	Construction of water network, drainage network and sewage system	Water & Air pollution	Stockpile soil and debris in selected section of the site	Contractor
			Reduce fugitive dust by regular removal of spoils	
			Reduce erosion and limit impacts of silting and sedimentation	
Water environment	Construction water usage	Water pollution	Provision of portable chemical toilets for site workers	Contractor
		Hydrocarbon spillage	Heavy duty equipment and vehicles using diesel must be properly maintained and inspected at regular intervals. All vehicle maintenance must be done at an approved off-site maintenance location such as a garage. Best practice for cleaning accidental oil spillage will be employed in accordance with site operation and monitoring procedure, to include the use of clay/soil.	
		Storm water	Establish drainage network and storm water detention area to prevent sheet flow to the marine environment and to eliminate erosion.	
Air environment	Excavation, backfilling, hauling and other dusty site activities	Excessive fugitive dust	Vehicles causing excessive fugitive emission should be removed from the site	Contractor
			Monitoring of dust particles in the environment	
			Employ dust suppression techniques.	

Area	Project Activities	Potential Risk	Mitigation	Responsibility
Noise and vibration	Excavation, backfilling hauling and other heavy duty vehicular activities	Excessive generation of noise and vibration	Silencers and mufflers on construction equipment should be properly fitted and maintained	Contractor
			If site activities will have excessive noise, they should be scheduled at times least likely to impact those in hearing distance	
<b>Operation Phase</b>				
Waste Management	Operation of Hotel Facility	Sickness & Disease	Centralized storage areas will be located within the development for the proper handling and storage. Solid waste removal will be facilitated by the existing Authority	Owner/ Manager
			A sewage treatment facility will be constructed and designed to treat the sewage to the tertiary level	
			Conservation of water will be utilized with low flush toilets and water conservation taps.	
Storm water	Operation of Hotel Facility	Flooding & Sedimentation	Designed drainage network constructed to discharge storm water in accordance with the standards of the National Works Agency.	Contractor
			Clearing and maintenance of establish drainage network and storm water detention area to prevent sheet flow to the marine environment and to eliminate erosion.	Owner / Manager
		Hydrocarbon spillage	Best practice for cleaning accidental oil spillage will be employed in accordance with operation and monitoring procedure, to include the use of clay/ soil.	
Noise	Operation of Hotel Facility	Excessive noise	All activities that will produce excessive noise will be kept in sound proof area to prevent disturbances to client/ guest and surrounding communities	Owner/ Manager
Aquatic fauna	Excavation, backfilling hauling and other site construction activities	Increase turbidity through increased sedimentation and/or siltation impacting marine biodiversity	Conditions that can lead to soil erosion should be avoided. Drainage channels should be fitted with silt screens.	Contractor

<b>Area</b>	<b>Project Activities</b>	<b>Potential Risk</b>	<b>Mitigation</b>	<b>Responsibility</b>
	Beach clearing and modification			
Wildlife	Excavation, backfilling hauling and other site construction activities	No regional specific wildlife resource occupies the area. However, there is potential for temporary loss of wildlife form the Pre-construction and construction activities	The site is disturbed through various activities. Wild life is mobile in nature and will more than likely relocate to other areas in the vicinity where they are less likely to be endangered	
Vegetation resources	Pre-construction and construction clearing and land modification	In order to construct his development the land must be cleared. This is potential lost of diversity in the project area.	Landscaping measure to be put in place incorporating much of the existing plants	Contractor
Pre-construction, construction and operation.	Provide an aesthetically appealing recreation facility.	Infringe on prescriptive rights to beach access during all stages of the project.		
Pre-construction, construction and operation.	Excavation, backfilling hauling and other site construction and operation activities.	Damage of items of heritage significance	Any cultural heritage found will be investigated and studied and secure through the JNHT	Contractor
Pre-construction, construction and operation	Excavation, backfilling hauling and other site construction and operation activities.	Potential congestion on the roadways.	Increase traffic is not anticipated as the service roads is presently not utilized by local residents. Movement of backfill and soil will be confined to service roads. Where necessary, movement of material will be carefully planned if it is transported on main road.	Contractor
			Entrance/ Exit to site should be regularly checked and clean for mud/soil spread by trucks leaving the site.	

<b>Area</b>	<b>Project Activities</b>	<b>Potential Risk</b>	<b>Mitigation</b>	<b>Responsibility</b>
Pre-construction, construction and operation	Excavation, site clearance, site construction and operation activities	Pollution issues from solid waste generated. If these waste are not properly managed they could negatively impact the environment	A management plan to execute solid waste management to ensure that during all phases of the project solid waste is collected, handled and disposed of at the Municipal Dump. Centralized storage areas will be located within the development for the proper handling and storage. Solid waste removal will be facilitated by the existing Authority	Contractor
Pre-construction, construction and operation	Excavation, site clearance, site construction and operation activities	The potential for sewage waste pollution during the site clearance, construction and operation phases of the project exist.	The use of portable chemical toilets during pre-construction and construction phases of the project. The handling and disposal will be effectively managed as part of the project management and monitoring plans	Contractor
			As part of the proposed development, a sewage treatment facility will be constructed. This facility is designed to treat the sewage to the tertiary level and will complement the surrounding environment. Trade effluent will also be treated to meet and exceed the regulatory standard	
Pre-construction, construction and operation	Excavation, site clearance, site construction and operation activities	Availability of reliable source of each utility for the development of the resort.	Water and energy conservation and minimization strategies will be employed. Utilized the re-use of treated effluent for irrigation. The re-use effluent will meet the regulatory standard for re-use.	Contractor

## 8 Mitigation Measures

### 8.1 Site Preparation and Construction

#### 8.1.1 Physical

##### 8.1.1.1 Rockfall Protection

- During construction phase, (phase 3 villas), large, loose boulders should be selectively removed by mechanical means, so as to minimize the risk of rockfall during site clearance
- A buffer zone (50m) consisting of undisturbed woodland vegetation should be maintained between phase 3 development and phases 1 and 2 developments as part of rock fall mitigation. The purpose of the buffer is to minimize movement of dislodged boulders down slope.
- Rockfall protection methods such as rock berms, wire/net mesh and catch fences should be employed as direct physical/structural mitigation measures.

##### 8.1.1.2 Water Quality

- Sediment/silt trap and turbidity barriers/silt screens should be placed along the coastline to protect the marine environment from pollution as a result of construction activity for the hotel.
- Oils and other petrochemicals should be contained by using a bund to prevent spills on site.
- Adequate storage, collection and disposal of construction spoils and solid waste during the construction phase of the project is critical to reduce impact to the marine environment. All waste should be disposed of at an approved dump site.
- Storm water drainage systems should be channelized.
- Monitoring of the marine water quality of the area should be conducted fortnightly during and after construction up to a period of one month after completion. The following parameters should be tested:
  - Nitrates



- Phosphates
- BOD
- TSS
- Faecal Coliform
- Turbidity

#### 8.1.1.3 Noise

- Use equipment that has low noise emissions as stated by the manufacturers.
- Use equipment that is properly fitted with noise reduction devices such as mufflers.
- Operate noise-generating equipment during regular working hours (e.g. 7 am – 7 pm) to reduce the potential of creating a noise nuisance during the night.
- Construction workers operating equipment that generates noise should be equipped with noise protection. A guide is workers operating equipment generating noise of  $\geq 80$  dBA (decibels) continuously for 8 hours or more should use ear muffs. Workers experiencing prolonged noise levels 70 - 80 dBA should wear earplugs.

#### 8.1.1.4 Air Quality

- Areas should be dampened every 4-6 hours or within reason to prevent a dust nuisance and on hotter days, this frequency should be increased.
- Minimize cleared areas to those that are needed to be used.
- Cover or wet construction materials such as marl to prevent a dust nuisance. This includes those being transported on trucks.
- Where unavoidable, construction workers working in dusty areas should be provided and fitted with N95 respirators.

#### 8.1.1.5 Storage and Transportation of Raw Materials and Equipment

- A central area should be designated for the storage of raw materials. This area should be lined in order to prevent the leakage of chemicals into the sediment.
- Raw materials that generate dust should be covered or wetted frequently to prevent them from becoming air or waterborne.
- Fine grained materials (sand, marl, etc.) will be stockpiled away from drainage channels and low berms will be placed around the piles which themselves will be covered with tarpaulin to prevent them from being eroded and washed away.
- Raw material should be placed on hardstands surrounded by berms.
- Equipment should be stored on impermeable hard stands surrounded by berms to contain any accidental surface runoff.
- Bulk storage of fuels and oils should be in clearly marked containers (tanks/drums etc.) indicating the type and quantity being stored. In addition, these containers

should be surrounded by bunds to contain the volume being stored in case of accidental spillage.

- Paths of the planned roadways should be used, rather than creating temporary pathways just for equipment access.
- Adequate and appropriate road signs should be erected to warn road users of the construction activities. For example reduced speed near the construction site.
- Raw materials such as marl and sand should be adequately covered within the trucks to prevent any escaping into the air and along the roadway.
- The trucks should be parked on the proposed site until they are off loaded.
- Heavy equipment should be transported early morning (12 am – 5 am) with proper pilotage.
- The use of flagmen should be employed to regulate traffic flow.
- For the modification of the pond, backfill should be carried using the specifications set out in the ASTM for compaction.

#### 8.1.1.6 Solid Waste and Sewage

- Provide portable sanitary conveniences for the construction workers for control of sewage waste. A ratio of approximately 25 workers per chemical toilet should be used.
- Showers should be provided for the workers.
- A detailed solid waste management plan should be developed and included as an integral part of the construction project for the Coral Spring Hotel development.
- Skips and bins should be strategically placed within the campsite and construction site.
- The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour.
- The skips and bins at both the construction campsite should be emptied regularly to prevent overfilling.
- Disposal of the contents of the skips and bins should be done at an approved disposal site.

#### 8.1.1.7 Vending and Food Hygiene

- Provision of adequate supply of potable water.
- The monitoring of the various ‘cook shops’ by public health authorities, and with the monitoring of the construction management team, to ensure proper hygiene is being followed.
- The provision of areas to adequately wash hands and utensils.

#### 8.1.1.8 Extraction of Mineral Resources

- Buffer zone of a minimum of 200m should be left between the quarry operations and the project site
- Regular wetting of the haul road and floor of the quarry should be conducted to minimize dust nuisance.
- Quarry to be operated in accordance with the conditions of the quarry licence set out by the Mines and Geology Division.
- An estimated 12,000m<sup>3</sup> to 18,000m<sup>3</sup> of backfill will be required for land reclamation for hotel development. It is recommended that there be negotiations between the developer of the Coral Spring Hotel and the quarry operator to supply fill material to the hotel. The quarry material for this purpose would be taken from the western side of the quarry closest to the hotel development and this could be done during site preparation and construction phases. This is intended to exhaust the material on the western side of the quarry at the completion of the hotel construction. This will then allow quarrying to be transferred to the eastern side of the quarry which would result in reduced dust pollution and noise nuisance and would therefore minimize these negative impacts when the hotel is opened for business. This would result in a win-win situation for both parties.
- The Commissioner of Mines should reconsider a review of the location of the existing Stewart Bay Quarry Zone so as to eliminate or minimize any land-use conflicts that may arise between the developers of the Coral Spring Hotel and quarrying.

#### 8.1.2 Natural Hazards

- Vegetation should be selectively removed at the footprint of proposed buildings and access roads and other access routes. Maintaining vegetation cover will be critical as this will have the effect of reducing the risk of rockfalls.
- Construction of villas should be limited to the hillside slopes not exceeding 26 degrees (50 percent slope) as recommended in the guidelines of the Hillside Development Manual prepared by the MGD (2014). This is necessary as the hillside is influenced by a geological fault which has resulted in an abundance of large, detached rocks on the slope.

- Construction should be limited to very low densities on the hillside so as to minimize the amount of vegetation to be removed.
- During construction phase, (phase 3 villas), large, loose boulders should be selectively removed by mechanical means, particularly in areas that are in alignment or, in close alignment with the footprint of building structures and facilities.
- A buffer zone (woodland vegetation left undisturbed) with a minimum 50m should be maintained between phase 3 development and phases 1 and 2 developments as part of rock fall mitigation. The purpose of the buffer is to minimize movement of dislodged boulders down slope.
- Rockfall protection methods such as rock berms, wire/net mesh and catch fences should be employed as direct physical/structural mitigation measures.

### **8.1.3 Biological**

#### **8.1.3.1 Terrestrial**

An approach involving the artificial re-creation of impacted floral support habitat is proposed for the development, which would be incorporated into an overall landscaping plan for the development. Components related to the development of the approach are outlined below:

1. All trees of a diameter equal to or greater than twenty five centimetres at one meter above ground level will be slated for preservation, provided that the trees do not fall within the footprint of any proposed buildings.
2. All trees defined as per point 1 above will be tagged with fluorescent flagging tape as per condition so as to identify them for preservation.
3. The positions of all trees identified in point 1 above will be mapped and overlaid on the site boundaries so that they can be seen in relation to proposed development.
4. Where possible, tree types to be introduced onto the property for landscaping purposes should be typical of the limestone forest environment within which the

development is being implemented. Thus, flowering trees, such as Coccuswood and Spanish Elm could be introduced onto the site

5. The types of vegetation to be grown on the property should contain both flowering and hedge plants. Additionally, ornamental palms, bromeliads and other types of ornamental plants that do not require significant amounts of water to sustain growth would be appropriate.
6. Bird waders, tree/pole mounted bird houses and feeder locations would complete the process of artificially recreating the lost faunal support habitat that would have existed prior to the implementation of the development.

#### 8.1.3.2 Seagrass

Mitigations will be required for any potential seagrass impacts. Additionally, dredged materials (which are anticipated to be primarily sandy in nature) will require disposal. Figure 8.1.1 shows two areas for proposed mitigations. One area represents seafloor that could be considered for the re-planting of seagrasses removed from the proposed wading area. This location is approximately 0.44 hectares in area or almost double that of the area of seagrass that will be impacted if wading area dredging is conducted. The second location represents shoreline that has been impacted by erosion. Sediments dredged from the proposed wading area could be utilized for the rehabilitation of the eroded area indicated on Figure 8.1.1.



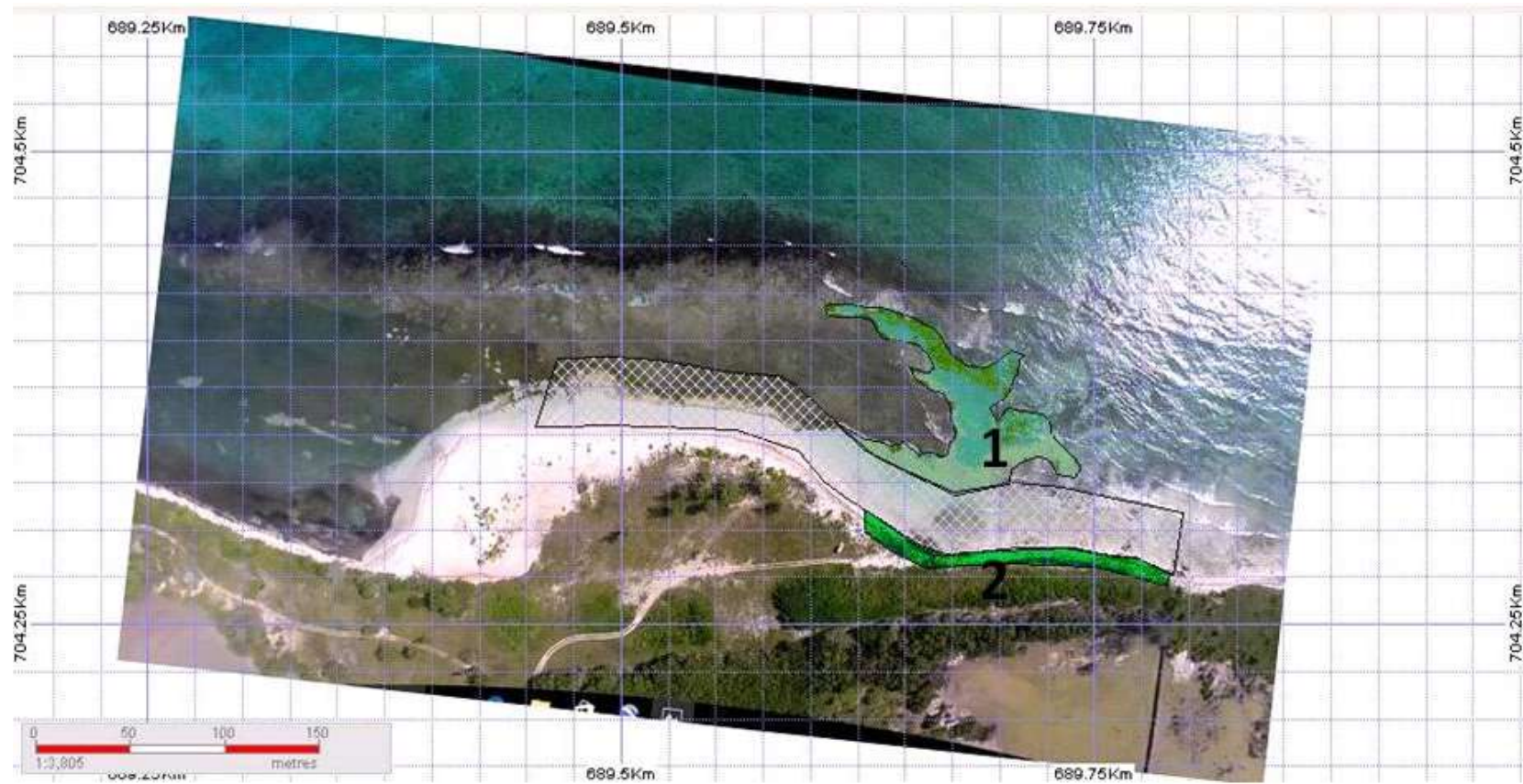


Figure 8.1.1: Proposed Mitigation Areas of Seagrass within Proposed Wading Area that will Require Mitigation (1) seagrass mitigation area, (2) dredged sand disposal area – reclamation of eroded shoreline

#### **8.1.4 Heritage**

The JNHT (Appendix 8) proposed that an Archaeological Impact Assessment (AIA) be carried out to ensure that any heritage which may be present on the project site is identified and mitigation measures implemented in advance of the development. Arrangements have been concluded with the JNHT for the AIA.

#### **8.1.5 Human/Social/Cultural**

##### **8.1.5.1 Emergency Response**

- Public health and safety training should be an integral part of the training programme for operators of equipment and machinery, particularly for earthworks and building construction activities at the Coral Spring Hotel site.
- A lead person should be identified and appointed to be responsible for emergencies occurring on the site. This person should be clearly identified to the construction workers.
- The construction management team should have onsite first aid kits and make arrangements for the nurse and doctor at Falmouth Hospital to be on call for the construction site. Prior arrangements should be made with health care facilities/clinics to accommodate any eventualities.
- Material Safety Data Sheets (MSDS) should be stored onsite.

##### **8.1.5.2 Aesthetics**

- Skips and bins should be strategically placed within the campsite and construction site.
- The skips and bins at the construction campsite should be adequately designed and covered to prevent access by vermin and minimise odour.
- The skips and bins at both the construction campsite should be emptied regularly to prevent overfilling.

#### **8.2 Operation**

##### **8.2.1 Physical**

- Rockfall protection methods such as rock berms, wire/net mesh and catch fences should be employed as direct physical/structural mitigation measures.

- Public health and safety training should be an integral part of the training programme for operators of equipment and machinery, particularly for earthworks and building construction activities at the Coral Spring Hotel site.

#### 8.2.1.1 Water Quality

- Adequate storage, collection and disposal of construction spoils and solid waste during the operation phase of the project is critical to reduce impact to the marine environment. All waste should be disposed of at an approved dump site.
- Storm water drainage systems should be channelized.
- Sewage should be treated to the tertiary level to reduce impacts on the marine environment.
- Monitoring of the marine water quality of the area should be conducted on a quarterly basis during hotel operations. The following parameters should be tested:
  - Nitrates
  - Phosphates
  - BOD
  - TSS
  - Faecal Coliform
  - Turbidity

#### 8.2.1.2 Utilities Consumption

In addition to design and infrastructural measures for the reduction of water consumption, the hotel should also ensure operational measures are employed in order to manage the use of this resource. Summarized is a list of recommended operational strategies for the reduction of water consumption:

<b><i>Departments</i></b>	<b><i>Operating Procedures</i></b>
<b>Housekeeping</b>	<ul style="list-style-type: none"> <li>• Do not leave the tap running while cleaning, using buckets for holding water instead</li> <li>• Make sure that all faucets do not leak and are in good repair</li> <li>• Report immediately any leaking or dripping faucet or toilet</li> <li>• Give guests the option of changing linen and towels every two or three days</li> <li>• Use only the minimum required amount of detergent in the laundry</li> <li>• Reuse rinse-water in the first cycle of washing of the next load</li> <li>• Separate the laundry's hot-water system from the guest room hotel-water system if possible</li> </ul>

<b>Departments</b>	<b>Operating Procedures</b>
	<ul style="list-style-type: none"> <li>• Hotel guests can be given politely written cards as to how to conserve water in their bathrooms, for example to, shut off water during tooth brushing, shaving, and other unnecessary period</li> <li>• Keep utility bills to track the consumption of water</li> <li>• Purchase and use water-saving equipment always</li> <li>• Establish an effective employee training program about water conservation</li> </ul>
<b>Food and Beverage</b>	<ul style="list-style-type: none"> <li>• Do not leave faucets running</li> <li>• Wash food products in buckets, bowls or containers</li> <li>• Use dishwasher with sufficient loads</li> <li>• Make regular inspections of dishwasher pumps for water leakage</li> <li>• Do not use water to defrost or thaw frozen food products, defrost in refrigerator</li> <li>• Report immediately any leaking and dripping faucet</li> <li>• Install infrared-activated faucets and toilets in restaurant rest rooms</li> <li>• Track the consumption of water by regular monitoring utility bills</li> <li>• Establish an effective employee training program about water conservation</li> </ul>
<b>Maintenance</b>	<ul style="list-style-type: none"> <li>• Recover waste pool water for reuse</li> <li>• Make regular inspections of circulating pumps for water leakage</li> <li>• Report immediately any pool or faucet leakage</li> <li>• Purchase and use water-saving pool equipment</li> <li>• Track the consumption of water by regular monitoring utility bills</li> <li>• Establish an effective employee-training program about pool water conservation</li> <li>• Consult pool specialists about effective maintenance of swimming pool</li> </ul>

### 8.2.1.3 Solid Waste Management

- i. Provision of solid waste storage bins and skips.
- ii. Provision of adequately designed bins and skips to prevent access by vermin.
- iii. Monitor beach garbage.
- iv. Contracting a private contractor to collect solid waste in a timely fashion to prevent a build-up.
- v. All solid waste generated during operation will be recycled/reused on site and where this is not practical removed and disposed of at an approved disposal site such as the Retirement dump in St. James.

## 8.2.2 Natural Hazards

### 8.2.2.1 Storm Surge

The current setback requirement for buildings from the high watermark on a gentle sloping coastline is 30m (Appendix 5). This is a planning requirement that is established by the National Environment and Planning Agency. The hotel development proposes a 30m setback from the HWM as stipulated by the Planning Authorities. Storm surge modeling for the specific site, show that the surge height for a 50-yr storm is 1.6m and inundations levels of 3.3m.

- To maintain a 30m setback from the high watermark, areas inland from the 30m setback that are below the 1.6m elevation should be raised to a minimum of 1.6 m Above Mean Sea Level.

### 8.2.2.2 Erosion Potential

- Ensure that vegetation are kept in place and maintained.

### 8.2.2.3 Limestone Hills/Scarp Slope

- Controlling the removal of vegetation for site clearance is critical for the site. This should be limited only to areas within the footprint of the villas and in areas where infrastructure works will be conducted.
- Density of development should be low as this would reduce erosion and sedimentation problems that may arise.
- The design of storm water drainage system on the hillside should include erosion and sediment control measures to minimize or prevent the blocking of drains.
- The development of villas on the limestone hills should conform to guidelines presented in the Hillside Development Manual for Jamaica prepared by the Mines and Geology Division.

### 8.2.2.4 Rockfalls

Reducing rockfalls will include manual eliminations using a minor's bar to break and remove small loose rock ( $< 5 \text{ m}^3$ ) on the slope (Figure 8.2.1) as well as engineering and



structural methods for rockfalls protection such as rock berms, wire/net mesh and block wall net screens to control rock falls on the slope (Figure 8.2.2).



*Figure 8.2.1: Manual Elimination using a miner's bar to break and remove smaller pieces of rock down the slope (Courtesy of the General Council of Martinique)*



*Figure 8.2.2: Example of Block Wall Net Screens for trapping boulders which are mobilized from the upper slope (Courtesy of the General Council of Martinique)*

#### 8.2.2.5 Beach/Coastline Area

- Beach replenishment could be done by removing material on the western side of the foreshore area of the beach to be placed on the beach front on the eastern side of the property.

#### 8.2.2.6 Earthquake

- Loose rocks will be dislodged from the scarp slope during ground shaking from a moderate to large earthquake. To minimize the impact of rock-falls, a buffer zone with a minimum width of 50m should be created between Phase 3 development and Phases 1 and 2 developments. The impact of dislodged boulders from ground vibration due to a moderate earthquake would be significantly reduced as the dense woodland vegetation would prevent large rocks from falling to the foot of the slope.
- Design of all structures if the project must be in conformance to Jamaica's building codes for this type of development and the relevant approval must be obtained. There should also be proper monitoring by the regulatory authorities.

#### 8.2.2.7 Hurricanes

The mitigation measures will be concerned with reducing the impacts caused by hurricane wind forces and coastal flooding. In order to mitigate the impact of a hurricane, the following should be considered.

- To maintain a 30m setback from the high watermark, areas inland from the 30m setback that are below the 1.6m elevation should be raised to a minimum of 1.6 m Above Mean Sea Level.
- Design specification for the roof of buildings to withstand hurricane force winds should be based on the 1:50 year return period and in accordance with the current Jamaica Building Code
- The Jamaica Application Document for the International Building Code (IBC) has a wind speed map for the Island which is recommended to be used to aid in roof designs to withstand hurricane gale force winds.
- A Disaster Preparedness Management Plan or a Disaster Contingency Plan should be developed for the Coral Spring Hotel development to assist with hurricane preparedness during the on-set of a tropical storm or hurricane.

### **8.2.3 Human/Social/Cultural**

#### **8.2.3.1 Emergency Response**

- Have first aid kits located in various sections of the hotel.
- Make prior arrangements with health care facilities to accommodate any eventualities.
- Arrange with other health practitioners to be on call or have an in house physician/nurse.
- Design and implement an emergency response plan.
- Staff should be trained in CPR.
- Coordinate with mutual aid organisations/agencies such as with the local fire brigade.

## 9 Energy Use and Conservation

### 9.1 Energy Use Impact

Energy generation is the largest source of human-induced Green House Gas (GHG) emissions. GHG emissions cause global climate change, which in turn affects human habitation and livelihood in many ways: The Intergovernmental Panel on Climate Change (IPCC 2007) predicts a 2-6 degrees Celsius (°C) rise in global temperature by the end of the century. Rising sea level damages coastal habitats. Increased frequency of extreme weather conditions such as cyclones, droughts, and floods threaten food supply with impacts on agricultural products. Increasing number of tropical-borne diseases impact human health and increased vulnerability to food production.

Energy consumption contributes significantly to a hotel's operating cost. In general, energy cost account for as much as 25% of total operating costs. This results in expensive hotel rates that can lower a hotel's competitive edge in the tourism market. Energy efficiency offers hotels a quick and low-investment method of reducing energy-use without compromising guest comfort. Energy efficiency can reduce a hotel's energy cost by 10%-40% depending on the measures taken. This in turn lowers the hotel's operating cost, resulting in a higher profit margin and increased competitive ability of the business.

Ocean by H10 Hotels will lead the design and development of the Hotel proposed for Coral Spring. H10 Hotels is known to be keen on environment and energy conservation. The corporate environmental policy is as follows:

## Ocean Hotels Environmental Policy



- Ocean Hotels takes care as much as possible about environment and natural resources. The scopes of our policies include, but are not limited to the following topics:
  - Environmental assessment and management.
  - Environmental health and education.
  - Planning and environmental design.
  - Environment and sustainable development.
  - Natural resources use and recycle
- Support training schemes to improve employment opportunities.
- Promote local cultural values to preserve local traditions and customs.
- Ocean Hotels is focused on energy efficiency programmes. In this regards, monitoring reports are periodically done in order to ensure that environmental plans are executed and corrective actions are implemented.



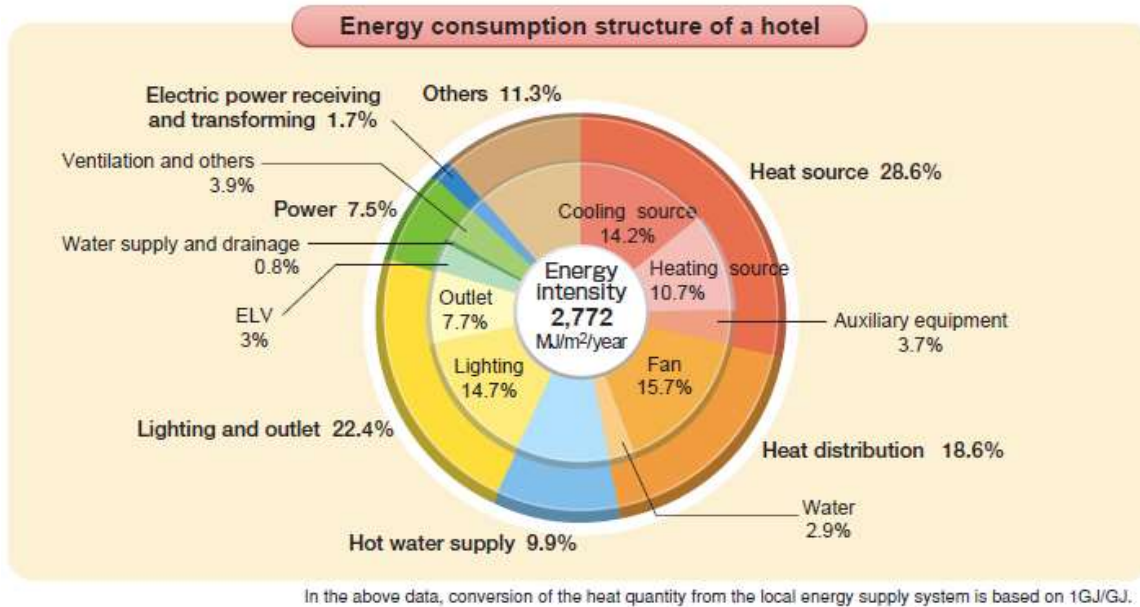


Figure 9.1.1: Energy consumption pattern for a typical hotel

## 9.2 Energy Efficiency Design Considerations

### 9.2.1 Energy Efficiency Design Guidelines for the Proposed Development

The following general design principles should be considered for incorporation into final design:

- ❖ Site structures to fit into the existing environment as much as possible and thereby minimize the disturbance of the natural environment.
- ❖ Maximize the vegetation coverage,
- ❖ Use energy efficient equipment during construction
- ❖ Install renewable energy generation systems such as solar and wind
- ❖ Cogeneration systems for heating and possible power generation
- ❖ Design building to capture as much natural lighting and cooling as possible
- ❖ Install only ENERGY STAR® equipment
- ❖ Based on the topography of the proposed site it should be considered to use gravity to achieve required water pressure by locating water storage at the higher elevation and gravity feed to buildings

### 9.2.2 Building Envelope

The building envelope includes all partitions that seal indoor spaces from outdoor air and temperature (windows, doors, walls, roofs, foundations).

- ❖ Consider using super-insulated walls (typically R40). Install high-efficiency doors and windows when possible to avoid heat loss and infiltration.
- ❖ Choose windows with a low U-factor (rate of heat loss), low-emittance coatings (transmit light and control heat gain and glare, reduces ultraviolet rays responsible for fading fabrics), and/or low conduction gas filling. Reduce solar radiation and conditioning costs by shading windows (add roof overhangs or louvers, plant trees near windows, etc.).
- ❖ Design a “cool roof” to avoid high cooling equipment operation costs: apply a special coating to reflect solar radiation and reduce surface heating.

### 9.2.3 Water Use

To save water install:

- ❖ Low-flow shower heads (1.5 gallons/ minute, cut use by at least 50%). Low flow toilets (use 1-1.6 gallons per flush rather than 5-7 gallons).
- ❖ Install aerators on faucets (0.5 gallons/ minute, save 3-17 gallons/day per faucet).
- ❖ Install de-super heaters to redirect waste heat from the cooling system, or use grey-water heat recovery piping to preheat water.

### 9.2.4 HVAC

HVAC systems physically affect guests’ well-being in a hotel, so it is important to choose a system that both reduces energy consumption and improves comfort.

- ❖ Install a central air-conditioning system rather than individual room units so that hotel operators can control set-points and monitor performance.
- ❖ Limit the temperature range to avoid extreme temperatures.
- ❖ Install efficiency controls: electronic thermostats adjust the temperature based on programmed occupancy periods, and computerized energy management systems control energy use based on occupancy, weather, time of day, etc.
- ❖ Use variable speed drives to control air handling motors and pumps.
- ❖ Conduct regular equipment maintenance: prevent energy losses caused by dirt or pipe/duct leakage, and extend equipment life by regularly cleaning condensers, intake louvers, evaporator coils, and air filters; develop a routine maintenance check-list to insure peak efficiency.

### 9.2.5 Lighting

In large hotel such as is the case for the proposed Coral Spring Hotel development, energy usage for lighting can add up to 30% of total energy consumption. Efficient lamps, luminaires, and controls will reduce consumption, save money and improve lighting in the hotel, the following should be considered.

- ❖ Use LED lighting as much as possible.
- ❖ Install lighting controls to avoid lighting spaces that are not in use (i.e. key-activated lighting in guestrooms, occupancy sensors in restrooms and storage rooms, dimming systems that adjust according to daylighting or event requirements).
- ❖ For outdoor lighting, install photo-sensors to automatically activate lamps when daylight diminishes, and place motion sensors in lesser-used areas.
- ❖ Conduct routine maintenance: clean and replace lamps on a fixed schedule to avoid dirt and dust build-up and to insure full-light output.
- ❖ Place windows in guestrooms to take advantage of natural lighting.

#### **9.2.6 Spa**

- ❖ Install a thermal cover when not in use to prevent constant heat loss or excess indoor humidity levels. Verify that heaters are functioning properly by regularly checking water temperature.

#### **9.2.7 Laundry Services**

Equip facilities with ENERGY STAR® qualified washers and dryers. These machines use less water and consequently require less energy to heat, and they also increase water extraction during the spin cycle so that less dry time is required.

Consider Ozone laundry systems which are high-efficiency machines that inject ozone into the cleaning process, thereby requiring less hot water and cleaning chemicals. Air-to-air heat exchangers can also be added to dryers to recover heat from the machine and use it to heat incoming air. This system cuts dryers' energy requirements by up to 50%.

#### **9.2.8 Office Equipment**

- ❖ Use flat-panel LCD computer monitors which consume up to 90% less energy than traditional monitors.
- ❖ Set printers and copiers to “sleep” mode when not in use.
- ❖ Use recycled paper whenever possible and remember to check for ENERGY STAR® qualified equipment.

## 10 Analysis of Alternatives

### 10.1 Introduction

Analysis of the project alternatives considered four options:

1. The No Action Alternative
2. Previous Proposed Uses of the site
3. The Development as proposed
4. The Development as proposed with modifications
5. Locate the Development in another location
6. Sewage Final Discharge
7. The Preferred Alternative

### 10.2 No-Action Alternative

The “No Action” alternative would mean the termination of all activities relating to the project resulting in the site being left in its existing condition. The main consequence of this alternative is examined for its physical, biological and socio-economic implications.

Physically, the site is unlikely to undergo any major changes from its present condition except for what may occur from natural phenomenon such as hurricanes.

Biologically, the vegetation present on the site is likely to remain the same, other than the potential for uncontrolled growth of weeds, bushes and trees introduced by avifauna, wind or other means on the proposed lot.

The socioeconomic implications for the surrounding communities, the tourism industry and the country would be the most significant. The implementation of the development will 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, the development will add to the islands’ ability to market itself to visitors from markets previously under represented through previous marketing activities. It will also see the entrance of a new brand (H10) to further diversify offering of the Jamaican tourism product.

Positives:

- No nuisance from site clearance and construction activities (dust, noise etc.) potentially affecting surrounding Coral Spring Village community and flora and fauna.
- No potential negative impact on marine water quality and/or marine benthic communities, as well as no floral and faunal habitat and species loss.

Negatives:

- No provision of employment opportunity, foreign exchange revenue, benefits associated with the construction industry and potentially significant business opportunities for existing and new tourism support businesses.
- Inability of Jamaica's tourist industry to market itself to visitors from markets previously under represented.
- No introduction of the H10 brand to further diversify offering of the Jamaican tourism product.

### **10.3 Previous Proposed Uses of Sites**

In the 1990's planning approval was granted for the development of a hotel on this site, however funding proved to be a challenge and it was not materialized.

In 2008 Felicitas Limited along with a group of local and overseas investor proposed the development of a marina along with 36 luxury villas. The site was the subject of some controversial sand mining and the project was not continued.





Figure 10.3.1: Layout of proposed marina and villas development

Positives:

- Provision of employment opportunity, foreign exchange revenue, benefits associated with the construction industry and potentially significant business opportunities for existing and new tourism support businesses.
- Opportunity for Jamaica's tourist industry to market itself to visitors from markets previously under represented.

Negatives:

- Nuisance from site clearance and construction activities (dust, noise etc.) potentially affecting surrounding Coral Spring Village community and flora and fauna.
- Potential negative impact on marine water quality and/or marine benthic communities.

#### **10.4 The Development as Proposed**

The development as proposed by the developers, and as outlined in this EIA document 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 improvement in the aesthetics of the area. The project will provide direct employment for approximately 2000 persons during construction, and 1000 persons during operation.

The development is also expected to 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 planned for the region.

Positives:

- Employment opportunities, foreign exchange earnings, increased property values and improvement in the aesthetics of the area.
- Positive contribution to social infrastructure, overall residential development, upkeep and renewal of the residential community.
- Installation of a tertiary level sewage treatment facility
- In line with other current and projected developments planned for the region.

Negatives:

- Nuisance from site clearance and construction activities (dust, noise etc.) potentially affecting surrounding Coral Spring Village community and flora and fauna.
- Potential negative impact on marine water quality and/or marine benthic communities as well as floral and faunal habitat and species loss.

## **10.5 The Development as Proposed with Modifications**

### **10.5.1 Development in Phases**

The project as presented is to be developed in 3 phases (Hotel 1, Hotel 2 and Villas) with each phase running consecutively. This means that construction will be completed in one phase before starting the next. This will allow for better management and control during the construction of each phase leading to reduced environmental impacts. It will also allow for “lesson learnt” for one phase to be applied in the next phase. The phase approach is also likely to lead to improve cash flow as Phase 1 would be revenue ready within one year (370 days) and be generating income for the owners.

Positives:

- Better management and control during the construction of each phase leading to reduced environmental impacts.
- “Lesson learnt” approach for one phase to be applied in the next phase.
- Likely to lead to improve cash flow as phase 1 would be revenue ready within one year (370 days) and be generating income for the owners

Negatives:

- Increased construction costs (equipment rental etc.) due to phasing. Costs would tend to be lowered if all construction took place in a single sitting.

### **10.5.2 Layout Alternatives**

Figure 4.5.1 and 4.5.2 present alternative layout for the Villas along the sloping southern section of the site where they are to be located. Figure 4.5.2 would see the layout being more closely aligned along the contours and this should reduce the cutting required to accommodate the structures.

Positives:

- Reduced costs due to less cutting into hillside.
- Better management and control during the construction of each phase leading to reduced environmental impacts.
- “Lesson learnt” approach for one phase to be applied in the next phase.
- Likely to lead to improve cash flow as phase 1 would be revenue ready within one year (370 days).

Negatives:

- Increased construction costs (equipment rental etc) due to phasing. Costs would tend to be lowered if all construction took place in a single sitting.

### **10.5.3 Reduce Size of the Development**

Two alternatives were considered for the size of the development as set out below. One for 1,252 habitable rooms and the other for 932 habitable rooms, with plot area ratio of 30% and 17.77% respectively.

1252 Habitable Rooms**DEVELOPMENT DATA**

<b>LAND SIZE</b>	253,251,00 SqM / 62.58 Acres	
<b>FLOOR AREA RATIO</b>	0.50 : 1	
<b>TOTAL FLOOR AREA</b>	126.625,50 sqm	
<b>TOTAL NUMBER OF ROOMS</b>	1017	
<b>PROPOSED DENSITY</b>	20 H.R./AC. = 1.252 H.R.	
<b>NUMBER OF JUNIOR SUITES</b>	930	<b>X 1 H.R.</b> = 930
<b>NUMBER OF MASTER SUITES</b>	50	<b>X 2 H.R.</b> = 100
<b>NUMBER OF VILLAS</b>	37	<b>X 6 H.R.</b> = 222
<b>TOTAL NUMBER OF HABITABLE ROOMS</b>	1252 H.R.	
<b>NUMBER OF STORIES</b>	5	= 17,5 m
<b>PLOT AREA RATIO</b>	30 %	
<b>NUMBER OF PARKING SPACES</b>	<div>1 space to each 3 guest units</div> <hr/> 339 parking space	
<b>SET BACKS</b>	30 m. from the High Water Mark 1,5 m. from boundries per floor	

932 Habitable Rooms**DEVELOPMENT DATA**

<b>LAND SIZE</b>	253,251,00 SqM / 62.58 Acres	
<b>FLOOR AREA RATIO</b>	0.4972 : 1	
<b>TOTAL FLOOR AREA</b>	125.938 sqm	
<b>TOTAL NUMBER OF ROOMS</b>	831	
<b>PROPOSED DENSITY</b>	14.90 H.R./AC. = 1.252 H.R.	
<b>NUMBER OF JUNIOR SUITES</b>	780	<b>X 1 H.R.</b> = 780
<b>NUMBER OF MASTER SUITES</b>	26	<b>X 2 H.R.</b> = 52
<b>NUMBER OF VILLAS</b>	25	<b>X 4 H.R.</b> = 100
<b>TOTAL NUMBER OF HABITABLE ROOMS</b>	932 H.R.	
<b>NUMBER OF STORIES</b>	5	= 17,5 m
<b>PLOT AREA RATIO</b>	17,77 %	
<b>NUMBER OF PARKING SPACES</b>	<div>1 space to each 3 guest units</div> <hr/> 277 parking space	
<b>SET BACKS</b>	30 m. from the High Water Mark 1,5 m. from boundries per floor	



Positives:

- A reduced number of habitable rooms means a reduced development footprint would ultimately result in reduced potential environmental impact area for flora, fauna and marine resources.

Negatives:

- Employment numbers (both during construction and operation) will not be as high as if it was the Development as Proposed.
- The possibility that revenue to be earned would be reduced due to the reduced number of habitable rooms.

#### **10.5.4 Retention of the Forested Slopes**

The southern section of the site possesses a topography of relatively steep slopes and dense vegetation. It is this area that the villas are proposed for. As an alternative, the developer may consider eliminating the villas and leaving the slopes in their natural state. The Forestry Division's Private Forestry Programme provides property tax exemptions for land owners who allow their forested properties to remain undeveloped. This would reduce the impact associated with slope instability.

Positives:

- Reduction of the impact associated with slope instability.
- Reduced development footprint (due to elimination of villas) would ultimately result in reduced potential environmental impact area for flora and fauna in that area.

Negatives:

- The possibility that revenue to be earned would be reduced due to the reduced number of habitable rooms (due to elimination of villas).

## **10.6 Locate the Development in Another location**

No other locations were considered for the proposed development. The property is owned by Felicitas Limited who are the project proponents and have proposed the project in order to utilize the property for an activity for which it is zoned. H10 Hotels is also supporting the project because they consider the location ideal. 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 all desired amenities and infrastructures including a tertiary level sewage treatment system.
- The location is a reasonable distance (1km) away from the surrounding communities.

## **10.7 Sewage Final Discharge**

Other options to dispose of the effluent is via deep injection well or/and sea outfall. The use of a deep injection well would require a permit to construct a well from the Water Resources Authority (WRA) while the use of a sea outfall will require a Beach License from the National Environment and Planning Agency (NEPA).

Positives:

- Reduced cost (construction and maintenance) when compared to wastewater treatment plant construction and operations.

Negatives:

- Deep well injection and marine outfall pipelines as means of disposing treated sewage are both retrograde steps in the environmental industry. Any operational problems during sewage treatment can result in raw, untreated sewage being discharged into the marine environment (in the case of a marine outfall pipeline), which would have disastrous effects on water quality and nearby reefs and the benthic environment. In the case of deep well injection, there is the potential for contamination of groundwater.

### **10.8 Preferred Alternative**

Based on the above, the Development as Proposed in the EIA is the most economical option that will result in the provision of an enhanced tourism product, with potential impacts which can be mitigated.

## 11 Environmental Monitoring and Management

### 11.1 Monitoring Plan

The Monitoring Plan to be developed for the project should incorporate the pre-construction, construction and operational phases of the project. The objective of the monitoring activities should be to ensure adherence to regulatory standards, approval conditions 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 monthly monitoring report be submitted to NEPA.

The monitoring report should include:

- ❖ Raw data collected
- ❖ Tables/graphs (for comparison and trends)
- ❖ Presentation of progress of project (Status report)
- ❖ Areas of non-compliance
- ❖ Recommendations
- ❖ Appendices with photos/data, etc.

In addition, it is recommended that several parameters be monitored before, during and after the project implementation to record any negative construction impacts and to propose corrective or mitigation measures. The suggested parameters include but are not limited to the following:

- 1) Marine Water Quality to include but not be limited to:
  - a. pH
  - b. electrical conductivity
  - c. turbidity
  - d. BOD
  - e. Total Suspended solids (TSS)
  - f. Faecal Coliform
  - g. Nitrates and Phosphates
- 2) Air quality
- 3) Noise
- 4) Coral and Fisheries

- 5) Traffic
- 6) Solid Waste Generation and Disposal
- 7) Sewage Generation and Disposal
- 8) Equipment Maintenance
- 9) Health and Safety

#### **11.1.1 Preconstruction/Site Clearance Monitoring**

- ❖ During site clearing activities, those trees that will be saved and incorporated into the development must be identified and protected. There should be a week verification of all trees to be retained. (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). Daily inspections to ensure that site preparation activities are not being conducted outside of regular working hours (e.g. 7 am – 7 pm). In addition, a one off noise survey should be undertaken to determine workers exposure and construction equipment noise emission. Project engineer / construction site supervisor should monitor the construction work hours. NEPA should conduct spot checks to ensure that the hours are being followed. The noise survey is estimated to cost approximately **J\$330,000** per monitoring exercise. This survey should be undertaken by a qualified company with the expertise and equipment to conduct same.
- ❖ Daily monitoring to ensure that the activity is not creating a dust nuisance. The project engineer / construction site supervisor should monitor the site preparation. NEPA should conduct spot checks to ensure that this stipulation is followed.
- ❖ Background readings should be taken of all water quality parameters prior to site preparation. Readings should be conducted weekly.
- ❖ Undertake daily inspections of trucks carrying solid waste generated from site preparation activities to ensure that they are not over laden as this will damage the public thoroughfare and onsite lead to soil compaction.



Person(s) appointed by NWA may perform this exercise.

- ❖ Daily monitoring of vehicle refuelling and repair should be undertaken to ensure that these exercises are carried out on hardstands. This is to reduce the potential of soil contamination from spills. Spot checks should be conducted by NEPA.

Person(s) appointed by NWA may perform this exercise.

- ❖ Traffic should be monitored during preconstruction. Person(s) appointed by NWA may perform this exercise.
- ❖ Undertake daily inspections to ensure that workers are wearing adequate personal protective equipment (PPE), such as hard hats, hard boots, air protection, safety glasses, reflective vests and fall protection is necessary. Ensure that safety signage is in place.
- ❖ Health, safety and emergency response plans should be prepared prior to site preparation and construction phases.

#### **11.1.2 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 is in a suitable container and is kept in an appropriate area and where necessary removed to an approved disposal site. (Daily Monitoring). In addition, undertake daily assessment of the quantity of solid waste generated and keep records of its ultimate disposal.
- ❖ Exposed soil areas must be monitored to determine potential for erosion, silting and sedimentation particularly during storm events. (Weekly Monitoring)
- ❖ 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).

- ❖ Undertake weekly marine water quality monitoring or a frequency agreed to with NEPA to ensure that the construction works are not negatively impacting on water quality.  
Any organization with the capability to conduct monitoring of the listed parameters should be used to perform this exercise. It is recommended that a report should be given to NEPA at the end of each monitoring exercise. This is estimated to cost approximately **J\$ 255,000** per monitoring exercise.
- ❖ Daily inspections to ensure that construction activities are not being conducted outside of regular working hours (e.g. 7 am – 7 pm). In addition to environmental noise monitoring, a noise survey should be undertaken to determine workers exposure and construction equipment noise emission. Noise monitoring to be conducted monthly at the site and settlements near to site.  
The project engineer / site supervisor should monitor the construction work hours. NEPA should conduct spot checks to ensure that the hours are being followed. The noise survey is estimated to cost approximately **J\$330,000** per monitoring exercise. This survey should be undertaken by a qualified company with the expertise and equipment to conduct same.
- ❖ Daily monitoring to ensure that fugitive dust from access roads and raw materials are not being entrained in the wind and creating a dust nuisance. Frequent wetting should be conducted.  
The project engineer / site supervisor should monitor the construction work hours. NEPA should conduct spot checks to ensure that this stipulation is being followed. In addition, any Citizens Association within the area can be used to provide additional surveillance. The particulates survey is estimated to cost approximately **J\$290,000** per monitoring exercise. This survey should be undertaken by a qualified company with the expertise and equipment to conduct same.
- ❖ Conduct daily inspections to ensure that flagmen where necessary are in place and that adequate signs are posted along the roadways where heavy equipment interact with existing roads. This is to ensure that traffic have adequate warnings and direction. Person(s) appointed by NWA may perform this exercise.
- ❖ Daily monitoring of vehicle refuelling and repair should be undertaken to ensure that these exercises are carried out on hardstands. This is to reduce the potential of soil/sand contamination from spills. Spot checks should be conducted by NEPA.
- ❖ Undertake daily inspections to ensure that workers are wearing adequate personal protective equipment (PPE), such as hard hats, hard boots, air protection, safety

glasses, reflective vests and fall protection is necessary. Ensure that safety signage is in place.

- ❖ Health, safety and emergency response plans should be prepared by the Contractor prior to site preparation and construction phases.
- ❖ Where possible, construction crews should be sourced from within the study area. This will ensure that the local community will benefit from the investment.
- ❖ Coral colonies in the vicinity of the monitoring sites should be monitored quarterly or at a frequency agreed to with NEPA. This survey should be undertaken by a qualified company with the expertise and equipment to conduct same. This will include:

1) Photo Inventory and Roving Surveys:

Corals of particular interest (endangered species, diseased or bleached colonies for example) and representative corals from each site should be tagged and a new photo inventory established for additional long term monitoring.

2) Fish Surveys:

The fish component of the AGRRA survey should be conducted.

3) General Parameters:

Physicochemical water quality parameters, including but not limited to Temperature, pH, Light Irradiance, Salinity and Turbidity should be obtained within each site using a Hydrolab water quality multiprobe.

4) To monitor the potential sediment impact from construction activities on the marine environment, one sediment trap should be deployed at each of the coral assessment sites. The settlers should be retrieved on a monthly basis, its contents analysed and redeployed to determine the rate of sedimentation (mg/cm<sup>2</sup>/day) and dispersal patterns over the area.

### **11.1.3 Operation Phase**

- ❖ Sewage - effluent quality must be periodically tested to determine compliance with regulatory standards and appropriateness for use as irrigation water. (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. (Monthly Monitoring).
- ❖ Marine Water quality monitoring should be done at least quarterly after construction. If three to six results demonstrate that the site or parts of the site have stabilised, the sampling frequency and sampling locations may be reviewed and reduced or discontinued as per and approved monitoring plan. This is estimated to cost approximately **J\$ 255,000** per monitoring exercise. This survey should be undertaken by a qualified company with the expertise and equipment to conduct same.

#### **11.1.4 Reporting Requirements**

##### **11.1.4.1 Water Quality**

A report shall be prepared by the Contracted party. It shall include the following data:

- i. Dates, times and places of test.
- ii. Weather condition.
- iii. A defined map of each location with distance clearly outlined in metric.
- iv. Test Method used.
- v. Parameters measured
- vi. Results
- vii. Conclusions

The report will be submitted to the Client or his designate within two weeks of the monitoring being completed.

The Client shall distribute the report within four (4) weeks of testing being completed to NEPA.

In the event that the water quality does not meet the required criteria, investigations shall be carried out and corrective actions were necessary taken and a re-test shall be scheduled at the earliest possible time and a new report submitted.

If three (3) to six (6) results demonstrate that the site or parts of the site have stabilised, the sampling frequency and sampling locations may be reviewed and reduced or discontinued as per approved monitoring plan.

Reports will be maintained on file for a minimum of three years.

#### 11.1.4.2 Coral and Fish

A report shall be prepared by the Contracted party. It shall include the following data:

- 1) Percentage Coral Cover
  - a. Live coral
  - b. Recently killed coral
  - c. Dead coral
  - d. Diseased or bleached coral
- 2) Percentage Algae Cover  
Where possible Algae will be identified and categorised (fleshy, calcareous and cyanobacteria.
- 3) General Substrate Composition  
The substrate type will also be identified (sand, pavement rock etc.)
- 4) *Diadema sp.* Counts
- 5) Fish counts, species and size classes
- 6) Presence of fish nets, pots, spearfishers, invasive and rare species.
- 7) Other Data

Any rare, endangered, commercially important (lobster and conch) and invasive organisms observed will also be noted and photographed, as well as the presence/absence of seagrasses. Any obvious sedimentation, anchor damage, marine debris and other direct impacts will also be recorded.

The report will be submitted to the Client or his designate within two weeks of the monitoring being completed.

The Client shall distribute the report within four (4) weeks of testing being completed to NEPA.

Reports will be maintained on file for a minimum of three years.

#### 11.2 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:

1. Response to natural hazards
2. Response to man-made hazards
3. Response to emergencies (fire, spills, accidents and medical emergencies)

Periodic drills should also be conducted to test the system preparedness for responding.

#### **11.2.1 Energy/Water Conservation and Waste Reduction**

The Management Plan will outline any energy and water conservation and waste reduction measures put in place by the Hotel such as but not limited to:

- i. Low volume flush toilets
- ii. Grey water irrigation of hotel grounds
- iii. LED lighting and inverter use / timer use etc.
- iv. Re-usable printer ink cartridges
- v. Recycling programme

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<http://www.livesciences.com/40276-coral-reefs>

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<http://smartenergy.illinois.edu/> - Energy Smart Tips for Hotels

[http:// www.greenhotels.com/](http://www.greenhotels.com/) - Green Hotels

<https://ams.confex.com/> - Thermal Comfort and Energy Saving in the Hotel Industry

## 13 Appendix

### 13.1 Appendix 1: EIA Terms of Reference

**TERMS OF REFERENCE**

**for an**

**ENVIRONMENTAL IMPACT ASSESSMENT**

**for a**

**PROPOSED HOTEL/RESORT PROJECT**

**at**

**Coral Spring, Trelawny**

**by**

**Felicitas Limited**

Prepared and Submitted by: National Environment and Planning Agency

August 2016

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The purpose of this document is to establish the Terms of Reference (TOR) for the EIA.

The EIA report must be produced in accordance with the approved TOR.

Where the need arises to modify the TOR, the required amendments/modifications are to be made and submitted to the Agency. Approval for the TOR must be obtained from the Agency, in writing, prior to the commencement of the EIA study.

The Terms of Reference to conduct the Environmental Impact Assessment are as follows:

The National Environment and Planning Agency and the Natural Resources Conservation Authority reserves the right to reproduce, transfer and disclose any and all contents contained in the submitted environmental impact assessment report without the written consent of the proponent, consultants and/or its agents.

The Terms of Reference to conduct the Environmental Impact Assessment (EIA) are as follows:

### 1. EXECUTIVE SUMMARY

Provide a brief statement on the content of the EIA report. The executive summary should provide a comprehensive overview and objectives for the project proposal, natural resources, justification for the project etc. In addition, it should include relevant background information and provide a summary of the main findings, including but not limited to main impacts and mitigation measures, analyses and conclusions in the report.

### 2. INTRODUCTION

The introduction should provide a background and seek to explain the need for and the context of the project and the EIA. It should also provide the delineation and justification of the boundary of the study area, general methodology, assumptions and constraints of the study.

The study area shall include at least the area within a 1km radius of the boundaries of the proposed site.

### 3. LEGISLATION AND REGULATORY CONSIDERATION

Outline the pertinent regulations, standards, government policies and legislation governing environmental quality, safety and health, cultural significant finds, protection of sensitive areas, protection of endangered species, siting and land use control at the local and national levels. The examination of the legislation should include at minimum, legislation such as the Natural Resources Conservation Authority Act 1991, Natural Resources Conservation Regulations 1996, amended 2015, Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013, Beach Control Act, Jamaica National Heritage Trust Act, Wild Life Protection Act, National Solid Waste Management Authority Act, the Housing Act, the Town and Country Planning Act, Building Act and Codes and Standards promulgated there under, Development Orders and Plans and all appropriate international convention/protocol/treaty where applicable. Describe traditional land use and advise of any prescriptive rights including public access rights.

#### 4. PROJECT DESCRIPTION

Prepare a detailed description of the project. This section will provide information on the proposed project and should include:

- History and background of the project,
- A location map at a scale of 1:12,500 (or an appropriate scale)
- The total area of the site.
- A master site layout plan showing the various components and design elements of the proposed development.
- A comprehensive description of all components and the various design elements of the project. e.g. design concept, components and framework, total number and types of guest rooms, total number of blocks, parking scheme, supporting services such as administrative and “back-of-house” facilities, amenities to serve the proposed development such as pools, restaurants, density, plot area ratios, building heights and number of storeys, setbacks (from property boundaries, main road etc.), safety and security, any beach works to be done inclusive of coastline modification, total area to be utilized
- Expected project components and design or project alternatives that may be considered by the developer
- Schematic plans for all alternatives
- A detailed landscape plan highlighting landscape design and requirements and whether or not there will be grading and proposed changes in topography.
- Details of proposed access(es) to the site to be used for pre-construction, construction and operational phases
- Details on infrastructure development including design plans for all components of the development including the proposed wastewater/sewage treatment system and disposal of treated effluent must be clearly outlined.
- A comprehensive drainage assessment. This assessment should take into consideration existing natural drainage channels, proposed man-made drainage/water features or any proposed changes in topography. Potential issues of increased surface runoff and sediment loading must also be addressed. Special emphasis should also be placed on the storm water run-off, drainage patterns, characteristics of the aquifer, including the level and status of the groundwater. In addition plans for providing utilities, particularly details relating to the source of potable water and electricity generation, roads and other services should be clearly stated.
- A Waste Management Plan which clearly outlines expected types and quantities of construction waste during the construction phase, general waste arising from material consumption of the workforce, as well as, the expected waste during the operational phase should be completed. Details should also be provided for any central disposal area(s) being considered to serve the proposed development
- Details of equipment and machinery to be involved, how these will be mobilized and areas to be used for storage of machinery and material should be clearly indicated.
- Details of workforce, including proposals for mobilization and accommodation should be indicated.
- All phases of the project should be clearly defined, the relevant time schedules provided and phased maps, diagrams and appropriate visual aids included in the Environmental Impact Assessment report.

- The study area should be clearly delineated and referenced. Taking into account the types of resources located in the area and the magnitude of the associated impacts, the study area should be large enough to include all valued resources that might be significantly affected by the project.

## 5. DESCRIPTION OF THE ENVIRONMENT

A survey of the proposed development site should be conducted for both the wet and dry seasons. This information will form the basis upon which impacts of the project will be assessed.

The following aspects should be described in this section:

### 5.1 PHYSICAL ENVIRONMENT

- Topography, soil type, climate, drainage, geology (including but not limited to seismicity and faults), geomorphology of the site and hazard vulnerability including impacts on current landscape, aesthetic appeal and hydrology should be examined. Special emphasis should be placed on storm water runoff, drainage patterns. Percolation tests should also be conducted within the proposed study area.
- Water quality for any aquatic (riverine and/or marine) environment or surface water feature in the vicinity of the development. Quality Indicators should include but not be limited to Nitrate, Phosphate, Faecal Coliform, Salinity and Total Suspended Solids.
- Climatic conditions and air quality in the area of influence including particulates
- Noise levels of undeveloped site and the ambient noise in the area of influence.
- Sources of existing pollution and extent of contamination.
- Availability of solid waste management facilities.

### 5.2 CARRYING CAPACITY

- The ecological carrying capacity of the site should be assessed

### 5.3 NATURAL HAZARDS

A risk assessment of the development in relation to the following must be undertaken

- Hurricanes, Earthquakes
- Natural hazard risk assessment should take in account climate change projections.

### 5.4 BIOLOGICAL ENVIRONMENT

Description of terrestrial habitats, existing vegetation, flora and fauna surveys inclusive of a species list; commentary on the ecological health, function and value in the project area, threats and conservation significance. This should include:

- Identification of and a detailed qualitative and quantitative assessment of terrestrial and aquatic habitats in and around the proposed project sites and the areas of impact. This must also include flora and fauna surveys and should include species lists. The assessment must be done according to internationally (scientific) acceptable standards.
- Special emphasis should be placed on rare, endemic, threatened, protected, endangered, invasive and economically important species. Migratory species should also be considered. There may be the need to incorporate micro-organisms to obtain an accurate baseline assessment. Identification and description of the different



ecosystem types and structure including species dominance, species dependence, habitats/niche specificity, community structure and diversity, possible biological loss or habitat fragmentation ought to be considered.

The field data collected should include, but not be limited to:

- Vegetation profile
- Other benthic features of the proposed development areas as well as the areas of potential impact
- Species lists must be provided for each community
- A habitat map of the area

## 5.5 HERITAGE

- An assessment of artifacts, archaeological, and cultural features of the site should be undertaken. Where there is a need this should be conducted in collaboration with the Jamaica National Heritage Trust.

## 5.6 SOCIO-ECONOMIC ENVIRONMENT

- Demography, regional setting, location assessment and current and potential land-use patterns (of neighbouring properties); description of existing infrastructure such as transportation, electricity, water and telecommunications, and public health safety; cultural peculiarities, aspirations and attitudes should be explored; and other material assets of the area should also be examined. There should also be an assessment of the present and proposed uses of the site and surrounding areas including any land acquisition needs and impacts on current users of the area during and post development. A socio-economic survey to determine public perception of the project (both negative and positive) should also be completed and this should include but not be limited to potential impacts on social, aesthetic and historical/cultural values. This assessment may vary with community structure and may take multiple forms such as public meetings or questionnaires.

## 6. PUBLIC PARTICIPATION

Describe the public participation methods, timing, type of information provided and collected from public and stakeholder target groups meetings. The sampling methodology employed must be appropriate for the population size and distribution and must be weighted towards the communities in closest proximity to the proposed development. The instrument used to collect the information must be included in the appendix. Stakeholder meetings should also be held to inform the public of the proposed development and the possible impacts and gauge the feeling/response of the public toward the development.

The issues identified during the public participation process should be summarized and public input that has been incorporated or addressed in the EIA should be outlined.

Public Meeting(s) should be held in accordance with the Guidelines for Conducting Public Presentation at a time and location signed off by the National Environment and Planning Agency (NEPA). A public meeting will be held to present the findings of the EIA once the EIA is completed and submitted for consideration. All relevant documents are required to be made

available to the public. In addition, any material change to the design of the project will require a further public meeting to be undertaken by the developer and all changes made to the document should be clearly outlined to the public.

## 7. IMPACT IDENTIFICATION AND ANALYSIS

A detailed analysis of the project components should be done in order to: identify the major potential environmental, health and safety impacts of the project; distinguish between levels of impact, significance of impact (a ranking from major to minor/significant to insignificant should be developed), positive and negative impacts, duration of impacts (long term or short term or immediate), direct and indirect and impacts, reversible or irreversible, long term and immediate impacts and identify avoidable impacts. This should be carried out for all project alternatives.

Cumulative impacts should also be evaluated taking into account previous developments and any proposed development immediately adjacent to the subject development within the area. The identified impacts should be profiled to assess the magnitude of the impacts. The major concerns surrounding environmental, health, and safety issues should be noted and their relative importance to the design of the project and the intended activities indicated. The extent and quality of the available data should be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should then be ranked as major, moderate and minor and presented in separate matrices for all the phases of the project (i.e. preconstruction, construction, occupation, operational and decommissioning/closure). The potential impacts may be subdivided into Physical Impacts, Biological Impacts and Socio-economic and Cultural Impacts. All impacts should be listed, ranked and assessed, preferably in a single table.

The impacts to be assessed will include but not be limited to the following:

### 7.1 PHYSICAL

- Impacts of construction activities such as site clearance, earthworks, geotechnical and engineering requirements and spoil disposal.
- Impacts of spills (such as oil and chemical spills)
- Impacts on Air Quality
- Impacts on Water Cycling and Quality (pollution of potable, coastal, surface and ground water)
- Impacts on/of Climate Change
- Demands/requirements of the following must be quantified
  - Water Supply
  - Sewage Treatment and Disposal - Empirical data must be provided to show that the proposed sewage treatment facility has the capacity to remove the nutrients to meet the National Sewage Effluent Standards;
  - Wastewater Disposal
  - Trade Effluent Discharges (if any)
  - Solid Waste Disposal



- Electrical Power (fossil fuels, wind, sun, wave and tidal)
- Communications and other utility requirements
- Transport Systems and supporting infrastructure required
- Operation and maintenance – waste disposal, site drainage, sewage treatment and disposal solution, and air quality;
- Impacts on visual aesthetics and landscape
- Noise
- Change in drainage pattern
- Impacts of the project on the carrying capacity of the proposed site.

## 7.2 NATURAL HAZARD

Potential impact of Natural Hazards: (such as Hurricanes and Earthquakes) and flooding potential

## 7.3 BIOLOGICAL

An assessment of the direct and indirect impacts of the project on the ecology of terrestrial and aquatic habitats with emphasis being placed on rare, endemic, threatened, protected, endangered, invasive and economically important species found. This should include habitat loss and fragmentation, loss of species and natural features due to construction and operation. The impact of noise and vibration especially on fauna should be included.

## 7.4 HERITAGE

Loss of and damage to: artifacts, archaeological, geological and paleontological features.

## 7.5 HUMAN/SOCIAL/CULTURAL

Effects on socio-economic status such as changes to public access and recreational use, impacts on existing and potential economic activities, public perception, contribution of development to national economy and development of surrounding communities. Socio-economic and cultural impacts to include land use/resource effects of the project must be considered.

## 7.6 PUBLIC HEALTH ISSUES OF CONCERN

## 7.7 RISK ASSESSMENT

Analyze the risks to human health and ecosystems associated with the development from both human activities and natural phenomenon. This should include: 1) Identifying the hazards 2) Assessing the potential consequences 3) Assessing the probability of the consequences and 4) Characterizing the risk and uncertainty. The monetary costs of the risks, the costs of emergency response and/or avoidance of risks should also be considered. The physical, biological and sociological status will provide the framework in which to assess the impacts of the proposed project.

## 8 IMPACT MITIGATION

The mitigation measures should endeavour to avoid, reduce and remedy the potential negative effects identified while at the same time enhance the positive impacts projected. Mitigation and abatement measures should be developed for each potential negative impact identified. Full details of the methods proposed to be employed in the implementation of these measures should be provided, including details on the scheduling/timelines, source of materials, location and responsible

parties where appropriate. Where appropriate, maps and diagrams should also be used to illustrate areas where mitigation measures are proposed to be implemented.

Where possible and applicable green building technology should be examined and a statement made on strategies that will be used to conserve energy and water in relation to this development. This should be carried out on all project alternatives.

## 9 ENERGY USE AND CONSERVATION

This section should provide methods of energy conservation that could be applied. Alternate sources of energy could also be provided and assessed, and a justification provided for the preferred energy source. Where possible and applicable, green building technology should be examined.

## 10 ANALYSIS OF ALTERNATIVES

Alternatives to the proposed development/project including the no-action alternative and project design alternatives should be examined in detail. These should be assessed according to the physical, ecological and socio-economic parameters of the site. This examination of alternatives should incorporate the use of the history of the overall area in which the site is located and previous uses of the site itself. Alternatives should also address specific aspects of the project such as methods proposed in the execution of the project (works) that have been identified as being causes of major impacts. A rationale for the selection of any project alternative should be provided.

## 11 ENVIRONMENTAL MONITORING AND MANAGEMENT

An environmental monitoring and management plan should be developed which will detail the requirements for construction and operational phases of the project. This should include, but not be limited to training for construction and operation staff, as well as include recommendations to ensure the implementation of mitigation measures and long term minimization of negative impacts

A draft environmental monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval should the permit be granted 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(s) and/or licence(s) granted.
- The activity being monitored
- The locations/sites selected for monitoring. 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.
- The parameters which will be monitored for each activity or implemented mitigation measure
- The methodology to be employed for the monitoring of the various parameters and the frequency of monitoring.
- The frequency of the submission of the monitoring reports to NEPA and other relevant agencies
- The responsible parties for the monitoring

- Possible energy and water conservation measures

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.

## 12 LIST OF REFERENCES

## 13 APPENDICES

The appendices should include but not be limited to the following documents:

- Reference documents
- Photographs/ maps
- Data Tables
- Glossary of Technical Terms used
- Final Terms of Reference
- Composition of the consulting team, team that undertook the study/assessment, including name, qualification and roles of team members
- Notes of Public Consultation sessions
- Instruments used in community surveys

## 14 ACTIVITIES

In order to effectively and efficiently conduct the Environmental Impact Assessment it will be necessary to carry out various activities which include:

### 14.1 DOCUMENTATION REVIEW

All documentation pertaining to the development will need to be reviewed. These should include, but not limited to, the project profile, site plan, drainage plan, vegetation clearance plan, applications made for financing or planning approval, and any technical and engineering studies that have been done.

### 14.2 ANALYSIS OF ALTERNATIVES

Alternatives to the site location, project design and operation conditions will be analyzed including the “no-action” alternative. These alternatives will be assessed based on the physical, ecological and socio-economic parameters of the site identified. The consultant should provide justification for the selection of the chosen alternative(s). The physical, biological and sociological settings will provide the framework in which to assess the different project alternatives. This would clarify, for instance, whether the site could be used for other purposes as well as whether there are any particular aspects of the development that can be sited differently, operated differently, etc.



### 14.3 IMPACT ASSESSMENT

The consultant should carry out a detailed impact assessment of the project components (pre-construction, construction and operation stages) in order to identify the potential impacts (positive, negative and cumulative impacts) that will be associated with the project. The significance and magnitude (major, moderate and minor) of the impacts identified will also be evaluated through the use of a weighted matrix.

The impacts to be assessed will include but not limited to the following:

- Effects of project design and engineering;
- Effects on visual aesthetics and landscape;
- Effect of noise and vibration;
- Effects of construction activities such as site clearance and geological formation, earthworks, hurricanes, access routes, transportation networks and spoil disposal;
- Effects of operation and maintenance activities such as waste disposal, traffic management, site drainage, sediment, sewage, public access and air quality; and
- Effects on ecology including effect on terrestrial and aquatic habitats
- Emphasis should be placed on any rare, endangered, and endemic species found
- Effects on socio-economic status such as changes to public access, recreational use, existing and potential uses, contribution of development to national economy and development of surrounding communities.

All findings must be presented in the EIA report and must reflect the headings in the body of the TORs, as well as, references. GIS references should be provided where applicable. One hard copy and an electronic copy must be submitted to NEPA for review after which the Agency will indicate the number of hard copies along with an electronic copy of the report to be submitted. One copy of the document should be perfect bound.

The report should include appendices with items such as maps, site plans, the study team and their individual qualifications, photographs, and other relevant information. All of the foregoing should be properly sourced and credited.

## 13.2 Appendix 2: Environmental Impact Assessment Team

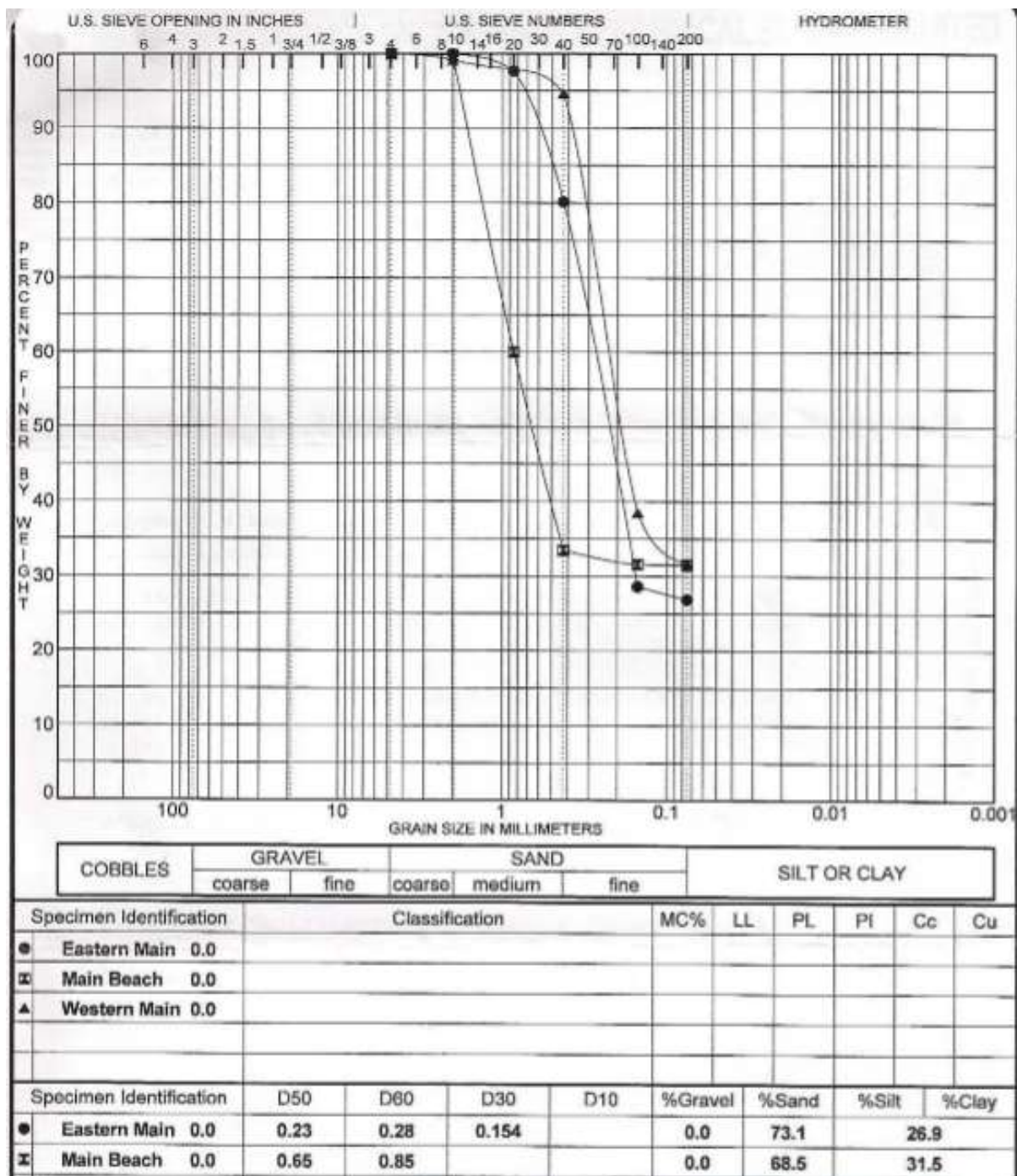
### Proposed Hotel Resort Development Project – Coral Spring, Trelawny

#### Environmental Impact Assessment Study Team

NAME	QUALIFICATION
Balfour Denniston (PE, PMP)	Chemical Engineer
Roberto Machado (PE)	Civil Engineer
Timon Waugh (PhD)	Environmental Consultant
Peter Wilson-Kelly (MPhil)	Coastal Zone Management Specialist
Norman Harris (MSc)	Geologist
Lawrence Barrett (PE)	Hydrologist



### 13.3 Appendix 3: Grain Size Distribution Analysis for beach sand at Coral Spring (Smith Warner International 2009)



### 13.4 Appendix 4: Water Sampling in Pond



**A:** Sample collection at JAD 2001 coordinate points 689702.891E 704204.47N



**B:** Water sample collection at JAD 2001 coordinate points 689 744.569E 704141.953N

## 13.5 Appendix 5: Hydrology Analysis

### A - Velocity versus slope for shallow concentrated flow

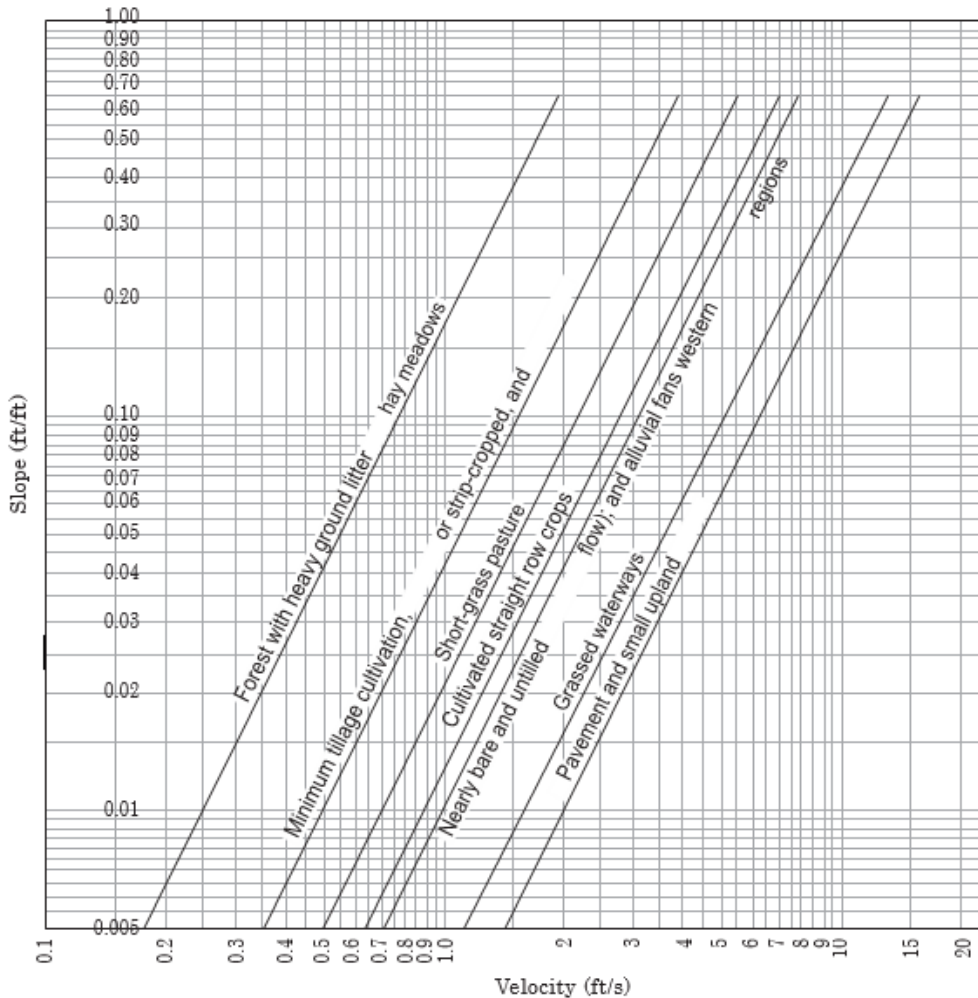


Table 15-3 Equations and assumptions developed from figure 15-4

Flow type	Depth (ft)	Manning's n	Velocity equation (ft/s)
Pavement and small upland gullies	0.2	0.025	$V = 20.328(s)^{0.5}$
Grassed waterways	0.4	0.050	$V = 16.135(s)^{0.5}$
Nearly bare and untilled (overland flow); and alluvial fans in western mountain regions	0.2	0.051	$V = 9.965(s)^{0.5}$
Cultivated straight row crops	0.2	0.058	$V = 8.762(s)^{0.5}$
Short-grass pasture	0.2	0.073	$V = 6.962(s)^{0.5}$
Minimum tillage cultivation, contour or strip-cropped, and woodlands	0.2	0.101	$V = 5.032(s)^{0.5}$
Forest with heavy ground litter and hay meadows	0.2	0.202	$V = 2.516(s)^{0.5}$

15-8

(210-VI-NEH, May 2010)

## B - Runoff coefficients for Rational Method

Table 2. Values of runoff coefficient, C, for use in the rational equation.

Type of Surface	Runoff Coefficient, C
Paved	0.7-0.9
Gravel roadways or shoulders	0.4-0.6
Cut, fill slopes	0.5-0.7
Grassed areas	0.1-0.7
Residential	0.3-0.7
Woods	0.1-0.3
Cultivated	0.2-0.6

Note: For flat slopes and permeable soils, use the lower values. For steep slopes and impermeable soils, use the higher values. See reference (12) for a detailed list of coefficients currently in use.

TABLE 7-10 Runoff Coefficients for the Rational Method

Description of Area	Range of Runoff Coefficients	Recommended Value*
Business		
Downtown	0.70-0.95	0.85
Neighborhood	0.50-0.70	0.60
Residential		
Single-family	0.30-0.50	0.40
Multiunits, detached	0.40-0.60	0.50
Multiunits, attached	0.60-0.75	0.70
Residential (suburban)	0.25-0.40	0.35
Apartment	0.50-0.70	0.60
Industrial		
Light	0.50-0.80	0.65
Heavy	0.60-0.90	0.75
Parks, cemeteries	0.10-0.25	0.20
Playgrounds	0.20-0.35	0.30
Railroad yard	0.20-0.35	0.30
Unimproved	0.10-0.30	0.20

It is often desirable to develop a composite runoff coefficient based on the percentage of different types of surface in the drainage area. This procedure often is applied to typical "sample" block as a guide to selection of reasonable values of the coefficient for an entire area. Coefficients with respect to surface type currently in use are listed below.

Character of Surface	Range of Runoff Coefficients	Recommended Value*
Pavement		
Asphaltic and Concrete	0.70-0.95	0.85
Brick	0.75-0.85	0.80
Roofs	0.75-0.95	0.85
Lawns, sandy soil		
Flat, 2%	0.05-0.10	0.08
Average, 2 to 7%	0.10-0.15	0.13
Steep, 7%	0.15-0.20	0.18
Lawns, heavy soil		
Flat, 2%	0.13-0.17	0.15
Average, 2 to 7%	0.18-0.22	0.20
Steep, 7%	0.25-0.35	0.30

The coefficients in these two tabulations are applicable for storms of 5- to 10-year frequencies. Less frequent, higher intensity storms will require the use of higher coefficients because infiltration and other losses have a proportionally smaller effect on runoff. The coefficients are based on the assumption that the design storm does not occur when the ground surface is frozen.

\*Recommended value not included in original source.

Source: *Design and Construction of Sanitary and Storm Sewers*, American Society of Civil Engineers, New York, p. 332, 1969.



## 13.6 Appendix 6: Survey Form

### Coral Springs Hotel Resort Development - Felicitas Limited

#### Survey

1. Gender of respondent: Male ☐ Female ☐
2. Age of respondent: Under 25 yrs ☐; 26 - 39 yrs ☐; 40 – 65 yrs; ☐ over 65 yrs ☐
3. Employment Status: Employed ☐ Unemployed ☐ Self employed ☐
4. Main Occupation
  - ☐ Farming, agro-processing
  - ☐ Small business operator – employs 1 – 10 persons
  - ☐ Large business operator – employs over 10 persons
  - ☐ Clerical, administrative, teacher, nurse, security personnel
  - ☐ Professional – ( Lawyer, Doctor, Engineer, Manager etc)
  - ☐ Housewife
  - ☐ Domestic helper/ Tradesman/ labourer
  - ☐ Other \_\_\_\_\_
5. Are you aware of the proposed hotel resort development? Yes ☐ No ☐
6. Are you aware of any other planned development for the area? Yes ☐ No ☐
7. What is the greatest fear concerning the project
  - ☐ Squatting ☐ Crime ☐ Air/Noise Pollution ☐ Water Shortage ☐ Do not know
8. How do you think the project will affect your community?
  - ☐ Provide jobs Yes ☐ No ☐
  - ☐ Attract others to live or work in community Yes ☐ No ☐
  - ☐ Destroy the environment Yes ☐ No ☐
  - ☐ Cause/contribute to flooding Yes ☐ No ☐
  - ☐ Have no significant impact Yes ☐ No ☐
  - ☐ Create dust and noise nuisance Yes ☐ No ☐
  - ☐ Cause traffic problems Yes ☐ No ☐
  - ☐ Improve the social and economic condition of the area Yes ☐ No ☐
9. Are you aware of any historically important places in your community? Yes ☐ No ☐

If yes, answer (a) & (b) below:

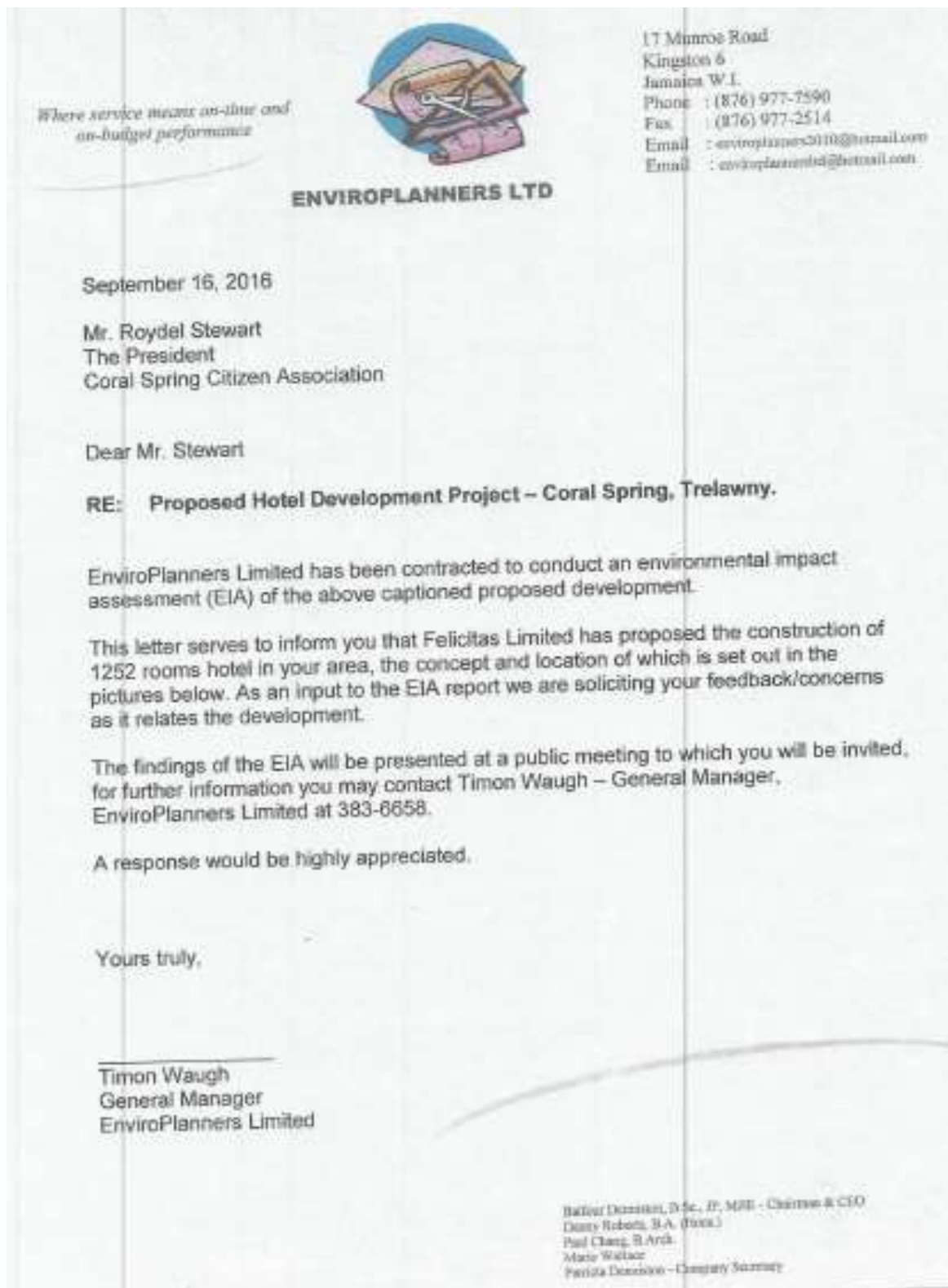
a) Name \_\_\_\_\_

b) Location \_\_\_\_\_

10. Are you in support of the hotel resort development? Yes ☐ No ☐



### 13.7 Appendix 7: Sample of Stakeholders Letter





## 13.8 Appendix 8: Jamaica National Heritage Trust Response

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**JAMAICA  
NATIONAL  
HERITAGE  
TRUST**

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79 DUKE STREET  
HEADQUARTERS HOUSE  
KINGSTON  
P.O. BOX 8934, KINGSTON C.S.O.  
JAMAICA, W.I.

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TELE: (876) 922-1287-8  
(876) 922-3990  
FAX: (876) 967-1703  
WEBSITE: [www.jnht.com](http://www.jnht.com)  
Email: [dorrickgray@jnht.com](mailto:dorrickgray@jnht.com)

October 20, 2016

Mr. Timon Waugh  
General Manager  
EnviroPlanners Limited.  
17 Monroe Road  
Kingston 6

Dear Mr. Waugh,

**Re: Proposed Hotel Resort Development Project -  
Coral Spring, Trelawny**

In response to the captioned proposed development the JNHT has conducted a search of its Sites and Monument Records and has found the site to be archaeologically sensitive. Due to the sensitivity of the site the JNHT will have to conduct an Archaeological Impact Assessment (AIA) which may include and Archaeological Evaluation (excavation by hand to ascertain the significance of buried or partially buried archaeological assets).

As part of the mitigation action an Archaeological Watching Brief / Monitoring (maintaining a watch) will be conducted during the ground breaking work of the resort construction.

Please note that the AIA and the Watching Brief will incur a cost to the developer.

Yours sincerely,

A handwritten signature in blue ink that reads "Dorrick Gray". The signature is written in a cursive style.

Dorrick Gray (Mr.)

Executive Director  
Jamaica National Heritage Trust  
C: Mrs. Laleta Davis Mattis, Chairman  
Jamaica National Heritage Trust

**JAMAICA  
NATIONAL  
HERITAGE  
TRUST**

79 DUKE STREET  
HEADQUARTERS HOUSE  
KINGSTON  
P.O. BOX 8934, KINGSTON C.S.O.  
JAMAICA, W.I.



TELE: (876) 922-1287-8  
(876) 922-3990  
FAX: (876) 967-1703  
WEBSITE: www.jnht.com  
Email: dorrickgray@jnht.com

October 11 2016

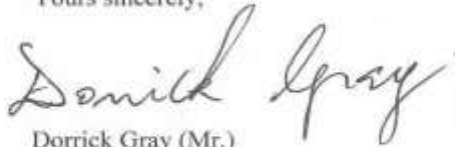
Mr. Balfour Denniston  
Chief Executive Officer  
EnviroPlanners Limited.  
17 Monroe Road  
Kingston 6

Dear Mr. Denniston,

**Re: Proposed Hotel Resort Development Project - Coral Spring,  
Trelawny**

Attached please find a brief historical background and proposed costing for the archaeological survey of the Hotel Resort Development Project. The brief background research on the site has pointed to Taino middens (refuse) and historical plantation that is of interest to us at the JNHT. We are therefore proposing that an Archaeological Impact Assessment (AIA) be carried out to ensure that the heritage in this area is identified and mitigation measures implemented to recover / preserve remnants of this heritage in advance of the development.

Yours sincerely,



Dorrick Gray (Mr.)  
Executive Director  
Jamaica National Heritage Trust

C: Mrs. Laleta Davis Mattis, Chairman  
Jamaica National Heritage Trust

## 13.9 Appendix 9: NWC Letter



**Water is life**

<input type="checkbox"/> 4 Marescaux Road Kingston 5 Tel: (876) 929-3540-5 Fax: (876) 960-6527	<input type="checkbox"/> 1A Portmore Mall St. Catherine Tel: (876) 998-8148 (876) 988-2648 Fax: (876) 988-3245	<input type="checkbox"/> 27A Manchester Avenue May Pen, Clarendon Tel: (876) 902-5781-2 (876) 986-2025 Fax: (876) 986-2718	<input type="checkbox"/> 22-24 Stennett Street Port Maria, St. Mary Tel: (876) 994-2441 (876) 994-2476 Fax: (876) 994-9965	<input type="checkbox"/> Bogue Industrial Estate P.O. Box 474 Montego Bay, St. James Tel: (876) 952-1640-1 (876) 952-5824 Fax: (876) 952-5485
<input type="checkbox"/> 48 Windsor Road St. Ann's Bay, St. Ann Tel: (876) 972-0111 Fax: (876) 972-1233	<input type="checkbox"/> 1 Lower Bevin Avenue Montego Bay, St. James Tel: (876) 940-3588 (876) 940-4447 Fax: (876) 952-8682	<input type="checkbox"/> 18 Rose Street Savanna-la-mar, Westmoreland Tel: (876) 955-2652/7 Fax: (876) 955-2052	<input type="checkbox"/> 9 Leaders Plaza Mandeville, Manchester Tel: (876) 962-8494 (876) 962-7637 Fax: (876) 962-4562	

November 9, 2016

Garfield O. Wood  
Managing Director  
4 Hillcrest Avenue  
Kingston 6

Dear Mr. Wood:

**Re: Coral Spring H10 Hotel Development - Trelawny**  
**NWC Ref # 0388E/16**

We acknowledge receipt of your application about the availability of water service to the proposed development at the above location.

The National Water Commission (NWC) advises that it is possible to provide the service requested, albeit at a Processing/Impact/Connection Fee once your application have been reviewed. The attached outlines what ought to be included in your submission.

It must be understood that this letter does not constitute an NWC approval; such approval must be endorsed by the President and Chairman.

Please note that the NWC does not operate a sewage disposal system in that area.

We trust this information will assist and look forward to hearing from you.

Yours truly,  
**NATIONAL WATER COMMISSION**



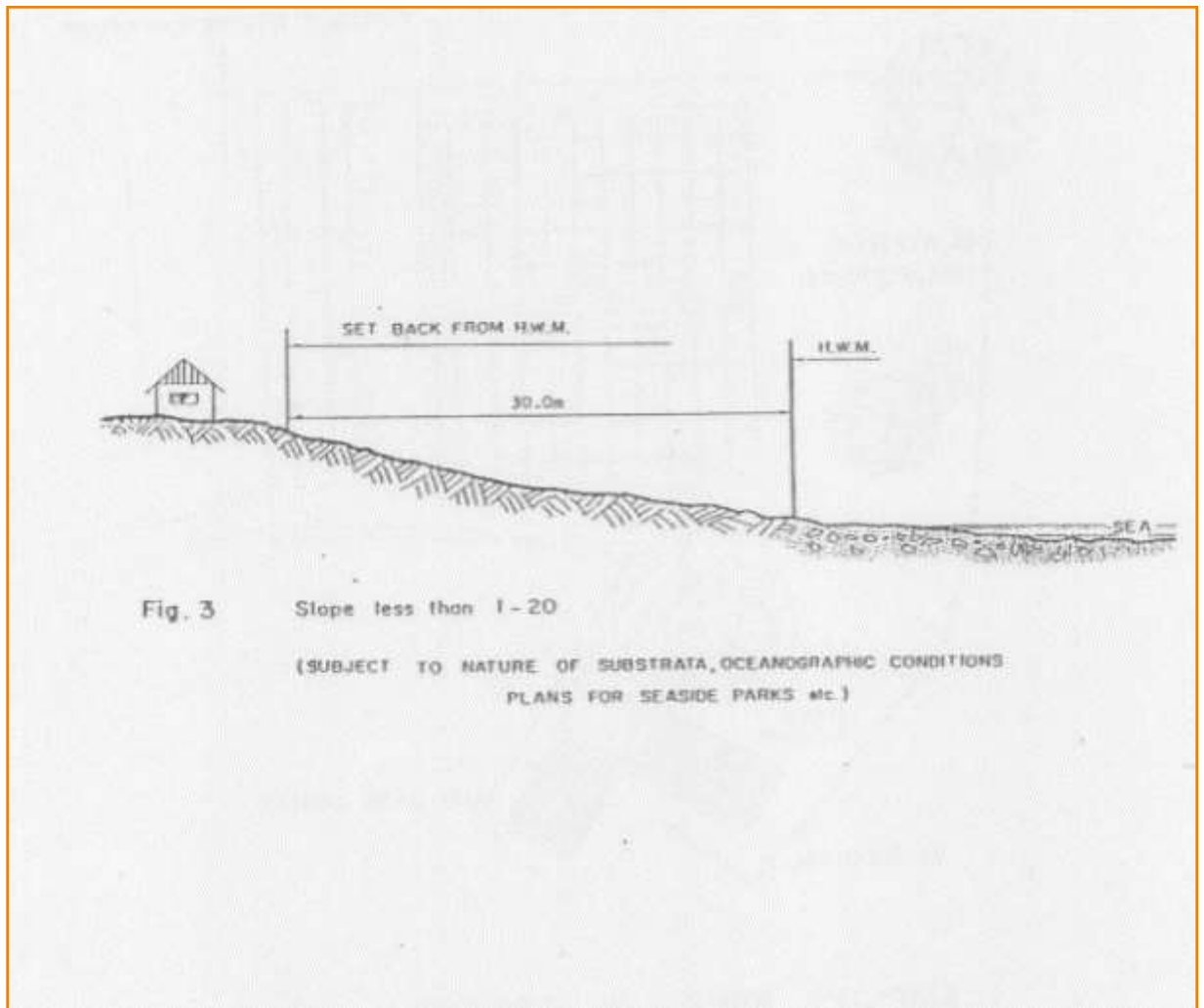
Ian Bennett  
Manager Engineering Design

C: Mr. Garth Jackson – VP, Engineering & Capital Projects, NWC

**Board of Commissioners:** Senator Aubyn Hill - Chairman, Baron Stewart - Deputy Chairman, Dwight A. Sibbles, Stephen Edwards, Dane Marsh, Methelina Scarlett Jones, Jeremy Palmer, Tyrone Robinson, Reverend Clement Clarke, Mark Barnett - President



### 13.10 Appendix 10: Setback Requirements from Coastline



National Environmental and Planning Agency (NEPA) setback requirements for buildings from high water mark for a gentle sloping shoreline.