ENVIRONMENTAL IMPACT ASSESSMENT

FLORENCE HALL HOUSING DEVELOPMENT, TRELAWNY

Prepared for:
Gore Developments Ltd.
3c Braemar Avenue
Kingston 5

Prepared by:
ESL Management Solutions Ltd.
20 West Kings House Road
Kingston 10

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Introduction

This document presents the findings of the Environmental Impact Assessment of the proposed Florence Hall Housing Development, proposed by Gore Developments Ltd. (GDL), in the parish of Trelawny. Environmental Solutions Ltd. (ESL) was contracted by Gore Developments Ltd. to carry out the Environmental Impact Assessment, as part of the permitting requirements stipulated by the National Environment and Planning Agency (NEPA).

Proposed Development

Florence Hall Housing Development is a housing development proposed by Gore Developments Ltd. close to Falmouth in Trelawny. Gore Developments Ltd. has acquired 72.4 ha (178.90 acres) at Florence Hall in the parish of Trelawny, and proposes to construct 828 two-bedroom detached homes on each residential lot. The lot sizes will be a minimum of 420.5 sq. m. (4,500 sq. ft.). The proposed development aims to satisfy the current housing demand along the North Coast stretch between Montego Bay (St. James) and Duncans (Trelawny).

The property is south of and bordered by the North Coast Highway, directly across from Oyster Bay and within proximity to Falmouth. Access to the property is via an entrance on the east of the Daniel Town Road just a few metres from the entrance to the state owned Trelawny Multi-purpose Stadium (located west of the property).

Amongst the 828 lots, a total of five lots have been allocated for dual purposes which may be used for both residential and commercial activities. These activities will be limited to small “corner shops” for groceries, dressmaking, hairdressing or other low-impact businesses. The development is to be divided into two major phases, which are naturally divided by a long green belt. This belt is a natural feature of heavily sloping land, which will be retained in its natural state. The development will also have several, large, medium and small sized neighbourhood parks, cave reservations, a large football field and a site for a basic school.

A sewage treatment plant has been designed to produce tertiary treated effluent that will meet NEPA effluent discharge standards. Specifications of the proposed treatment plant have been designed by Foreman, Chung and Sykes Civil and Structural Engineering Consultants. The sewage treatment plant will

be located at the lowest point of the property for a gravity fed system. A central collection system will collect all waste water flows from each household and direct it into the tertiary sewage treatment plant for discharge into the adjoining wetland at the northeast corner of the property. The sewage treatment plant will be buffered by a large green area to the south (shielding it from the homes) and buffered from the highway by the wetland.

In terms of water supply to the development a direct connection will be established to the newly connected water supply main along the north coast highway. This connection will supply approximately 956 m^3 of water per day. The estimate of water use required includes domestic, commercial, basic school and social needs.

A detailed drainage plan has also been designed for the development. Lots will be graded to fall towards the roads or drain paths and storm water will be retained at various points throughout the subdivision. This ensures that the post construction run-off will be no greater than the pre-development run-off without adversely affecting the highway north of the project.

Permitting and Legislative Requirements

The Environmental Permit and License System (P&L), introduced in 1997, is a mechanism to ensure that all developments in Jamaica meet required standards in order to minimize negative environmental impacts. The P&L System is administered by NEPA, through the Applications Section (formerly the Permit and License Secretariat). Permits are required by persons undertaking new development which fall within a prescribed category. Under the NRCA Act of 1991, the NRCA is authorized to issue, suspend and revoke permits and licences if facilities are not in compliance with the environmental standards and conditions of approval stipulated. An application for a Permit was prepared and submitted to NEPA. The TOR's for conducting the EIA were prepared based on the generic TOR's for Human Habitation, and submitted to NEPA for review and approval. Approval of the TOR's was given by NEPA in a letter dated February 12, 2009.

Methodology

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. An iterative approach among the environmental team members and other project professionals was adopted, and was facilitated by fortnightly or weekly team meetings as required. The EIA team worked very closely with the other project team members including the project manager, the developer, land surveyor, engineers and architect.

The team utilized the Charette-style approach to data gathering, analysis, and presentation whereby team members conducted the reconnaissance investigations together to determine the critical elements for analysis and the issues to be highlighted for the design and planning process. Team meetings were held to discuss the progress of investigations and analyses and facilitate integration of data toward an understanding of the systems at work in both the natural and built environment. Baseline data for the study area were generated using a combination of:

- Field studies
- Aerial observation
- Analysis of maps, plans, aerial photos
- Review of reports and background documents
- Structured Interviews
- Laboratory analyses

Detailed methodologies for the physical, biological and socio-economic aspects of the baseline survey are presented in the report.

The Existing Environment

The site is mostly dry limestone woodland and is considered a rural site. Typical karstic features such as joints, fissures, fractures, caves and sinkholes exist on the site. A major fault line also exists on the site. A great house dating back to the time of the English invasion is still present on site and is an important heritage site which will remain untouched as the development proceeds into construction and operation phases. There is evidence of charcoal burning and other disturbance on the site.

Surface and Ground Water Quality

All issues material to the site, such as hydrologic events, groundwater pollution incidents, flooding incidents, and other critical events were reviewed within a 5 km radius of centre of the site.

Hydrological Analysis

The hydrological assessment was taken largely from the drainage engineer report. It was done using both the Rational Method and TR-55 which is used around the world for peak flow estimation of small rural drainage basins and is the most widely used method for urban drainage design. Terrain analysis (i.e. watershed delineation) was done using Digital Elevation Models (DEM) and the inputs fed into TR-55 to estimate discharges for 10, 25, 50 and 100 yr return frequency.

Air Quality and Noise

The objective of the air quality monitoring exercise was to determine the normal concentration of respirable particulates in the project area prior to construction works. Air quality measurements were taken at five sites in the project area. The assessment involved measurement of ambient levels of respirable particulates, PM10 (<10 μm). Particulates were measured using Sensidyne (BDX 530) personal vacuum pumps (suction 2-3 1/min), attached to pre-weighed Millipore filters. The pumps were placed at the approximate respiratory height of pedestrians for a six hour period at the seven sites, over a one day period. The pumps were then returned to the ESL laboratory where the filters were stabilized and weighed to determine a Time Weighted Average (TWA) value for the particulates.

Ambient noise measurements were conducted at the stations sampled for air quality using a Quest Electronic Model 1800 Precision Impulse Integrating sound level meter. This instrument has octave band analysis capability. Wind direction and speed as well as any other unusual noise sources were also recorded. The data were correlated and compared with NEPA, OSHA and WHO standards for noise pollution.

Biological Environment

A preliminary site reconnaissance was conducted to provide an overview of the site layout, habitats and floral and faunal composition. This reconnaissance was facilitated by driving around the perimeter of the site and walking along some of the roads and other access points to the property and led to the establishment of several stations where point counts for birds and plant sampling were conducted on subsequent field trips. Subsequent field visits involved detailed information gathering. The site was divided into three key habitats identified as dry limestone forest, wetland and caves.

Socio-economic Environment

The main purpose of the socio economic analysis was to place the proposed project within the context of the local human environment, upon which it is expected to have an important influence. Similarly, the analysis also examined the ways in which the local human environment might impact the project and may be supportive of it. Of corollary concern, was the project's impact on the existing site in relation to any potentially important heritage elements that exists or are likely to exist. The project was also examined within its wider regional setting.

Archaeological, Cultural and Heritage

A three day Heritage Impact Assessment (HIA) was conducted on the cultural resources within the Florence Hall Estate by means of: literature search; oral history research; and a scoping field survey.

Issues Identified

Several issues have been identified for the proposed development that must be taken into consideration at the design, construction and operation phases. These issues have been explored in light of the potential impacts of the project on the existing environment, as well as the environmental attributes and how they may affect the project. The main issues that have been identified are:

- Water Resources Management, including groundwater flows and water quality, drainage and surface runoffs, sewage treatment and effluent disposal, and wetland management and effluent polishing.
- Geology: Maintenance of geological integrity of caves, voids, sinkholes and escarpments.
- Air Quality: Maintenance of acceptable air quality during construction
- Noise: Maintenance of acceptable noise levels during construction
- Soils and Landscaping: Prevention of erosion and excessive sediment runoff, conservation of natural vegetation as buffer zones around caves and other landscape features, appropriate management of open spaces, and prevention of soil and wetland contamination by landscaping chemicals.
- Natural Hazards: Mitigation of potential impacts from flooding and karstic surface and underground failures.
- Hazardous Materials: Handling and storage of hazardous materials during construction.
- Ecology: Preservation of the retention forest, wetland and cave ecology for essential ecological functions and attraction: protection of Oyster Bay (Glistening Waters) from chemical or other impairment.
- Socio Economics: Adequacy of social infrastructure for health, education and solid waste disposal. Change of traffic flows. Public safety
- Solid Waste Management: removal of vegetative matter; rocks and rubble; existing collection infrastructure; approved disposal site
- Heritage Values: Retention of valuable heritage elements (colonial and possible Taino artifacts) and the potential for development of heritage attractions for residents and visitors.

Potential Impacts and Mitigation Measures

Potential impacts during construction and operation phases have been identified and mitigation measures proposed for each. Many of these have already been incorporated in the design of the development. The most critical of these are represented in the design of the development footprint, the drainage system, the sewage plant

and effluent disposal system, and the use of the wetland as a final recipient of runoff and effluent. The retention of vegetative buffer zones, the inclusion of generous open spaces, the protection of the caves, the treatment of voids and the identification of heritage potential are all critical elements of the development.

Standard best practices for the construction phase have been proposed.

A discussion of cumulative impacts of the development in the context of similar developments in the zone of influence has been included and the respective responsibilities of the developers and Government agencies have been identified.

1.0 INTRODUCTION

This document presents the findings of the Environmental Impact Assessment of the proposed Florence Hall Housing Development, proposed to be located directly across from Oyster Bay and south of the North Coast Highway that separates them. Environmental Solutions Ltd. (ESL) was contracted by Gore Developments Ltd. (GDL) to carry out the Environmental Impact Assessment, as part of the permitting requirements stipulated by the National Environment and Planning Agency (NEPA) in respect of the proposed development.

1.1 Purpose

During early dialogue between GDL and the National Environment and Planning Agency (NEPA) in 2008, NEPA indicated to GDL that an EIA would be required for the proposed project. Several meetings were held between GDL and NEPA and GDL also sent out inquiry letters to relevant GOJ Agencies. Gore Developments submitted an application for a development permit to the NEPA on November 27, 2008. The application was accompanied by Project Information Form (PIF) and supporting documentation. NEPA's Generic Terms of Reference for Human Habitations were modified by ESL and specific TOR's were submitted to NEPA on November 27, 2008. The Terms of Reference were submitted to NEPA for their approval on November 27, 2008, with the Permit Application Form as directed by the Office of the Prime Minister in its letter of October 31, 2008 (Appendix I). The final TOR's were approved by NEPA in a letter dated February 12, 2009.

The approved TOR's are detailed in Section 2.0, while the document as approved by NEPA is presented in Appendix II.

1.2 Description of the Project

Gore Developments Limited has acquired 72.4 ha (178.90 acres) at Florence Hall, Trewlany, and proposes to construct 828 two-bedroom detached home on each lot. The lot sizes will be a minimum of 420.5m^2 (4,500ft^2).

The proposed development aims to satisfy the current demand for housing along the North Coast stretch between Montego Bay and Duncans and will support the housing needs for a majority of staff of the existing and future hotels, resorts and villas in the area.

1.2.1 Location

The property is south of and bordered by the North Coast Highway (on its northern section), and is directly across from Oyster Bay and approximately 4 km east of Falmouth (Plate 1.2.1 and Figure 1.2.1). Access to the property is from the North Coast Highway on to the Daniel Town Road and via an entrance on the east. A second entrance is planned onto the unnamed parochial road south of the property.

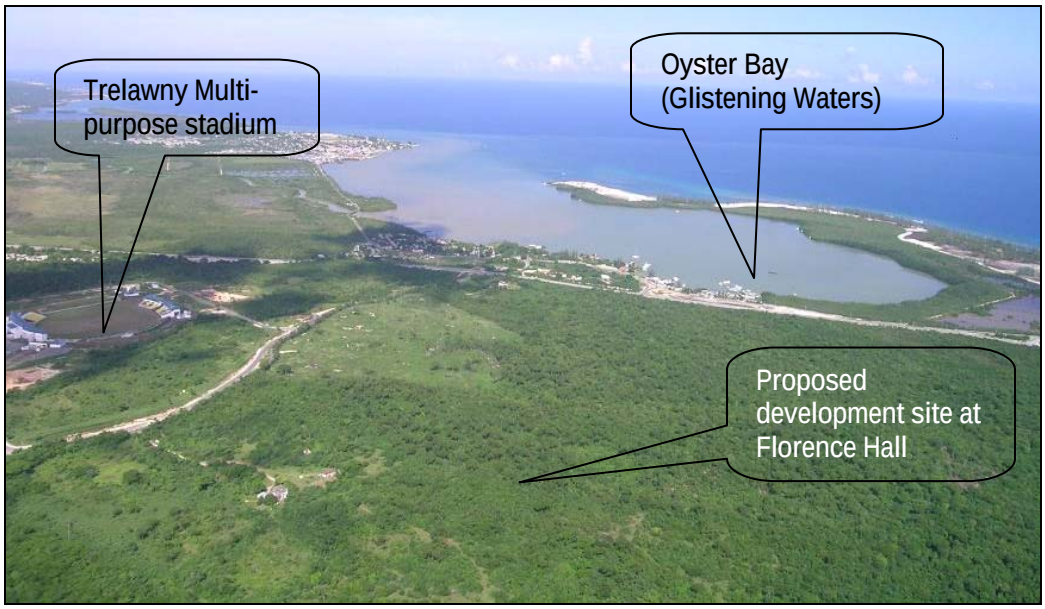

Plate 1.2.1: Aerial photograph of a section (western) of the undeveloped site and environs

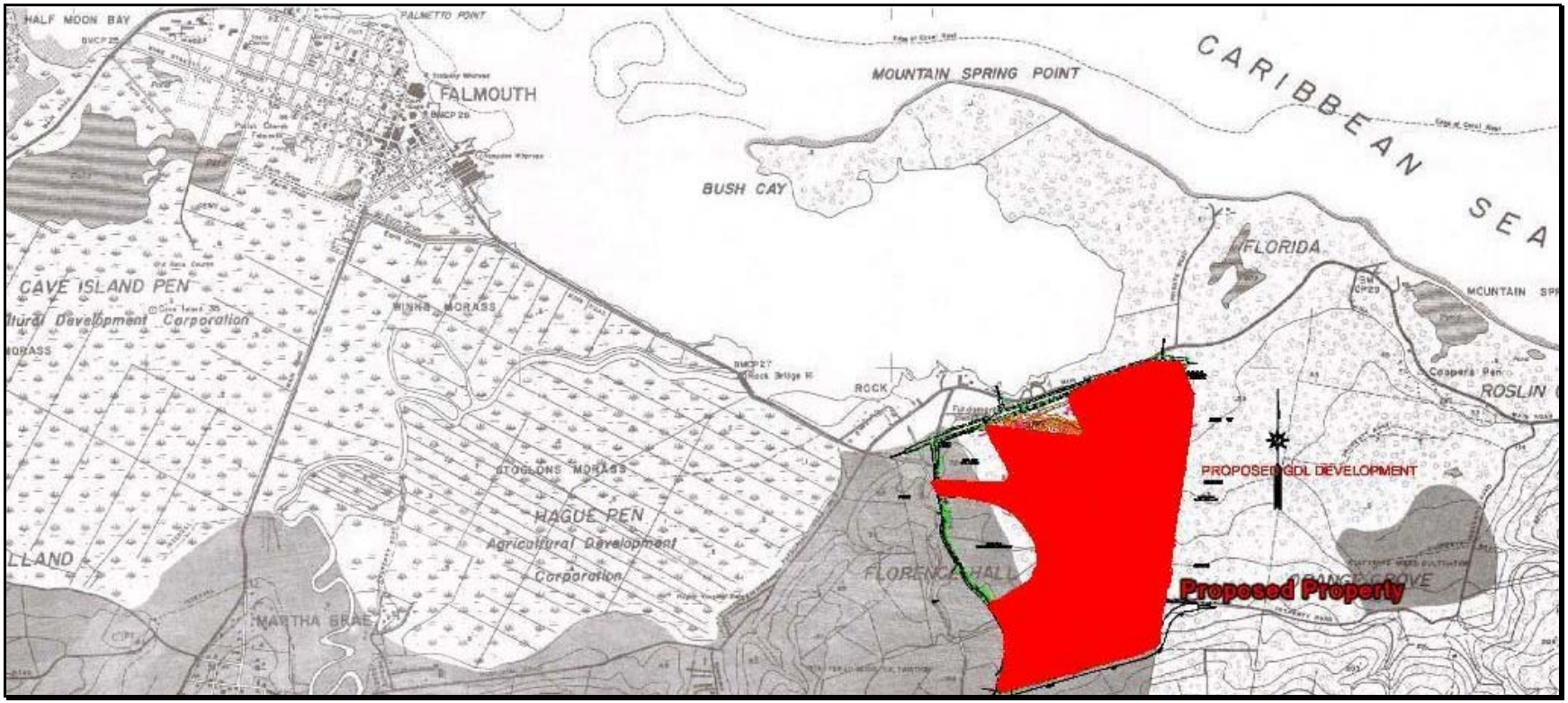

Figure 1.2.1 Location map of the proposed Florence Hall property in New Falmouth, Trelawny

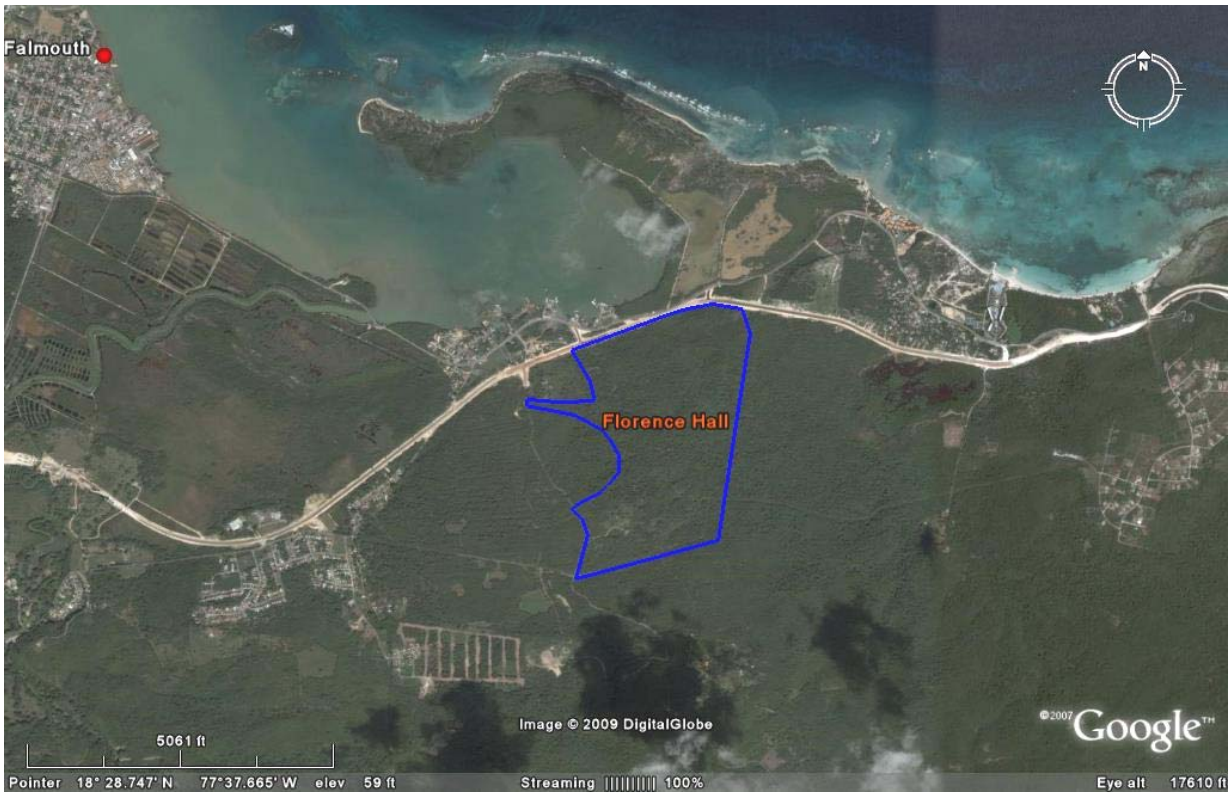

Plate 1.2.1a: Google Earth imagery of the location of the proposed Florence Hall Housing Development Project

1.2.2 Houses

The proposed house comprises 74.3m^2 (800 ft^2) of floor area and features two bedrooms, one bathroom, kitchen, dining and living room space. Building approval will be sought separately and after subdivision approval has been obtained (Figure 1.2.2).

Figure 1.2.2 Artists' impression of the semi-detached two-bedroom house for the proposed housing development at Florence Hall, Trelawny

1.2.3 Land Use

The proposed development includes land allocation as follows:

- Lots and road structures: 51.991 ha
- Open Spaces: 16.960 ha
- Drain Reserves: 0.119 ha
- Sewage Treatment: 2.930 ha
- Basic School site: 0.400 ha

A detailed Schedule of Areas is given in Appendix III and the Subdivision Layout is shown illustrated in Figure 1.2.3 below.

Figure 1.2.3 Florence Hall Subdivision Layout

1.2.4 Commercial Lots

Amongst the 828 lots, 5 lots have been allocated for dual purpose and allow for residential and commercial activities. These activities should be limited to small “corner shops” for groceries, dressmaking, hairdressing or other low-impact business.

1.2.5 Amenities

The development will be divided into two major phases, which are separated by a long green belt. This belt is a natural feature of heavily vegetated sloping land, which will be retained in its natural state. Included in the green belt are several large, medium and small size neighbourhood parks, a cave feature, space for a football field and a site for a basic school.

Healthcare can be accessed at the Falmouth Hospital which is within proximity to the proposed development as well as Health Centres in Duncans and Falmouth. Three pharmacies are located in Falmouth.

The Falmouth Fire Station and Police Station both have responsibility for the project area.

Solid Waste Collection is currently being undertaken by the Western Parks and Market (WPM) for the wider area and it is envisaged that this proposed development will be covered by WPM as well. Discussions will have to be made with the WPM to confirm these arrangements.

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The Florence Hall Great House is located on the site, but it is in poor structural condition and partially ruined. It will be retained for the proposed project and is sited within a large park area. The ruins will create an attractive feature for the residents.

1.2.6 Education

The schools in near proximity to the proposed development site include All Age, Primary Level and Secondary Level. These are:

All Age and Primary Level: Duncans All Age, Refuge Primary, Hague Primary, Salt Marsh All Age, Falmouth All Age

Secondary Level: William Knibb Memorial and Holland High Schools are both located in Martha Brae close to the proposed development. A lot slated for a private Basic School has been included in the subdivision plan.

1.2.7 Sewage Treatment

The location for the Sewage Treatment Plant is proposed at the lowest point of the property for a gravity fed system and will be buffered by a large green area, shielding it from homes. The expansive wetland area will shield the sewage treatment plant from the highway.

A central collection system will collect all waste water flows from household and direct it into the tertiary sewage treatment plant for discharge into the small wetland to the north east of the property and subsequently into the adjoining luminescent wetland system. The tertiary process is designed to consist of primary settlement, chlorine contact and reed beds (*Phragmites*). A detailed Engineers Report is included in Appendix III.

1.2.8 Water Supply

A direct connection (via 200 mm diameter pipe) will be established to the newly constructed water supply main along the North Coast Highway. This connection will supply approximately 956 m^3 of water per day to the proposed development of 828 houses. The estimate of water use required includes quantities for domestic, commercial, basic school and for other social needs. A detailed Engineers Report is included in Appendix III.

1.2.9 Drainage

Lots will be graded to fall towards the roads or natural drainage paths and storm water will be detained at various points throughout the subdivision. This will ensure that the post construction run-offs are no greater than the pre development run-offs without adversely affecting the highway north of the project site. A detailed Engineers Report is given in Appendix III.

1.2.10 Site Office and Construction Yard

1.2.10.1 Concrete Dry Batching Plant

A Concrete Batching Plant will be necessary during the construction phase of the proposed development. The concrete will be composed of water, cement, sand (fine aggregate) and coarse aggregate. Coarse aggregate may consist of gravel, crushed stone or iron blast furnace slag. Some specialty aggregate products could be either heavy weight aggregate or lightweight aggregate. Supplementary cementitious materials also called mineral admixtures may be added to make the concrete mixtures more economical, reduce permeability, increase strength, or influence other concrete products.

Concrete manufactured is produced at plants that store, convey, measure and discharge these constituents into trucks for transport to a job site. At this plant sand, aggregate, cement and water will all be gravity fed from the weight hopper into the mixer trucks. The concrete is to be mixed on the way to the site where the concrete is to be poured. Further details and specifications of the Dry Batching Plant are provided in Appendix III.

1.2.10.2Diesel Storage

A diesel storage tank will be installed on the property to supply fuel for the concrete mixer trucks that will service the batching plant. The tank is an Above Ground Storage Tank (AST) which will be installed on the north eastern section of the property, on the location for the Batching Plant.

1.2.10.3Phasing of the Project

The development will be constructed in three phases as outlined below:

1. Phase I – 278 Lots
2. Phase II – 277 Lots
3. Phase III – 136 Lots

2.0 TERMS OF REFERENCE – HUMAN HABITATION PROJECT

The Draft Specific Terms of Reference for the EIA for the Florence Hall Housing Development were prepared for the Generic Terms of Reference for Human Habitations, provided by NEPA. These Terms of Reference were submitted to NEPA with the Permit Application documents on November 27, 2008, as approved by the office of the Prime Minister in a letter dated October 31, 2008 (Appendix I).

The Terms of Reference were approved by NEPA on February 12, 2009 and are set out below:

The Environmental Impact Assessment for the Florence Hall Housing Development will:

1) Provide a complete description of the existing site proposed for development. Identify the major environmental issues of concern through the presentation of baseline data which will include physical, biological, social and heritage considerations.
2) Detail the elements of the development, highlighting areas to be reserved for construction and the areas which are to be preserved in their existing state, green areas and layout of project.
3) Outline the Legislation and Regulations relevant to the project at both the national, regional, and international levels as appropriate.
4) Predict the likely potential impacts of the development on the described environment, including direct, indirect, reversible, irreversible and cumulative impacts, and indicate their relative importance to the design of the development's facilities.
5) Identify mitigation action to be taken to minimize adverse impacts and quantify associated costs.
6) Include an outline Monitoring Plan which will ensure that the mitigation measures are adhered to.
7) Describe the alternatives to the project that could be considered at that site.
8) Assess public perception of the proposed development through review of existing information for projects in the area as well as interviews with stakeholders.

The following tasks will be undertaken in fulfillment of the Terms of Reference:

Task #1- Description of the Project

A comprehensive description of the project, noting areas to be reserved for construction, areas to be preserved in their existing state as well as activities and features which will introduce risks or generate impact (negative and positive) on the environment. This will include the use of maps, site plans, photographs, and other graphic aids and images, as appropriate, and include information on location, general layout and size, as well as pre-construction (e.g. topographical surveys, Google Earth ® images and

photographs), construction (e.g. location of batching plant, diesel storage, construction time table and phasing), and post construction plans (subdivision plan including layout and architects impression of house). The project will be implemented on a phased basis and all phases will be clearly defined, the relevant time schedules provided and phase maps included.

Task #2- Description of the Environment

This task involves the generation of baseline data which is used to describe the study area as follows:

i) physical environment
ii) biological environment
iii) socio-economic and cultural constraints.

The methodologies employed to obtain baseline and other data will be clearly detailed and references given as appropriate. The extent and quality of the available data will be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts.

Baseline data should include:

(A) Physical

i. A detailed description of the existing geology and hydrology will be given. Special emphasis will be placed on Karst features (caves, depressions and sinkholes), storm water run-off, drainage patterns, slope stability, effect on groundwater and availability of potable water.
ii. Water quality of the existing well (if accessible), the pond, the sinkholes and the historical data on coastal waters in the vicinity of the development will be presented. Quality Indicators will include but not necessarily be limited to nitrates, phosphates, faecal coliform, and suspended solids. Information will be presented on the water quality of the nearby Glistening Waters Lagoon.
iii. Climatic conditions and air quality in the area of influence including particulate emissions from stationary or mobile sources, NO_x, SO_x, wind speed and direction, precipitation, relative humidity and ambient temperatures.
iv. Noise levels at selected locations on the undeveloped site and the ambient noise in the area of influence.
v. Obvious sources of existing pollution and extent of contamination.
vi. Availability of solid waste management facilities.

(B) Biological

A detailed description of the terrestrial flora and fauna and habitats will be provided for this dry limestone wooded area with Karstic features. Information on rare, endemic, protected or endangered species will be provided. Migratory species will also be considered. Generally, species dependence, niche specificity, community structure and diversity will be considered as well as a DAFOR rank for each species. The sensitivity of the biological components of the Glistening Waters Lagoon will also be described.

(C) Socio-economic & cultural

Present and projected population; present and proposed land use; planned development activities, issues relating to squatting and relocation, community structure, employment, distribution of income, goods and services; recreation; public health and safety; cultural peculiarities, aspirations and attitudes should be explored. The historical importance of the area should also be examined. While this analysis is being conducted, an assessment of public perception of the proposed development will be conducted. This assessment may vary with community structure and may take multiple forms such as individual meetings, application of interview instruments, as well as the final requisite, public presentation of the findings of the EIA. Heritage and cultural aspects will be investigated and will include information on the Florence Hall Great House and any significant features of the caves on the site.

Task #3 - Legislative and Regulatory Considerations

The pertinent regulations and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and international levels will be given. The examination of the legislation will include at minimum, legislation such as the NRCA Act, the Housing Act, the Town and Country Planning Act, Building Codes and Standards, Development Orders and Plans and the appropriate international convention/protocol/treaty where applicable.

Task #4 - Identification of Potential Impacts

Potential impacts will be identified as they relate to, the following:

- Modification of karst features
- Change in drainage pattern
- Flooding potential

- landscape impacts of excavation and construction
- loss of natural features, habitats and species
- pollution of potable, coastal, surface and ground water
- air and noise pollution
- capacity and design parameters of proposed sewage treatment facility.
- socio-economic and cultural impacts
- risk assessment
- solid waste management
- the carrying capacity of the proposed site

Impacts will be identified as significant positive or negative impacts, direct and indirect, long term and immediate impacts, reversible and irreversible. Project activities and impacts will be represented in matrix form. Impacts will be identified as appropriate, for the site preparation, construction and operation phases. Cumulative impacts will also be identified.

Task #5 - Mitigation

Mitigation measures will be presented, as far as possible, for any potential adverse impacts due to the proposed development. Recommendations for utilizing the existing environmental attributes for optimum development will also be given particularly with respect to green areas, drainage issues and heritage museums. Mitigation measures will be costed as appropriate.

Task #6 - Monitoring

An outline Monitoring Plan will be prepared to monitor implementation of mitigation measures and project impacts during construction and operation phases.

The outline Monitoring Plan will include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit license(s) granted.
- The activity being monitored and the parameters chosen to effectively carry out the exercise.
- The methodology to be employed and the frequency of monitoring.
- The sites being monitored. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
- Frequency of reporting to NEPA

Requirements of the Monitoring Report will also be given and include, at a minimum:

- Raw data collected. Tables and graphs to be used where appropriate
- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).
- Recommendations
- Appendices of data and photographs if necessary.

Task #7 - Project Alternatives

Alternatives to the project will be presented including the No-Action Alternative. This examination of project alternatives will incorporate the use history of the overall area in which the site is located and previous uses of the site itself.

Reporting

All Findings will be presented in an EIA report and will reflect the headings in the body of the TOR's. Ten hard copies and an electronic copy of the report will be submitted to NEPA and copies prepared for the Parish Library and Parish Council offices to facilitate Public Reading. The report will include baseline data, references, plans, maps, and photographs, as well as appendices items such as plans, the study team, and supporting reports and documents.

The electronic copy will facilitate posting on NEPA's website to allow circulation to sister agencies and stakeholders for review.

3.0 LEGISLATION AND REGULATORY CONSIDERATIONS

This section presents the legislation and regulations pertinent to the proposed Florence Hall Development.

3.1 National Legislation – Natural Environment

3.1.1 Natural Resources Conservation Authority Act (1991)

The Natural Resources Conservation Authority Act was passed in the Jamaican Parliament in 1991 and provided the basis for the establishment of the Natural Resources Conservation Authority (NRCA) with primary responsibility for ensuring sustainable development in Jamaica through the protection and management of Jamaica's natural resources and control of pollution. Sections 9 and 10 of the NRCA Act stipulate that an Environmental Impact Assessment (EIA) is required for new projects and existing projects undergoing expansion.

The body is also responsible for investigating the effect on the environment of any activity that may cause pollution or which involves waste management. Sections of the Act that relate specifically to pollution control state that:

(i) No person shall discharge on or cause or permit the entry into waters, on the ground or into the ground, of any sewage or trade effluent or any poisonous noxious or polluting matter.

(ii) No person is allowed to construct or reconstruct or alter any works designed for the discharge of any effluent.

The Act also empowers the authority to require of any owner or operator of a pollution control facility information on the performance of the facility, the quantity and condition of effluent discharged and the area affected by the discharge of such effluent.

The Authority has the right to consult with any agency or department of Government having functions in relation to water or water resources to carry out operations to:

(a) Prevent pollutants from reaching water bodies.

(b) Remove and dispose of any polluting matter or remedy or mitigate any polluted water body in order to restore it.

3.1.2 Environmental Review and Permitting Process (1997)

The Environmental Permit and License System (P&L), introduced in 1997, is a mechanism to ensure that all developments in Jamaica meet required standards in order to minimize negative environmental impacts. The P&L System is administered by NEPA, through the Applications Section (formerly the Permit and License Secretariat). Permits are required by persons undertaking new development which fall within a prescribed category. Under the NRCA Act of 1991, the NRCA is authorized to issue, suspend and revoke permits and licences if facilities are not in compliance with the environmental standards and conditions of approval stipulated. An applicant for a Permit or License must complete an application form as well as a Project Information Form (PIF) for submission to the NRCA.

3.1.3 Wildlife Protection Act (1945)

The Wildlife Protection Act of 1945 prohibits removal, sale or possession of protected animals, use of dynamite, poisons or other noxious material to kill or injure fish, prohibits discharge of trade effluent or industrial waste into harbours, lagoons, estuaries and streams, and authorizes the establishment of Game Sanctuaries and Reserves. Protected under the Wildlife Protection Act are six species of sea turtle, one land mammal, one butterfly, three reptiles and several species of birds including rare and endangered species and game birds.

3.1.4 The Endangered Species (Protection, Conservation and Regulation of Trade) Act (2000)

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.

3.1.5 The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996)

The island of Jamaica and the Territorial Sea of Jamaica have been declared a Prescribed Area. No person can undertake any enterprise, construction or development of a prescribed description or category except under and in accordance with a permit. The Natural Resources Conservation (Permits and Licenses) Regulations (1996) give effect to the provisions of the Prescribed Areas Order.

3.1.6 Water Resources Act (1995)

The Water Resources Act of 1995 established the Water Resources Authority (WRA). This Authority is mandated to regulate, allocate, conserve and manage the water resources of the island. The Authority is also responsible for water quality control and is required under Section 4 of the Act to provide upon request to any department or agency of Government, technical assistance for any projects, programmes or activities relating to development, conservation and the use of water resources.

It is the responsibility of the WRA as outlined in Section 16 to prepare, for the approval of the Minister, a draft National Water Resources Master Plan for Jamaica. Areas to be covered in this Draft Master Plan of 1990 included objectives for the development, conservation and use of water resources in Jamaica with consideration being given to the protection and encouragement of economic activity, and the protection of the environment and the enhancement of environmental values.

Section 25 advises that the proposed user will still have to obtain planning permission, if this is a requirement, under the Town and Country Planning Act. In addition, Section 21 of the Act stipulates that if the water to be used will result in the discharge of effluents, an application for a license to discharge effluents will have to be made to the Natural Resources Conservation Authority or any other relevant body as indicated by the Minister.

With regard to underground water, Section 37 states that it is unlawful to allow this water to go to waste. However, if the underground water "interferes or threatens to interfere with the execution or operation of any underground works", it will not be unlawful to allow the water to go to waste in order to carry out the required works provided that there is no other reasonable method of disposing of the water. The Authority also has the power to determine the safe yield of aquifers (Section 38).

3.1.7 Quarries Control Act (1983)

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. The Minister may on the recommendation of the Quarries Advisory Committee declare as a specified area any area, in which quarry zones are to be established and establish quarry zones within any such specified area.

Section 5 of the Act states that a licence is required for establishing or operating a quarry, though this requirement may be waived by the Minister if the mineral to be extracted is less than 100 cubic metres. Application procedures are outlined in Section 8. The prescribed form is to be filed with the Minister along with the prescribed fee and relevant particulars. The applicant is also required to place a notice in a prominent place at the proposed site for a period of at least 21 days starting from the date on which it was filed.

3.1.8 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.

3.1.9 Clean Air Act (1964)

This act refers to premises on which there are industrial works, the operation of which is in the opinion of an inspector likely to result in the discharge of smoke or fumes or gases or dust in the air. An inspector may enter any affected premise to examine, make enquiries, make tests and take samples of any substance, smoke, fumes, gas or dust as he considers necessary or proper for the performance of his duties.

3.1.10 Noise Standards

Jamaica has no national legislation for noise, but World Bank guidelines have been adopted by the National Environment and Planning Agency (NEPA) and are used for benchmarking purposes along with the draft National Noise Standard that is being prepared. The guidelines for daytime perimeter noise are 75 decibels and 70 decibels for nighttime noise.

3.1.11 Trade Effluent and Sewage Regulations (1996) (Draft)

Jamaica has draft regulations governing the quality of the effluent discharged from facilities to public sewers and surface water systems. These draft regulations were gazetted in 2006. The draft guidelines require the facility to meet certain basic water quality standards for trade effluent including sewage (Table 3.1.11). The requisite permits and licenses are required to install and operate sewage treatment facilities.

Table 3.1.11: NRCA Sewage Effluent Standards

Immediate Technology Based Effluent Standards - Existing Plants	
Parameter	Effluent Standard
BOD_5	20 mg/l
TSS	30 mg/l
Nitrates (as Nitrogen)	30 mg/
Phosphates	10 mg/l
COD	100 mg/l
pH	6-9
Faecal Coliform	1000 MPN/100ml
Residual Chlorine	1.5 mg/l
Proposed Sewage Effluent Standards – New Plants	
BOD_5	20 mg/l
TSS	20 mg/l
Total Nitrogen	10 mg/l
Phosphates	4 mg/l
COD	100 mg/l
pH	6-9
Faecal Coliform	1000 MPN/100ml
Residual Chlorine	1.5 mg/l
Natural Resources Conservation Authority (NRCA) Interim Sewage Effluent Irrigation Standards	
Parameter	Standard Limit
Oil & Grease	10 mg/L
Total Suspended Solids (TSS)	15 mg/L
Residual Chlorine	0.5 mg/L
Biochemical Oxygen Demand (BOD)	15 mg/L
Chemical Oxygen Demand (COD)	<100 mg/L
Faecal Coliform	12 MPN/100mL

3.2 National Legislation – Socio-Economic Environment

3.2.1 Town and Country Planning Act (1958)

Section 5 of the Town and Country Planning Act authorizes the Town and Country Planning Authority to prepare, after consultation with any local authority, the provisional development orders required for any land in the urban or rural areas, so as to control the development of land in the prescribed area. In this manner, the Authority will be able to coordinate the development of roads and public services and conserve and develop the resources in the area.

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.

However, if the Minister is satisfied that the implementation of the provisional development order is likely to be in the public interest, he may, under Section 7 (2) of the Act, confirm it with or without modification by publishing a notice in the Gazette. Section 8 of the Act also gives the Minister the authority to amend a confirmed development order.

Section 10 of the Act states that a development order must include:

- clearly defined details of the area to be developed;
- regulations regarding the development of the land in the area specified;
- formal granting of permission for the development of land in the area.

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 section of the woodland area in which trees were felled during the forestry operations permitted under the order.

The tree preservation order is not applicable to the cutting down of trees which were already dead, dying or

had become dangerous and the order can take effect only after it has been confirmed by the Minister.

The Minister can, under Section 26 of the Act, make regulations to restrict and regulate the display of advertisements in any area to be developed if he considers this to be in the interest of public safety. Section 28 of the Act empowers the local authority to require the owner or occupier of land in the development area to take the steps necessary to ensure its proper maintenance.

3.2.2 Land Development and Utilization Act (1966)

Under Section 3 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".

3.2.3 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 given:

i. No individual or corporation is allowed to emit, deposit, issue or discharge into the environment from any source.
ii. 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.
iii. 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.
iv. No industrial waste should be discharged into any water body which will result in the deterioration of the quality of the water.

3.2.4 Country Fires 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).

3.2.5 The National Solid Waste Management Authority Act (2001)

The National Solid Waste Management Authority Act (2001) is "an act to provide for the regulation and management of solid waste; to establish a body to be called the National Solid Waste Management Authority and for matters connected therewith or incidental thereto". The Solid Waste Management Authority (SWMA) is to take all steps as necessary for the effective management of solid waste in Jamaica in order to safeguard public health, ensure that waste is collected, sorted, transported, recycled, reused or disposed of, in an environmentally sound manner and to promote safety standards in relation to such waste. The SWMA also has responsibility for the promotion of public awareness of the importance of efficient solid waste management, to advise the Minister on matters of general policy and to perform other functions pertaining to solid waste management.

3.2.6 Jamaica National Heritage Trust Act (1985)

The Jamaica National Heritage Trust Act of 1985 established the Jamaica National Heritage Trust (JNHT). The Trust's functions outlined in Section 4 include the following responsibilities:

- To promote the preservation of national monuments and anything designated as protected national heritage for the benefit of the Island;
- To carry out such development as it considers necessary for the preservation of any national monument or anything designated as protected national heritage;
- To record any precious objects or works of art to be preserved and to identify and record any species of botanical or animal life to be protected.

Section 17 further states that it is an offence for any individual to:

- willfully deface, damage or destroy any national monument or protected national heritage or to deface, damage, destroy, conceal or remove any mark affixed to a national monument or protected national heritage;
- alter any national monument or mark without the written permission of the Trust;
- remove or cause to be removed any national monument or protected national heritage to a place outside of Jamaica.

3.2.7 Land Acquisition Act (1947)

Section 3 of the Land Acquisition Act (1947) empowers any officer authorized by the Minister to enter and survey land in any locality that may be needed for any public purpose. This may also involve:

- Digging or boring into the sub-soil;
- Cutting down and clearing away any standing crop, fence, bush or woodland;
- Carrying out other acts necessary to ascertain that the land is suitable for the required purpose.

The Minister is authorized under Section 5 of the Act to make a public declaration under his signature if land is required for a public purpose provided that the compensation to be awarded for the land is to be paid out of the:

- Consolidated Fund or loan funds of the Government;

- Funds of any Parish Council, the Kingston and St. Andrew Corporation or the National Water Commission.

Once the Commissioner enters into possession of any land under the provisions of this Act, the land is vested in the Commissioner of Lands and is held in trust for the Government of Jamaica in keeping with the details outlined in Section 16. The Commissioner shall provide the Registrar of Titles with a copy of every notice published as well as a plan of the land. The Commissioner will also make an application to the Registrar of Titles in order to bring the title of the land under the operation of the Registration of Titles Act.

3.2.8 Registration of Titles Act (1989)

The Registration of Titles Act of 1989 is the legal basis for land registration in Jamaica, which is carried out using a modified Torrens System (Centre for Property Studies, 1998). Under this system, land registration is not compulsory, although once a property is entered in the registry system the title is continued through any transfer of ownership.

3.2.9 The Housing Act (1968)

The Jamaica Housing Act of 1968 is the legal basis for housing in Jamaica. The Act outlines the primary roles of the Minister of Housing; the procedures for acquisition of land required for schemes, the preparation and approval of schemes; and the preparation, approval, and completion of schemes prepared by housing associations.

The Housing Act established the Minister responsible for Housing as a Corporation Sole, which allows him to have perpetual succession and to acquire, hold and dispose of land and other property of whatever kind.

The Minister is advised under section 9 of the Act; that before approving a scheme, information be furnished to the Local Authority within whose area the scheme is to be operative. The particulars to be furnished shall include specifications and estimates, and particulars relating to roads, water supply, sewerage and lighting, if appropriate to the scheme.

The Minister before approving a scheme should also consider any objections or representations made to him in pursuance of this section and shall afford the Local Authority making such objections or representations an opportunity to be heard.

3.3 International Legislative and Regulatory Considerations

3.3.1 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.

3.3.2 Convention on Biological Diversity

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.

4.0 METHODOLOGY AND APPROACH

4.1 General Approach

A multi-disciplinary team of experienced scientists and environmental professionals was assembled to conduct the required resource assessment, generation and analysis of baseline data, determination of potential impacts and recommendation of mitigation measures. The EIA professional team is described in Appendix IV. An iterative approach among the environmental team members and other project professionals was adopted, and was facilitated by fortnightly or weekly team meetings as required. The EIA team worked very closely with the Gore Developments Ltd project team members including the project manager, engineers and architects.

The team utilized the Charette-style approach to data gathering, analysis, and presentation whereby team members conducted the reconnaissance investigations together to determine the critical elements for analysis and the issues to be highlighted for the design and planning process. Team meetings were used as a means to discuss the progress of investigations and analyses and facilitate integration of data toward an understanding of the systems at work in both the natural and built environment.

Baseline data for the study area were generated using a combination of:

- Field studies
- Intrusive tests
- Aerial observation
- Analysis of maps, plans, aerial photos
- Review of reports and background documents
- Structured interviews
- Laboratory analyses

4.2 Physical Environment

4.2.1 Site and Situation

The location of the proposed development relative to geographic indices, existing developments and major transportation arteries was determined, in order to identify the site and situational context. This was done using maps, plans and photos.

4.2.2 Geology, Hydrogeology and Soils

A definition of the study area was first done, based on the drainage area of which the proposed development forms a part. These boundaries were demarcated based on a desktop review of available topographical maps, aerial photographs and field reconnaissance along open and traversable access ways.

Baseline data collection for the study area included information on hydrology, geology, hydrogeology, geomorphology, topography and drainage and included review of existing reports and other information relevant to the study area.

4.2.3 Drainage and Storm Water Runoff

Data were collected and reviewed to determine the following:

1. Water demand based on population and consumption rate for the various demand sectors in the general area.
2. Pre and post project runoff rates for 10 yr return period.
3. Possibility for contamination of the ground and coastal waters as a result of the proposed development.

Climate data including rainfall were collected from the National Metrological Service.

An Explorative Drainage Assessment was done to determine the following:

1. The existing condition of the study area such as drainage characteristics, geomorphology and geology, and hydrology.
2. The existing water supply sources (production levels, installed capacity, operating efficiency, ability to satisfy existing and projected demands).

Additionally recommendations were made for appropriately designed flood control structures, as well as conducting a review of the proposed drainage plan. Potential water source(s) to satisfy the increased water demand were also investigated.

4.2.4 Hydrological Assessment

The hydrological assessment was interpreted largely from the report of the drainage engineers (Foreman, Chung and Sykes, 2008, Appendix III). The assessment was done using both the Rational Method and TR-55 which is used around the world for peak flow estimation of small rural drainage basins and is the most widely used method for urban drainage design.

Discharges for 10, 25, 50 and 100 year return frequency were determined.

To achieve this published data sources were accessed including the following:

- ✓ A Geotechnical Classification of Jamaican Rock, formerly the Geological Survey Division (currently the Mines and Geology Division, 1983)
- ✓ Satellite photographs taken from the Google Earth web server
- ✓ Topographic plans of parts of Florence Hall
- ✓ 1:50,000 (Provisional) Imperial Series Geological Sheets 8 (April 1974)
- ✓ Soils and Land Use Surveys as held by the WRA database
- ✓ Water Resources Authority Data Request (July 2008)
- ✓ Office of disaster Preparedness and Emergency management
- ✓ Internet searches of NEPA and other relevant websites

All issues material to the site, such as hydrologic events, groundwater pollution incidents, flooding incidents and other critical events were reviewed with a 5 km radius of the centre of the site.

4.2.5 Natural Hazard Risk

Assessment of natural hazard risk was accomplished through a review of relevant literature pertaining to soils, slopes and drainage, site assessment, and anecdotal reports on historical events from residents in the surrounding communities. All issues material to the site, such as hydrologic events, groundwater pollution incidents, flooding incidents and other critical events were reviewed with a 5 km radius of the centre of the site.

4.2.6 Air Quality

Air contains particulates in the form of dust. A portion of that dust with particle size less than 10 microns can be retained in the lungs. During construction and excavation activities the concentration of fugitive dust increases significantly and hence so too does the likelihood of respirable disease in humans increase.

The objective of the air quality monitoring exercise was to determine the normal concentration of respirable particulates in the project area prior to construction works. Air quality measurements were taken at five sites in the project area (Sites 1-3, 12 & 13). The sites are described in Table 4.2.6 and illustrated in Figure 4.2.6 below.

The air quality assessment involved the measurement of ambient levels of respirable particulates, PM10 (<10μm). Particulates were measured using Sensidyne (BDX 530) personal vacuum pumps (suction 2-3 1/min), attached to pre-weighed Millipore filters. The pumps were placed at the approximate respiratory height of pedestrians for a six hour period at the seven sites, over a one day period. The pumps were then returned to the ESL laboratory where the filters were stabilized and weighed to determine a Time Weighted Average (TWA) value for the particulates.

Table 4.2.6 Name and Location of Air Quality Sampling Stations

SAMPLE ID #	SAMPLE LOCATION	DESCRIPTION
Site #1	N 18.47303 ° W077.62756 °	This sampling station was to the south of the great house.
Site # 2	N 18.47316 ° W077.62365 °	This sampling station was along the southern border of the property just off a well worn track, in a cleared area. The surrounding area was densely vegetated.
Site # 3	N 18.48273 ° W077.62701°	This sampling site was south along the north coast highway approximately 3 m from the road way. The area was cleared.
Site # 4	N 18.48246 ° W077.62673°	Same as above
Site # 5	N 18.48262 ° W077.62652°	Same as above
Site # 6	N 18.48281 ° W077.62583°	Same as above
Site #7	N 18.48298 ° W077.62529°	Same as above
Site # 8	N 18.48200 ° W077.62801°	Same as above
Site # 9	N 18.48145 ° W077.62960°	This sampling site was close to the intersection of Daniel Town road and the North Coast highway.
Site #10	N 18.48054 ° W077.62549°	Sampling was done around a sink hole which was surrounded by large limestone rocks and dense vegetation.
Site #11	N 18.47450 ° W077.62988°	The area was cleared of its vegetation.
Site #12	N 18.47974 ° W077.62496°N	This sampling site was on the Daniel Town road along the western border of the property 200 m downwind of the Kemtek construction site.
Site #13	N 18.47384 ° W077.62950°	The sampling station was located between the Florence Hall property and the Kemtek construction site. Heavy machinery was working on the site. Buildings on the site were in varying stages of completion.

Figure 4.2.6: Air Quality Sampling Stations at Florence Hall

4.2.7 Noise

Noise has a significant impact on the quality of life, and in that sense, it poses a health risk to humans in accordance with the World Health Organisation's (WHO) definition of health. The effects of noise are seldom catastrophic, and are often transitory, but adverse effects can be cumulative with prolonged or repeated exposure.

Ambient noise measurements were conducted at the stations sampled for air quality (Section 4.2.6 above) using a Quest Electronic Model 1800 Precision Impulse Integrating sound level meter. This instrument has octave band analysis capability. Wind direction and speed as well as any other unusual noise sources were also recorded. The meter was calibrated before and after each set of readings with a calibrator which is pre-calibrated at production. The data will be correlated and compared with NEPA, OSHA and WHO standards for noise pollution.

4.2.8 Water Quality Methodology

Water quality determination, an important component of any environmental assessment, provides critical data on the condition of the water resource. The major objectives of the present water quality sampling programme are to assess land use practices prior to the construction of the Florence Hall Development and determine the nature and extent of existing land use impacts on the water quality of any surface or underground sources. These objectives were largely met through a detailed site investigation and the conduct of a water quality sampling exercise in July and December 2008.

Four sampling stations were selected, three of which are located on the project site and one station in the connecting mangroves on the opposite side of the North Coast highway. The station locations are listed in Table 4.2.8 and illustrated in Figure 4.2.8.

Table 4.2.8: Name and Location of Water Sampling Stations

SAMPLE ID	SAMPLING STATION NAME	LOCATION	SAMPLING STATION DESCRIPTION
FLC	Florence Hall Cave	N 18.47981° W077.62500 °	The cave is situated near the centre of the project site in an area with thick vegetation and large limestone rocks. The entrance to the cave notably had a significant number of birds. The water in the cave was greater than 10 feet in depth. The water was clear with floating debris on the surface.
FLWH	Florence Hall Water Hole (Sink Hole)	N 18.48044 ° W077.62547 °	This sink hole was surrounded by large limestone rocks and dense vegetation north of the cave. A large fern-like plant was observed growing in the middle of the sink hole. There is apparently some connectivity with the water in the sink hole and the mangroves as the typical amber coloured water and hydrogen sulphide odour was evident at the site.
FL Swamp	Florence Hall Swamp	N 18.48288 ° W077.62543 °	This station is situated approximately 20 meters south of the North Coast Highway in the mangroves near the northern property boundary. Typical of mangrove swamps the water was amber coloured but clear, with the characteristic hydrogen sulfide odour. Schools of fish were seen at the roots of the mangroves.
GW Swamp	Glistening Waters Swamp	N 18.48311 ° W077.62583 °	This sampling station is located in the wetlands approximately 15m north of the North Coast Highway. Notably the waters surface was covered with a thin layer of dust. The colour of the water was brown. Garbage was observed littered over the area.

Figure 4.2.8: Water Quality sampling stations on the Florence Hall Site

All samples were collected in pre-cleaned 2 litre polyethylene sample bottles at a depth of approximately 0.5m below the surface of the water. Bacterial samples were collected at the water surface in sterilized 100 ml glass bottles.

The following parameters were analyzed on all of the water samples:

- ◊ pH
- ◊ Salinity
- ◊ Temperature
- ◊ Dissolved Oxygen
- ◊ Total Suspended Solids
- ◊ Nitrate
- ◊ Phosphate
- ◊ BOD_5
- ◊ Total and Faecal Coliform

Salinity, Temperature and Dissolved Oxygen

Salinity, temperature, and dissolved oxygen were measured *in situ* at all sampling stations using a YSI Model 57 Salinity/Conductivity/Temperature (SCT) meter and also a YSI Model 33 oxygen meter respectively. Measurements were taken at the surface (~0.5m depth) of the water column.

4.3 Biological Environment

Several site visits were made for the purpose of conducting a complete biological assessment of the proposed project property. The ecological site reconnaissance at Florence Hall was conducted to provide an overview of the site layout, types of habitats and their floral and faunal composition. The visit involved driving around the perimeter of the site and walking along some of the roads and other access points. Notes on the plant composition and all species of plants and birds observed on site were recorded. Point counts for birds and/or plant sampling were also conducted on subsequent field trips. The main habitats on site are as follows:

i. Dry limestone forest
ii. Wetland
iii. Caves

4.3.1 Flora

Plants were identified in the various habitats and defined according to their growth habitat (large trees, small trees, shrubs, herbs and vines). For plants that could not be identified in the field, a specimen was taken for identification at the University of the West Indies herbarium.

4.3.2 Fauna

Point Counts were conducted for Bird surveys along with walking transects along existing trails on the site. The counting period was six (6) minute point counts at a minimum of ten (10) locations dispersed across the property. The habitat was zoned and points were selected using a stratified random system to ensure that each type of habitat was effectively sampled. Point counts for birds were conducted between sunrise and 9:00 Am in order to sample during the period of highest activity for the majority of bird species so as to

maximize the level of detectability. Playbacks of pre-recorded bird calls were used at several locations to determine the presence of specific species of concern.

Additional night-time counts were conducted throughout the site from sunset to 8:30 Pm in order to survey those birds or other wildlife that were expected to be most active only at night. Observations of butterflies and other wildlife were recorded.

4.4 Socio-economic Environment

The main purpose of the socio economic analysis was to place the proposed project within the context of the local human environment, upon which it is expected to have an important influence. Similarly, the analysis also examined the ways in which the local human environment might impact the project and may be supportive of it. Of corollary concern, was the proposed project's impact on the existing site in relation to any potentially important heritage elements that exists or are likely to exist. The project was also examined within its wider regional setting.

The methodological approaches to this assessment were in keeping with the data base needed to support proper analysis and useful findings. The approaches included:

1. Desk Research
2. Rapid Appraisal

Desk Research

This involved the review and analysis of all the relevant socio-economic data available from both recommended sources and other national sources to help to put the Project into its local context.

Included in desk research was Project specific documentation. For example pre feasibility or feasibility reports which included project concept and positioning, and marketing plans. Technical reports where they have been developed, were perused particularly in relation to health and safety issues,

Rapid Appraisal

This involved the use of established techniques that would allow the Consultants to obtain a prompt yet in-depth orientation to the project area and its constituent communities. The methods included a site

reconnaissance along with interviews with key stakeholders' which helped to identify the major issues for the developer to consider.

During the reconnaissance the Consultants explored the project area to familiarise themselves with the site boundaries, landmarks and community locations. At the same time meetings were held with key persons who were strategic in relation to the socio-economic assessment. The site recon was also used as an observation method for features, establishments or activities that might warrant further investigation, such as: heritage elements, social capital, informal or unplanned settlements (including squatting) and obvious forms of environmental degradation, tourism-related activities and business activities of significance.

4.4.1 Communities of Interest

The project zone of immediate influence was defined based on the likely socio-economic impact of the development in relation to:

i. Its local environment and community setting and
ii. The wider community it serves and will influence.

The immediate zone of influence included the following communities:

- Main Towns:
  1. Falmouth
  2. Martha Brae
  3. Duncans

- Other Communities:
  1. Rock
  2. Hague
  3. Daniel Town
  4. Coopers Field

The wider community included mainly the parish of Trelawny. Issues of land use, worker & residential population expansion and supporting social infrastructure were the main concerns in the assessment.

The rapid urban appraisal encompassed the following methodologies:

- In-depth structured interviews as well as non-structured *ad hoc* discussions with non-targeted individuals and groups of individuals, within the defined communities.
- Similarly in-depth structured interviews as well as non-structured interviews with targeted key informants.

**Non-targeted respondents are those that were approached on a random basis, but in selected locations. Whereas targeted individuals are those key informants, pre selected for interviewing, whether by appointment or otherwise.*

The number of interviews conducted was a total of 300. This was deemed sufficient to bring into focus those positive or negative impacts that the communities and stakeholders perceive as a result of the project.

4.4.2 Demographics and Livelihoods

Demographic data were sourced from the Statistical Institute of Jamaica (STATIN).

4.4.3 Physical Infrastructure

Physical infrastructures were delineated for the area.

4.4.4 Traffic Pattern, Transportation and Access Roads

Traffic patterns, access to the property and the North Coast Highway were assessed with context of the major development.

4.4.5 Archaeological and Cultural Heritage

The Heritage Impact Assessment (HIA) was conducted to conform to standard international Heritage Impact Assessment methodology and included the following:

1. A Statement of the Terms of Reference (TOR's), aims and objectives of the HIA

2. Literature search

A number of archives were investigated including the National Library of Jamaica, the Jamaica National Heritage Trust and the Jamaica National Archive in Spanish Town, St. Catherine. Written documentation and maps were also examined.

3. Oral history investigation

A significant amount of oral history exists especially in rural areas such as Florence Hall. Unfortunately none of the persons who worked on the Florence Hall estate is currently living on the estate. However, several of their descendants who have lived there for many years were interviewed. A number of sites were identified, most of which confirmed the results of the archival, and more especially the map research.

4. Field Survey Strategy

An attempt was made to determine the existence of all recorded or known sites through a focused field walking exercise.

It was the decision of the Consultant to firstly confirm those elements of the site that were indicated by the map of 1838, secondly any other elements that the informants knew about and could take the Consultant to directly and thirdly to conduct a ground survey during the walk to the site to identify any other sites especially Taino remains. Photographs were taken of all elements.

5. Reporting

Reporting included:

- A description of the heritage elements identified
- A statement of the impact of the Development on heritage elements
- Mitigation measures to include recommendations for the preservation of heritage elements and their integration into the project and actions that will need to be undertaken at each project site for the detailed EIA
- GAP analysis
- Determination of suitability for legal protection

4.4.5.1 Archaeological and Cultural Heritage – Aims and Objectives

The aim of the Heritage Impact Assessment (HIA) of the Florence Hall Development was to identify the Cultural Heritage Resources (CHR) within the Development Area, to determine the impact of the development activities on them, and to identify gaps in our current knowledge. This was accomplished through the following:

1.0 Conducting oral history and archival research to obtain information on the history of the area and the sites of historical interest within it
2.0 Conducting a survey of the Development Area to identify and record the Cultural Heriatge Resources within it
3.0 Analysing the impact of the proposed development on these CHR
4.0 Recommendation of mitigation for any adverse impacts
5.0 Recommendation of possible methods of incorporating the cultural heriatge designs and definitions into the overall design of the project to provide value added
6.0 Identification of the gaps in current knowledge and recommend actions to fill them

4.4.6 Public Consultations

Public consultations for the EIA serve three main purposes:

a. Data gathering
b. Information sharing
c. Determination of public sentiment

Data gathering was accomplished through targeted stakeholder interviews, meetings, *ad hoc* discussions and through the application of specifically designed interview instruments (Appendix VII).

Information sharing on the main components of the project was done as appropriate, with key stakeholders in order for them to fully understand the project and be able to supply relevant information.

Public sentiment was determined from the comments given and questions asked during the interviews, meetings and application of interview instruments.

If NEPA requires submission of this EIA it is likely that a *Public Presentation of the Findings of the EIA* will also be required by NEPA. This would be staged according to the NEPA Guidelines for Public Consultations and would require 21 days public notification prior to staging the event, the submission of a report on the public presentation and a 30-day period following the public presentation to allow for the submission of public sentiment.

4.5 Prediction of Potential Impacts

The various aspects of the project and the potential impacts on the physical, biological and socio-economic environment were identified and are presented in an Impact Matrix. Various aspects have been highlighted for in-depth consideration and include the following:

i. Loss of vegetation and loss or alteration of habitat or fauna

ii. Drainage, especially with respect to existing natural underground drainage and man-made drainage/water features to be implemented into the development

iii. Karst topography, caves and sinks

iv. Increased surface runoff, potential impacts on downstream communities and sediment loading to the coastal zone, particularly Oyster Bay

v. Natural hazard risk

vi. The method, level and location of the sewage treatment facility and the impact of its disposal on the environment, and required set back distances

vii. Increase in traffic flow unto the North Coast Highway

viii. Cumulative impacts of the project along with other existing or planned developments

Impacts were identified based on the following factors:

- Duration: short, medium or long term
- Direction: positive or negative
- Magnitude: major of minor
- Type: reversible or irreversible

Where applicable the impact of the existing environment on the proposed project has been discussed.

4.6 Limitations to the Study

Some limitations to the study were identified and are recorded here to ensure that there is complete understanding of the methodology used, the data generated and the application of impact prediction. These limitations relate to:

i. Physical Environment
ii. Biological Environment
iii. Socio-economic Environment
iv. Archaeological and Cultural Heritage

In relation to the physical environment the geotechnical studies present several limitations. Geotechnical considerations were significant for this study because of the karst topography that is characteristic of the site. Borehole and soil investigations were conducted by JENTECH (Appendix V) and made available for review.

The EIA team recommended the application of Resistivity surveys to determine the extent of sub-surface cavities without surface expression. The resistivity surveys were commissioned but could not be completed due to equipment failure. Only one site was completed. As a result an alternative investigation was recommended by the geotechnical engineers. This was the use of Ground Penetrating Radar (GPR) technology (Appendix V). The GPR has indicated several cavities which have no surface expression, but the interconnections of the cavities are not known.

The archaeological and cultural investigations presented some gaps which limits the study. The most critical gap in the current knowledge relates to the Taino Indians. Taino sites exist all along the north coast and as close to Florence Hall as the site of the Trelawny Multi-Purpose Stadium to the west, as well as to the east of Florence Hall. However, as the area has not been surveyed in an archaeologically systematic manner there are large segments such as Florence Hall for which no Taino sites have been identified. A second gap includes the specific locational identification, interpretation and understanding of the historic built environmental features including the positive identification of the African Jamaican workers' village.

5.0 THE EXISTING ENVIRONMENT

5.1 Physical Environment

5.1.1 Site and Situation

The site is centered on UTM 222600 mE, 2044947 mN. It is bound by the North Coast Highway and a wetland along its northern boundary. The western boundary is adjacent to two other properties owned by third parties and the main road to the Trelawny Stadium and Daniel Town. The east and south are bordered by secondary forest and JPS Co. power line reserve road, respectively. The proposed project site covers approximately 72 hectares (179 acres).

The North Coast Highway forms a dyke north of the wetland area. The wetland extends further east on lands outside of the development area. The wetland area with the highway embankment forms a surface water storage area upstream of the highway. The existing ground surface includes depressions and caverns at various parts of the site that detain and retain surface runoff. The proposed property is presently overgrown with trees and brush where well fractured limestone and rough limestone outcrops predominate the landscape.

5.1.2 Climate

The climate of the site, like the rest of Jamaica, is subtropical with northeasterly prevailing winds and average daily temperatures varying from 23 ^{o}C in January to about 28 ^{o}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. 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 in November and 105 in May. There are two distinct periods of higher than average rainfall from October to January and during May. The August and September 30-yr mean annual (1951-1980) rainfall for Trelawny was obtained from the Meteorological Office website and is recorded at 154 mm and 166 mm. Current measured rainfall values for August 2008 and September 2008 were recorded at 212 mm and 157 mm respectively.

During the period June to November each year extreme weather conditions are produced by tropical systems that develop in the north Atlantic and Caribbean basins. These systems move westwards through

the Caribbean region and generate intense rainfall of long duration and when tropical storms or hurricanes develop high velocity winds accompany the rainfall. 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.

5.1.3 Topography

The topographical survey activities exposed the existing ground where mostly limestone outcrops were observed. Cavities extending to the surface that can be entered and others that cannot were observed. The proposed development land is located on the slopes of the rolling limestone hills in the area. The land slopes from the south to the northeastern corner of the property (Figure 5.1.3), therefore sloping gently toward the highway where ground elevations range from 45 m at its highest along the southern boundary to just over 1 m asl toward the highway.

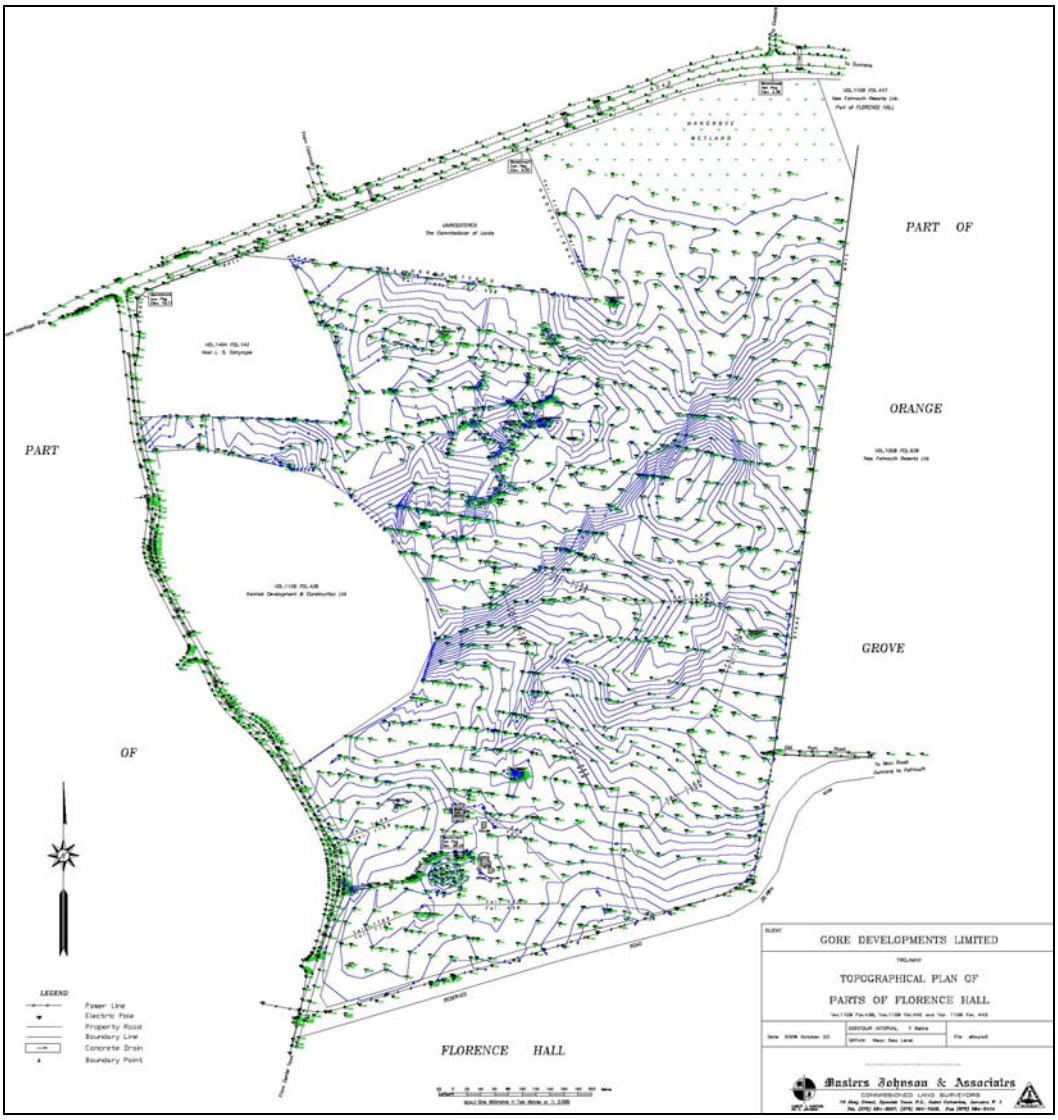

Figure 5.1.3 Topography of the proposed property at Florence Hall

5.1.4 Geology, Hydrology and Soils

Published geological information (Geological Sheet 08, 1:50,000 Imperial Series, extract shown in Figure 5.1.4a) indicates that the majority of the site underlain by the Miocene aged Montpelier Limestone Formation (Mm) (Plate 5.1.4) with slivers of the younger Falmouth Formation (Qf) and recent Marsh and Peat (Qm) deposits occupying the northern edge of the site. The Montpelier Formation is the youngest member of the larger White Limestone Group and comprises well bedded white chalks with abundant flint nodules with some grey silty limestone clay in the lower portions. It is up to 460 m (1500 ft) thick and lies

conformably above the older Walderston-Browns Town Formation. There is significant karstification of the limestone with several well defined caves and depressions on the property. “Karst” refers to landforms and geologic features that have resulted from the dissolving of the carbonate bedrock (limestone) underground. Overlying soils are very thin to nonexistent being confined to the lower areas or depressions in the limestone. The Falmouth Formation (Qf) consists of a series of elevated reefs whilst the marsh and peat deposits comprise soft brown clays. The Marsh and Peat (Qm) deposits correspond with the wetland identified along the south-eastern corner of the site.

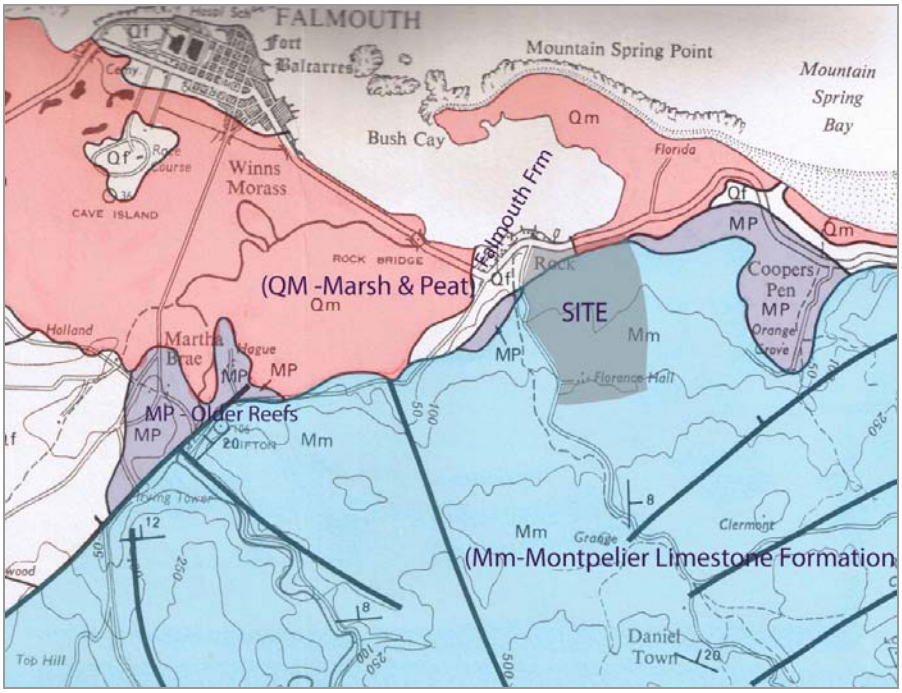

Figure 5.1.4a Extract of geological map (Sheet 08) showing the proposed housing development (shaded grey). Bold lines represent geological faults (Scale – 1:50,000)

Plate 5.1.4 Outcrops of the Montpelier White limestone as seen on the proposed project site at Florence Hall

Structurally, there are no known regional faults that cross the site, however, on a local scale, there appears to be a fault scarp the trends in a similar NE-SW direction as the regional faults. The linear feature is clearly seen on the geology map (Figure 5.1.4a above), and on the site topographic plans. There is an approximate 10 – 15 m vertical difference across the fault. All the large caves located on site are located to the north of the fault, suggesting at the least that both may be related. It is possible a large stress fracture related to the regional faults and possibly not active. This will need to be verified, as the scarp was over-grown with vegetation during the site visit.

The WRA classifies the geology as a Limestone Aquiclude, which is an impermeable rock that acts as a barrier to groundwater flow. The Limestone Aquiclude defines the majority of the site while the Alluvium aquiclude underlies only a limited portion of the northern boundary of the site. Even with this classification, there are several active water wells that tap the Montpelier Limestone Formation within 5km of the site, indicating that groundwater is present and accessible for use, though its extent may be limited. Its presence may be limited to areas of showing mature karstification or/and faulting or a combination of both. Figure 5.1.4b below shows the aquifer classification, caves (from public record), faults, reported incident of flooding and other hydrologic features within 5km of the site.

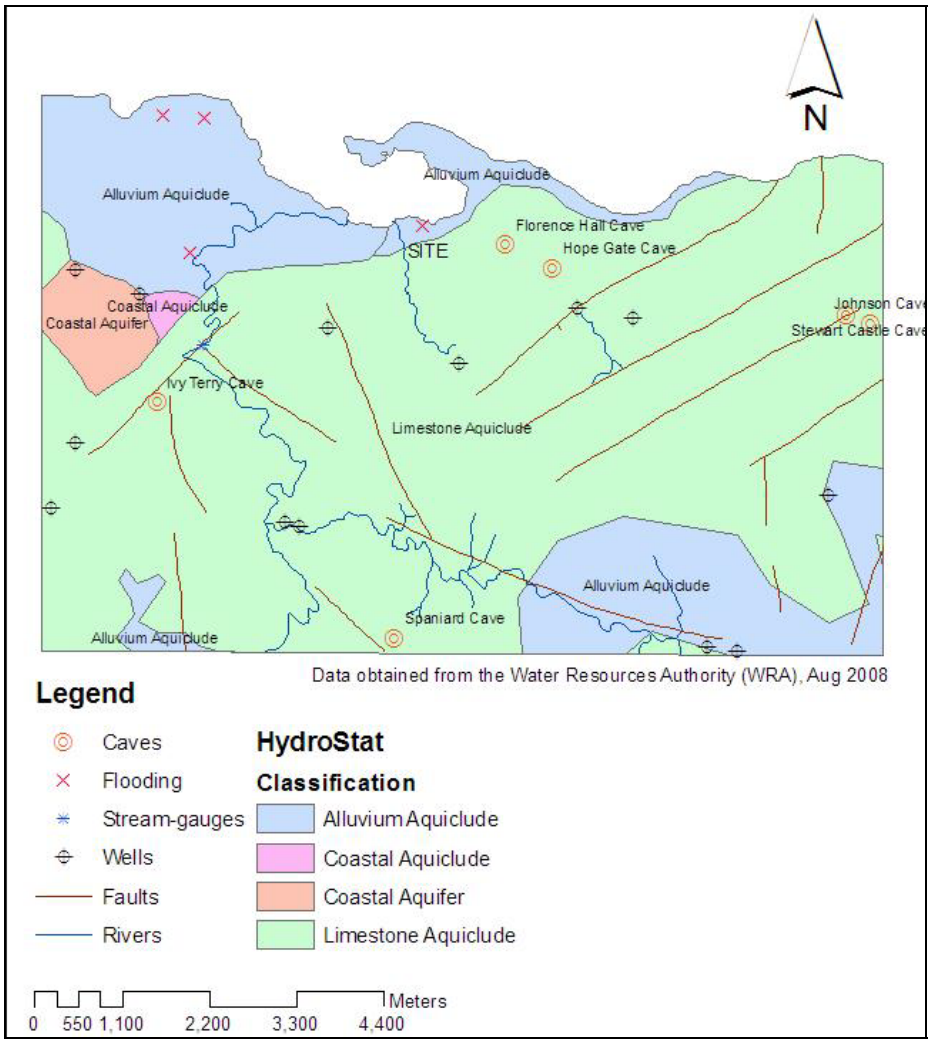

Figure 5.1.4b Hydrogeological setting as observed on the proposed property at Florence Hall

5.1.4.1 Geotechnical Investigations

Boreholes

An intrusive investigation was undertaken at the site and consisted of 11 boreholes spread across the site (Appendix III). The material encountered ranged from bauxitic clay to calcareous sand and gravel to fractured limestone rocks. The boreholes suggest that the most competent material lies to the south east of the site (See report in Appendix III, BHs 13 & 16) and has very little clay overburden. BH 11, 12, 14, and 15 present more bauxitic clay and sand in the upper 4m (13ft) with fractured rock presenting at depth. The geology, when viewed in light of the presentation of the pond near the old Great House, the presence of gullies leading to the pond, the 1:25 gradient fall to the pond and a cave/depression 200m northeast of the

pond at the same elevation as the pond, it suggests that there may be settling of cover sediments (clays which are normally formed as a consequence of dissolution of the limestone) into a *buried solution doline/sinkhole*. A doline/sinkhole is typically a bowl-shaped depression that can range in size from a small hole in the ground, with a diameter less than 1 metre, to a huge chasm, hundreds of metres across and tens of metres deep. A buried solution doline is one where the solution doline is filled with sediment often caused by a change in the environmental conditions. The site topography suggests that it may be a least 80m across. The depth is uncertain as this is dependent on the subsurface dissolution feature, which may be fracture clusters to caves. Ground Penetrating Radar (GPR) evidence suggests that the feature may extend to over 5m in depth from the surface. The presence of a hand dug well further indicates that groundwater may have been encountered at in the past centuries.

Ground Penetrating Radar (GPR)

A GPR (ground penetrating radar) survey was conducted during December 2008 to further identify subsurface voids given the numerous surface presentations of karst features as noted above. The GPR survey consisted of over 67km of GPR profiles using a prescribed line spacing of 10 m. The survey report indicated that the difficulty of the terrain caused limited access and this reduced the profile spacing particularly in the northwest of the site, or caused areas to not be surveyed. Additionally, given the limitations of GPR systems, the vertical extent (thickness) of voids is difficult to decipher and that accuracy of the survey is limited to the location and top of each void with the thickness of each void being interpreted and as such the depth and thickness of the voids should be viewed as generalizations only. The produced maps (Figure 5.1.4.1a) and the written report indicate that “the vast majority of voids” are located within 2-6 m depth and appear overall to be small, with a few over 7 m in size. The report states that the absence of voids in the north and northwest of the site is due mainly to the minimal GPR coverage in these areas and should not be interpreted as a “lower likelihood of voids”.

Three areas of special note (see Figure 4 within the GPR report, Appendix III) at the extreme north bordering the marshland (beneath the proposed sewage treatment plant) this is consistent with the understanding of the development of the salt marsh pond; 2) along the south (highly fractured, lenticular rock to the southwest and an apparent interconnected voids system to the southeast between 1-6m depth) the latter is consistent with the buried solution doline suggested by the surface evidence but the extension of the feature to the southeast suggests that is larger than initially appreciated; and 3) highly fractured zone at 684097E, 703307N, which has a surface presentation as a topographic depression and is probably an incipient dissolution feature.

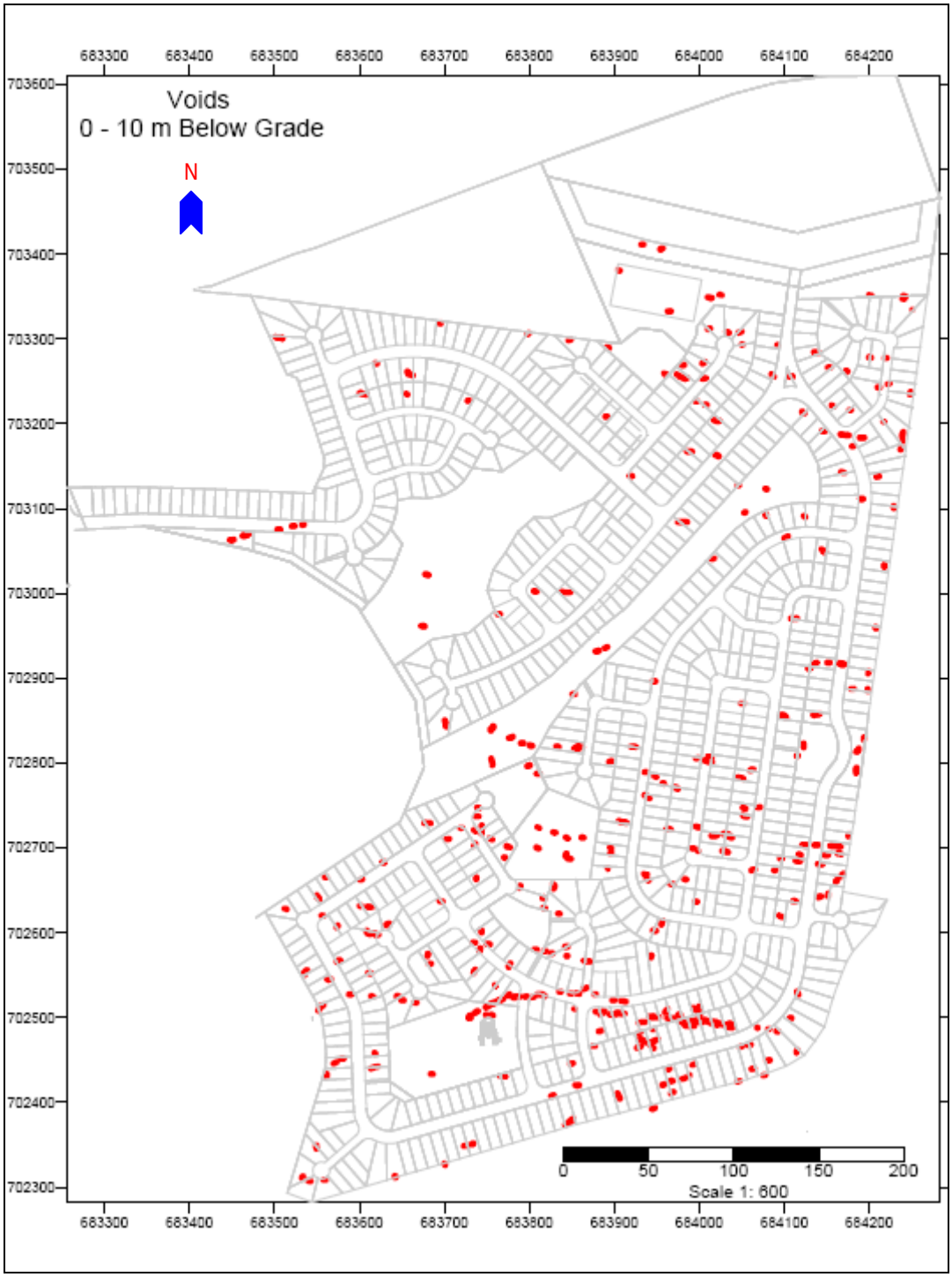

Figure 5.1.4.1a - UltraGPR survey results of all voids detected between 0-10 m. Ovals showing areas of concern as determined in the GPR report (Source: GPR report Dec. 2008)

The location of caves and depressions noted during the site walkover are shown in Figure 5.1.4.1b. However, a total of eight caves have been confirmed in the topographical survey. A few of these caves are located outside of the coverage of the GPR hence an appreciation of subsurface connectivity or extent was not established. All together the data suggests that the site is likely to have many dissolution sinkholes, at least two buried sinkholes, extensive dissolutional openings (fractures) beneath the surface and caves at multiple levels and based on the most recent engineering classification of karst (Waltham and Fookes, 2005) the karst classification is a combination of kIII (mature) to kIV (complex).

Care needs to be taken with long-term stability on such terrains, especially the control of water flows, which is the key to minimizing sinkhole failures in karst. This should include the ban of soakaway drains, the use of flexible infrastructure lines for liquids and the diversion of inbound surface flows. Control of groundwater abstraction is also critical to controlling the formation of sinkholes. Blocking of natural drainage conduits can lead to the development of new voids at the locations of the redirected flows. Appropriate evaluation of the risks (short and long-term) will need to be conducted by the geotechnical and structural engineers in relation to the stability of the structures over the life-time of the project. The cross-section in Figure 5.1.4.1c below illustrates the typical forms of sinkholes that have been encountered on the site travelling from south to north.

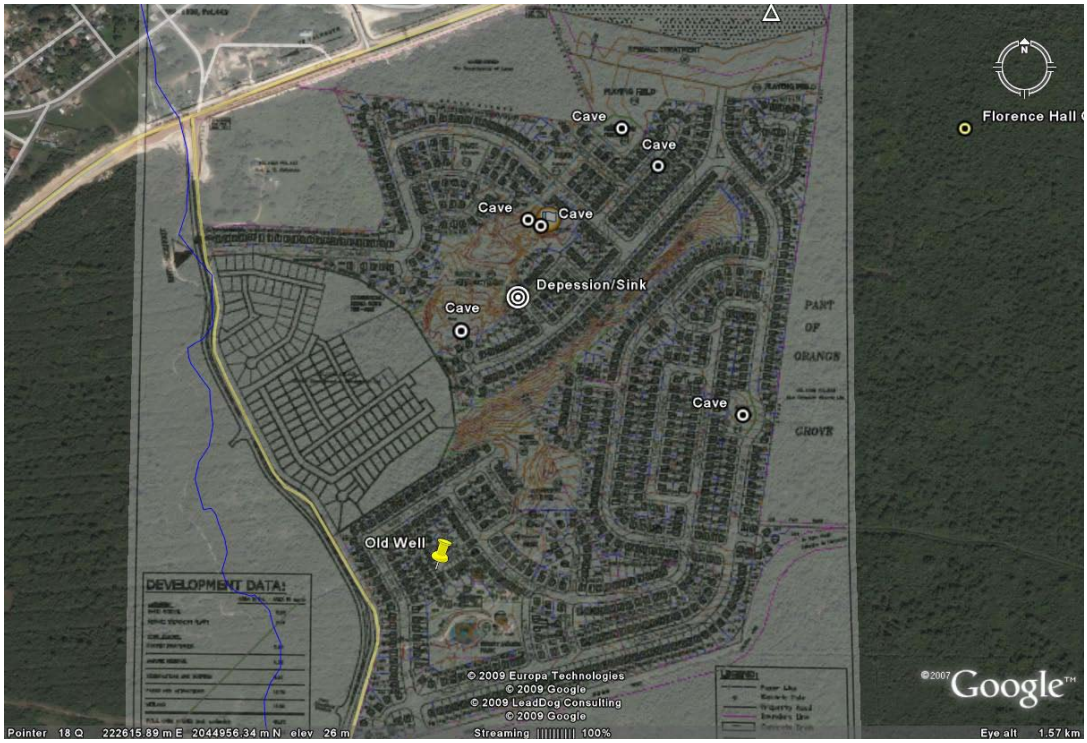

Figure 5.1.4.1b Known caves and depressions as identified on the project site

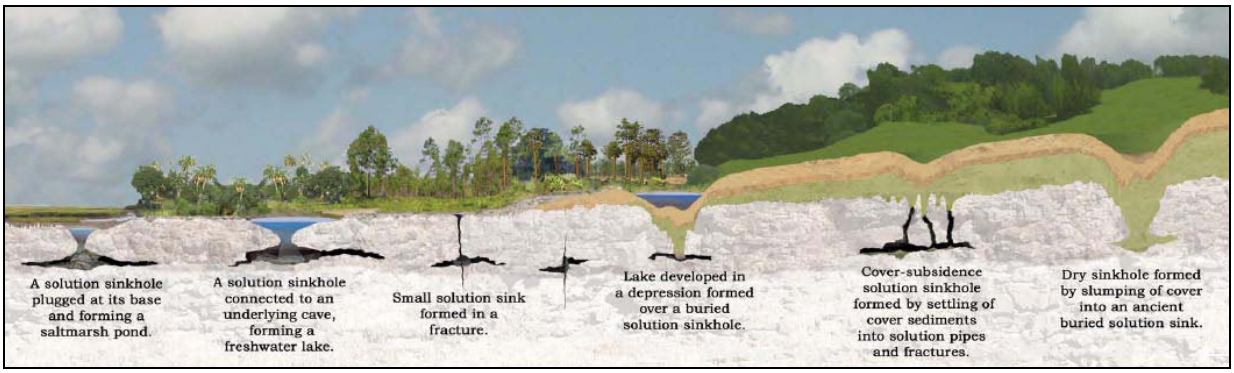

Figure 5.1.4.1c Typical forms of sinkholes encountered on the Florence Hall site from north (on the left) to south (on the right). Not to scale. Figure is representational

5.1.5 Groundwater and Surface Water Resources

The nearest, surface water course to the site is a dry gully called the Daniel Town Gully, which lies more than 10 m at its closest approach to the western site boundary. The gully is associated with the larger Martha Brae Watershed Unit according to the Water Resources Authority (WRA). Gullies are part of the natural drainage system and carry substantial flows during heavy rainfall events. The lower reaches of this gully has been substantially modified as part of the development of the Trelawny Stadium road works. The gully does not impact materially on the site but influences drainage close to the site.

The WRA is not aware of any material groundwater or surface water contamination issues, but are concerned about the impacts of storm water and sewage disposal on existing surface and groundwater systems.

Groundwater vulnerability is most likely to be considered moderate to high due to the limited protective soil cover and mature karstification (sinkholes, etc) that allow rapid connection to subsurface water.

Groundwater levels at the two closest wells, Hague East (1.2 km west) and Daniel Town (0.6 km south), show groundwater levels at 4 m (13 ft) and 56.4 m (185 ft) respectively. The dates for these measurements are unknown and possibly may represent a groundwater condition that may be different today. Figure 5.1.4.1b above shows all wells within the 5 km of the site.

Recent intrusive investigation (Appendix V - Jentech, 2008) that advanced 11 boreholes at 1 m to 6 m depth encountered no standing groundwater. The drilling sub-contractor report did identify groundwater within on-site caves at approximately 7.5 m bgl. Other instances of groundwater noted on the site were seen near the surface in a small opening in the limestone (possible cave shaft) at least 2 m deep. Plate 5.1.5 below shows groundwater at surface and possible cave shaft. This water body is within 100 m north west of a larger cave.

Plate 5.1.4.1 Groundwater at surface (depth greater than 2 m) suggesting a connection to an underground cave. Opening about 2-3 m across and probed to an equal depth before the measuring device was unable to penetrate further due to an obstruction.

There are no rivers or streams on the property due to the presence of mature karst. A wetland (salt marsh pond) is located to the northeastern end of the property. The boreholes BH 3 (4.6 m) and BH 4 (6.5 m), advanced within 50 m of the southern edge of the salt marsh pond, did not encounter groundwater suggesting that the salt marsh may be linked to localised karstification such as a historic solution sinkhole that has been in filled and possibly has a groundwater contributing component via the sub-surface fracture conduit system.

5.1.5.1 Water Demand

Mains water is currently supplied by the National Water Commission. The proposed development will require approximately 240,000 imperial gallons of water per day. The NWC has confirmed in writing that it is possible to provide the required amount on the condition that the developers pay the requisite development of infrastructure costs (Appendix I).

5.1.5.2 Sewerage Facilities

There are no large municipal sewerage facilities noted within 2 km of the site.

5.1.6 Natural Hazards

5.1.6.1 Hurricanes

Jamaica is susceptible to hurricanes and other storm events as indicated by the historic hurricane tracks (Figure 5.1.6.1a). The rainy season is from May to October, with peaks in May and October, and tropical depressions, storms and hurricanes can occur any time during this period. These systems usually bring large volumes of rain with or without flash floods, slow inundation and high winds. The peak of the hurricane season is usually by September of any given year and hurricanes and tropical storm tracks are most likely to impact Jamaica (Figure 5.1.6.1b).

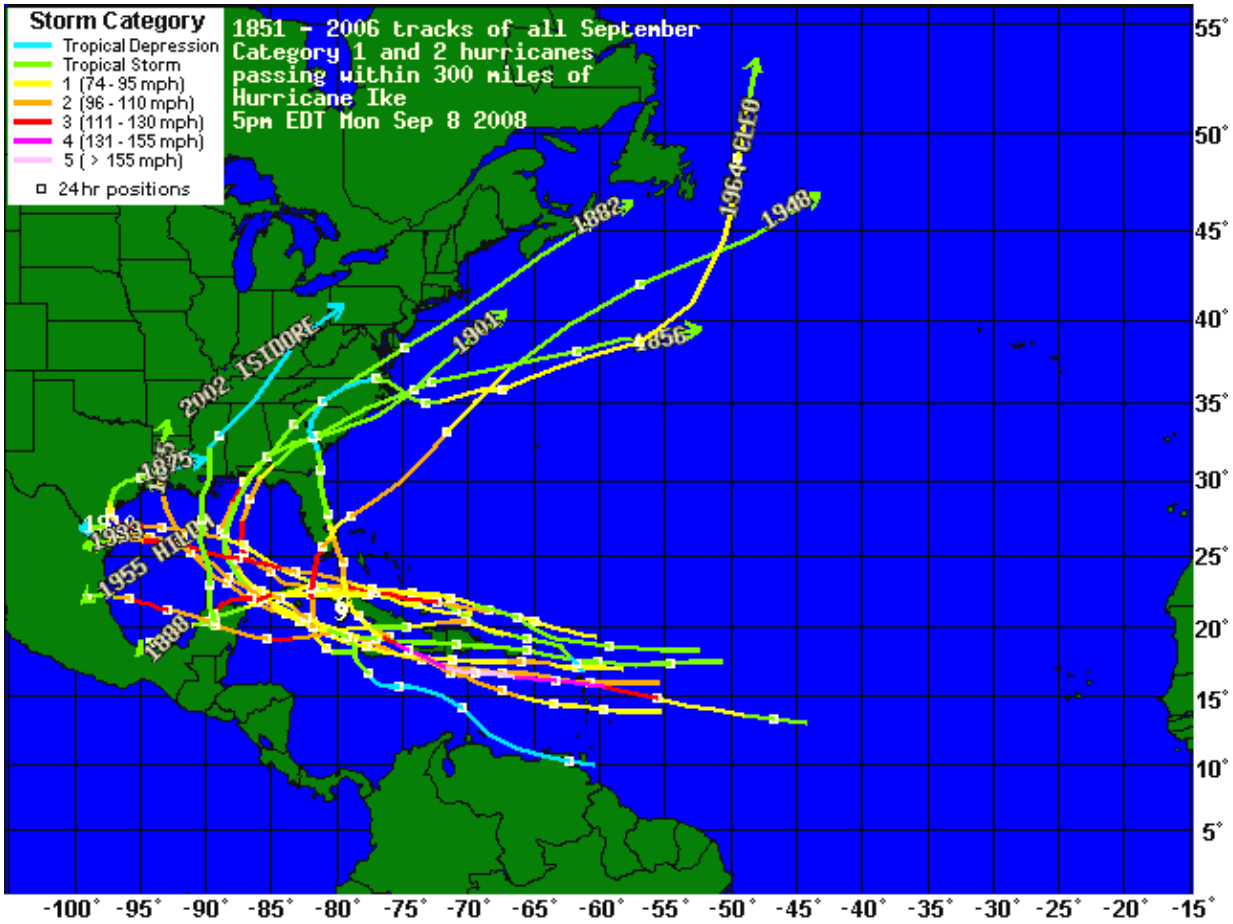

Figure 5.1.6.1a Historic hurricane tracks across Jamaica – 1880-2006

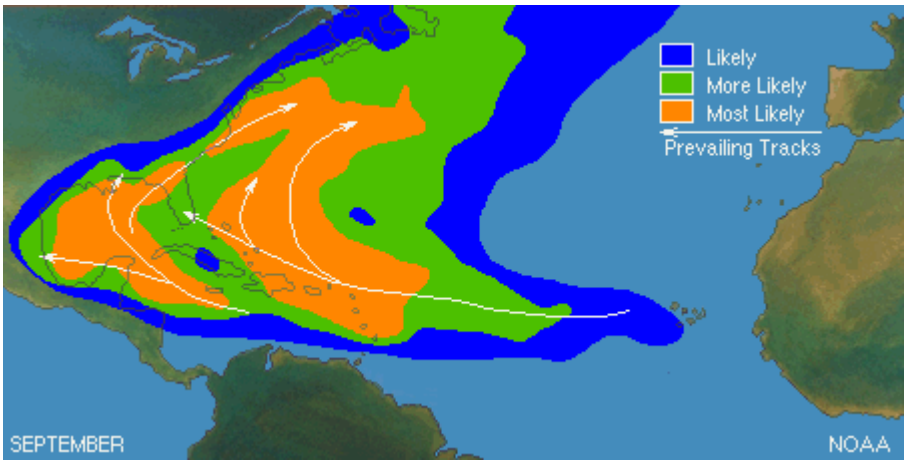

Figure 5.1.6.1b Typical Atlantic Basin hurricane tracks in September

5.1.6.2 Flooding or Other Disaster Incidents

No flooding, outside of localised areas of standing water, has been noted on the site. Given the site's karst properties, it is likely that localised flooding will occur at areas of known ponding, such as the pond adjacent the old great house. Google Earth images show no indication of a pond at the site, suggesting that the possibility of the pond drying out completely periodically. This is typical of a buried doline/sinkhole that drains at its base, as percolating water slowly migrates through the base of the sinkhole over time. Normally these buried sinkholes are filled with water for several months following intense and sustained rainfall. Given the presence of other depressions and caves, it is likely that flooding of these depressions occurs perennially.

5.1.6.3 Seismic Hazard

The seismic hazard map of Jamaica (Figure 5.1.6.3) shows that the project site lies in an area that can expect a Modified Mercalli Intensity of 6 with a 10% chance of exceedance in any 50 year period. Expected horizontal ground acceleration is projected to be between 12 -14 cm/s^a.

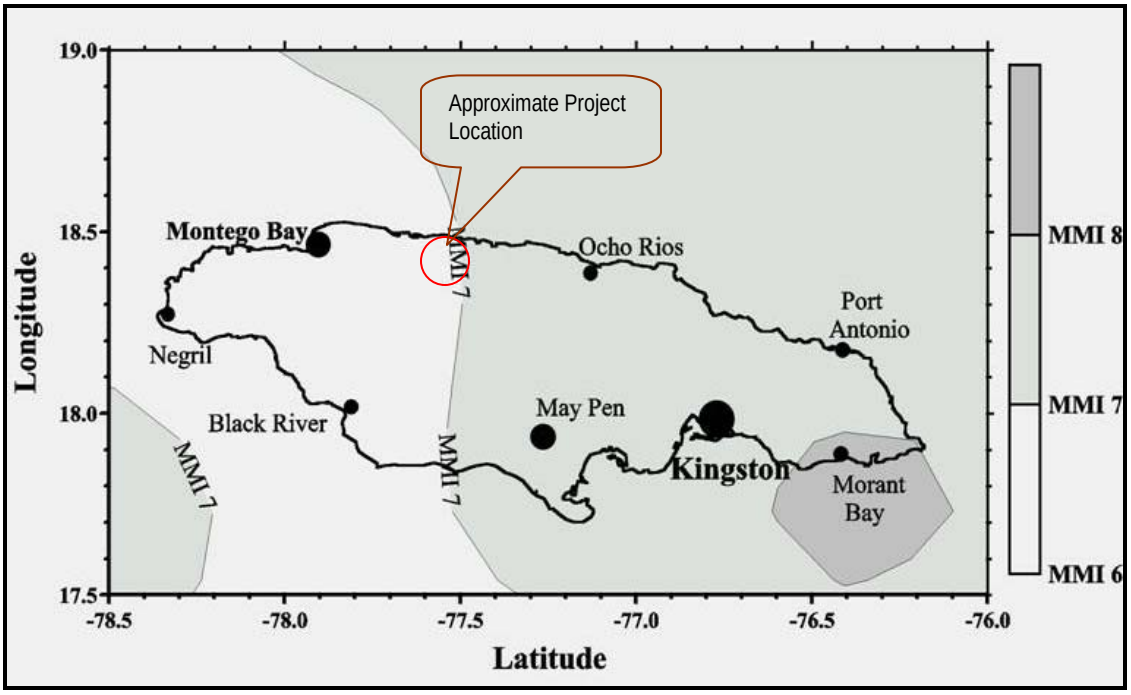

Figure 5.1.6.3 Expected Maximum Mercalli Intensity across Jamaica with a 1 in 50yr return frequency (Source: Shephard, *et al.*, 1997)

5.1.6.4 Landslip Hazard

The topography and geology suggests that landslips would be a negligible risk. Any slopes created would need to be done according to the geotechnical design specifications to mitigate the risk of failure.

5.1.6.5 Pollution Incidents

The WRA database has no record of any pollution incidents.

5.1.7 Hydrological Assessment

5.1.7.1 Proposed Water Demand

Project development documents indicate that approximately 908,500 litres of water per day (240,000 imperial gallons/day) will be required for the site. This is based on the assumption of 828 lots with 4 residents per lot using approximately 270 litres of water per day (72 gallons per day). It is unlikely that projected demand will be higher than the proposed water demand. The NWC has confirmed that they will be able to supply this quantity of water provided the infrastructure development costs are paid by the developer.

5.1.7.2 Storm Water Runoff

The site drainage evaluation was taken substantially from the design engineers report (FCS, 2008a). Please refer to this document for a more complete analysis of the points discussed below. Rainfall data used are presented in Table 2 below. The Rational Method was used to evaluate site's storm runoff by the design engineers. Scoping calculations using TR-55 was used for storm runoff comparison as part of the evaluation.

Table 5.1.7.2: Rainfall intensities from Falmouth, Trelawny (1951-88) (Source: Meteorological Service of Jamaica)

Exceedance Probability	100% (1yr return)	50% (2yr return)	20% (5yr return)	10% (10yr return)	(4% 25yr return)	(2% 50yr return)	1% (100yr return)
24 hr rainfall (mm) Falmouth, Trelawny	-	102	131	159	194	220	246

5.1.7.3 Site Storm Runoff

Pre-Development

The drainage report (Foreman, Chung and Sykes, 2008) predicted total-site storm runoff with a 10% (1 in 10 yr) chance of occurrence in any one year is a maximum of 9.2 m^3/s. With storage in the wetland area an output of 2.3 m^3/s at the North Coast Highway is predicted. This is an approximate 75% reduction in outflows. For comparison, a simple scoping evaluation of the run-off from the site using TR-55 with no storage predicts a 8.4 m^3/s runoff from secondary forest, the size of the development property which is comparable to the runoff from the project site as determined by the rational method.

Post-development

The FCS drainage report indicates a 22.4m^3/s at reach No. 3 (representing approximately 93% of the post runoff drainage area) for a 1:10yr event. Storage in the wetland and the retention ponds reduces this outflow to by 78% to 4.6 m^3/s. The results of both the pre and post results are presented in Table 5.2.7.3 below. From the table it is clear that storage plays a significant role in the overall functioning of the pre-and post-development drainage.

Table 5.1.7.3: Predicted run-off figures with pre-and post-development comparisons. The outputs with storage incorporated are reported in brackets.

Site Area	Site Runoff with a 1:10yr event
Pre-development without storage (*with storage)*	9.2 m^3/s (2.3 m^3/s)
Post-development without storage (*with storage)*	22.4 m^3/s (4.6 m^3/s)
Increase above existing	13.2 m^3/s (2.3 m^3/s)
Percentage increase above existing	140% (100%)

The detention that exists in the pre-development phase is free from any large scale anthropogenic activity, especially fly-tipping (i.e. illegal dumping of waste in places other than an authorized landfill) and infiltration is estimated to be between 10-20 mm/hr. In the post-development scenario this will patently not be the case as the site will be extensively developed and re-surfaced both reducing the natural infiltration capacity and the number of natural detention areas and modifying the land use to give increased runoff. Given this and the dependence of the post-development system on detention on a highly modified surface, a comprehensive maintenance programme should be incorporated into the overall long-term environmental protection plan for the development scheme. This is to ensure that there is minimal reduction in the design capacity of the storage structures proposed in this drainage system. Reductions can occur due to blockages as a result of fly-tipping and other unintended human activity.

5.1.8 Water Quality

The results of the baseline water quality sampling exercise conducted at the proposed Florence Hall Housing Development Site on August 14, 2008 and December 2, 2008 are presented in Table 5.1.8a below.

Table 5.1.8a Water Quality Data for Florence Hall, Trelawny

PARAMETERS	SAMPLING STATIONS								NRCA Ambient Fresh Water Standard	NRCA Ambient Marine Standard
	FL Cave		FL WH		FL Swamp		GW Swamp			
	14/8/08	2/12/08	14/8/08	2/12/08	14/8/08	2/12/08	14/8/08	2/12/08		
pH	7.96	7.15	8.18	7.54	8.10	7.70	7.98	7.84	7-8.4	8.0-8.44
Conductivity / mS cm-1	10.08	8.14	6.07	2.85	-	19.19	-	11.55	150-600	-
Salinity (ppt)	-	4.5	-	1.5	13.1	11.2	16.5	6.6	-	-
Dissolved Oxygen (mg/L)	8.25	7.37	8.00	6.34	7.50	6.4	7.50	6.6	-	4.5-6.8
BOD (mg/L)	4.0	8.0	18.0	13.0	17.0	10.0	16.0	18.0	0.77-1.7	0.57-1.16
TSS (mg/L)	1.33	1.0	2.00	4.0	3.50	4.33	4.40	32.70	-	-
Nitrate as Nitrogen (mg/L)	5.94	4.40	1.76	0.88	17.6	8.80	17.6	8.80	0.1-7.5	0.001-0.081
Phosphate (mg/L)	1.0	0.30	0.33	0.39	0.7	0.09	0.4	0.04	0.01-0.8	0.001-0.055
Chloride (mg/L)	2761.6	2240.0	984.1	715.0	-	-	-	-	5-20	-
Sulphate (mg/L)	410.0	350.0	215.0	100.0	-	-	-	-	3.0-10	-
Total Coliform (MPN/100mL)	240	1100	>2400	1100	240	240	240	15	-	48-256
Feacal Coliform (MPN/100mL)	240	460	1100	4	93	240	21	<3	-	<2-13
Oil & Grease (mg/L)	2	12	16	24	4	38	4	15	-	-
Iron (µg/L)	<20.0	23	21.0	28	36.0	136	67.0	106	-	-
Lead (µg/L)	79.0	107	53.0	54	141.0	181	169.0	156	-	-
Manganese (µg/L)	<20.0	<20	102.0	26	68.0	51	130.0	50	-	-
Zinc (µg/L)	<10.0	<10.0	<10.0	<10.0	<10.0	27.0	10.0	21.0	-	-
Copper (µg/L)	10.0	<10.0	<10.0	<10.0	21.0	<10.0	24.0	<10.0	-	-

Four water quality sampling stations were selected for investigation. Three of these sampling stations were situated on the Florence Hall Development site and one in the connecting (Glistening Waters) mangroves on the coastal side of the North Coast Highway. The results generated for the two sampling exercises and historical data for the Glistening Waters are presented in the following sections.

◊ *pH , Salinity, Chloride and Sulphate*

The salinity and pH data show that the waters are somewhat brackish. The high concentration of chloride and sulphate ions recorded at all four sites confirms that there is some saline intrusion as well as the connectivity between the waters at Glistening Waters and Florence Hall.

◊ *Dissolved Oxygen)*

Dissolved oxygen levels were at or above saturation at all sites measured. The higher oxygen levels recorded is likely to be a result of the photosynthetic activity of the algal species present.

◊ *Biochemical Oxygen Demand (BOD_5)*

The BOD levels exceeded the NRCA BOD standard of between 0.77-1.7 mg/L at all sampling stations indicating elevated organic loading at these sites.

◊ *Nitrate and Phosphate*

The data show that nitrate and phosphate loading at all sites investigated was significant.

◊ *Total and Faecal Coliform*

Whereas faecal bacterial levels were low at the Glistening Waters sampling station, significant bacterial levels were measured at the Florence Hall sites. The FLWH station in particular had notably high faecal bacterial levels.

Faecal coliform contamination at these stations maybe the result of animals grazing on the land as well as the downstream effects of subsurface sewage disposal at nearby properties.

◊ *Oil and Grease*

The oil and grease levels were elevated at all sampling sites on the second field sampling event. Of significance is the fact that elevated FOG levels were recorded on both sampling events at the FLWH station. This trend indicates that it is likely that this station is being impacted by anthropogenic activities.

◊ *Total Suspended Solids (TSS)*

The total suspended solids were generally low at all sampling stations except the Glistening Waters station on the second field sampling event. The elevated suspended solids loading are likely to be the result of the rainfall that had occurred recently in the project area. The sampling station had a thick layer of debris. The physical characteristics of the waters on the Florence Hall property point to the fact that the water holes and mangroves are indirectly/directly connected. Further their similar chemical composition confirms the linkages within the Florence Hall water systems as well as those in Glistening Waters. The nature and extent of the linkage can be further investigated. This information is however critical to the use and management of the water systems on the Florence Hall property and the preservation of the phosphorescence in Glistening waters. The following is an extract taken from the Environmental Impact Assessment Report for Oyster Bay prepared by Environmental Solutions Ltd.

"Oyster Bay, also known as Glistening Waters on the north coast of Jamaica is one of the world's most brilliant bioluminescent bays. This bay shares some similarity to Mosquito Bay in Puerto Rico. Mosquito Bay is described as one of the world's healthiest bioluminescent bays. Both bays have been studied extensively by scientists from John's Hopkins University. Mosquito Bay is surrounded by mangroves, and is very shallow at its entrance. The mouth of the bay is situated in such a way that the currents allow ocean waters to enter the bay. The shallowness of the bay results in high evaporation, the saltier surface water sinks to the bottom. This heavier water moves out to sea and the surface waters which are abundant in plankton flow into the bay bringing populations of *Pyrodinium*, the dinoflagellate responsible for the bioluminescence (Verde, 1993).

Vitamin B12, the essential nutrient for dinoflagellates is produced by scavenging bacteria from the rotting detritus from the mangroves. Because of the shallowness of the bay, B12 and other nutrients stay in the bay rather than being flushed out (Verde, 1993). Oyster Bay is similar to Mosquito bay with respect to its extensive mangrove coverage and shallowness. It can be assumed that the similar flow and nutrient balance that is required for Mosquito Bay would likely be true for Oyster Bay. This balance is very delicate, if the rate of flushing of the bay increases or the nutrient balance is altered then the *Pyrodinium* population

may decline considerably. A bioluminescent bay in Hawaii and the Bahamas suffered severe damage because of changes in the water movements in the bay. Oyster Bay should be managed with the intention of preserving or regenerating existing stocks of *Pyrodinium*. No physical changes to the areas within and surrounding the bay should be made to alter the existing environmental conditions (Webber, Edwards and Hibbert, 1998). "

The use of the mangroves for sewage disposal should be carefully evaluated in light of the fragile nutrient balance that is required to sustain the dinoflagellates in Glistening waters. Already the data show some elevated nutrient, oil and grease and bacterial levels.

Table 5.1.9 Water Quality Data for Oyster Bay, Trelawney, Jamaica, November 2004

Parameters	Sampling Stations										NRCA Draft Ambient Marine Standards
	1	2	3	4	5	6	7	8	9	10	
pH	8.4	8.3	8.4	8.3	8.3	8.3	8.3	8.3	8.3	8.2	8.0-8.44
Salinity (ppt)	36.1	34.9	36.1	36.0	19.5	6.0	32.2	34.9	6.8	6.2	-
Dissolved Oxygen (mg/L)	5.6	6.0	6.6	5.8	6.1	6.5	5.2	5.9	6.2	6.4	4.5-6.8
BOD (mg/L)	2.0	6.0	1.0	1.0	1.0	7.0	1.0	1.0	1.0	1.0	0.57-1.16
Nitrate (mg/L)	0.25	0.99	0.24	0.07	2.79	1.12	0.68	1.67	4.77	2.36	0.001-0.081
Turbidity (NTU)	0.29	0.67	0.66	0.79	4.64	4.12	6.99	4.38	4.63	31.1	-
Phosphate (mg/L)	1.1	0.01	0.04	0.06	0.2	0.03	0.03	0.1	0.03	0.03	0.001-0.055
Oil & Grease (mg/L)	2.0	1.0	0.9	1.6	1.1	2.0	2.3	0.9	1.1	1.5	-
Total Coliform (MPN/100ml)	<3	3.0	<3	<3	1100.0	460.0	43.0	75.0	1100.0	460.0	48-256
Faecal Coliform (MPN/100ml)	<3	<3	<3	<3	<3	240.0	<3	7.0	21.0	43.0	<2-13

5.1.9 Air Quality

Air pollutants are transportable via air currents and are damaging to our health and our environment. The air contaminants investigated in this EIA are respirable particulates and gaseous emissions.

Particulates (dust) enter empty lots and undeveloped areas from unpaved roadways, fields, and other open spaces from wind, traffic, and other surface activities. The concentration of ambient particulate matter provides an indication of baseline levels which should be maintained during construction and operation of any proposed development(s).

The particulates of greatest concern to humans are those with internal diameter below 10 microns, generally referred to as respirable particulates. Respirable particulates on undeveloped lands are generally from a combination of natural and anthropogenic sources such as pollen, roadside dust, smoke from vegetation and wood burning or vegetation clearing. If the site is located downwind of industrial operations then combustion activities would also be a significant source. The results of the air quality sampling exercise conducted on August 14 and December 2, 2008 at Florence Hall are presented in Table 5.1.9 a below.

Table 4.1.9 a: Air Quality Data, Florence Hall, Trelawney

LOCATION	SAMPLE ID.	CONCENTRATION OF GAS			
		CO/ppm	SO_2/ppm	NO_2/ppm	O_2 / %
N 18.47303 ° W077.62756 °	Site # 1	0.0	0.0	0.3	20.9
N 18.47316 ° W077.62365 °	Site # 2	0.0	0.0	0.0	20.9
N 18.48273 ° W077.62701°	Site # 3	0.0	0.0	0.0	20.9
N 18.48246 ° W077.62673°	Site # 4	0.0	0.0	0.0	20.5
N 18.48262 ° W077.62652°	Site # 5	2.0	0.0	0.0	20.7
N 18.48281 ° W077.62583°	Site # 6	0.0	0.0	0.0	20.9
N 18.48298 ° W077.62529°	Site # 7	2.0	0.0	0.0	20.5
N 18.48200 ° W077.62801°	Site # 8	2.0	0.0	0.0	20.9
N 18.48145 ° W077.62960°	Site # 9	4.0	0.0	0.0	20.9
N 18.48054 ° W077.62549°	Site # 10	0.0	0.0	0.0	20.9
N 18.47450 ° W077.62988°	Site # 11	0.0	0.0	0.0	20.9
N 18.47974 ° W077.62496°N	Site # 12	0.0	0.0	0.0	20.9
N 18.47384 ° W077.62950°	Site # 13	1.0	0.0	0.0	20.9

Very low levels (0-0.3ppm) of sulphur dioxide and nitrogen dioxide were measured across the project site. Oxygen levels were within the expected levels. Measurable carbon monoxide (CO) levels were recorded at a few sites. The CO levels were however not elevated.

Respirable particulate levels were considerably elevated at all sites monitored during the second sampling event (Table 5.1.9b). This is likely a result of the coal burning practiced on the project site. Sites 12 and 13 were downwind of an adjacent construction site and is the likely contributor of the particulates measured at these sampling sites.

Table 5.1.9b: Respirable Air Quality Data, Florence Hall, Trelawney

Sample ID	Location	Monitoring results /μg/m³		NEPA 24 Hr Guideline μg/m³
		1	2	
Site #1	N 18.47303 ° W077.62756 °	88.0	227.7	150
Site # 2	N 18.47316 ° W077.62365 °	230.5	417.4	
Site #3	N 18.48273 ° W077.62701°	-	293.4	
Site # 12	N 18.47450 ° W077.62988 °	-	757.2	
Site # 13	N 18.47384 ° W077.62950 °	-	776.5	

5.1.10 Noise Assessment

Jamaica does not currently have regulations governing noise. The National Environmental and Planning Agency (NEPA) has in place a draft National Noise Standard for Jamaica. The permissible limit for the noise standard is dependent on the zone in which the noise source occurs. For residential areas noise levels should be within 55 dBA during daytime hours and 50 during the quiet time period of 10 pm to 7 am. The data indicates that noise levels were outside of this range at Sites 3, Sites 5-9 and Site 11 (Table 5.1.10).

Table 5.1.10: Noise readings from the project site

SAMPLE ID	NOISE / DBA	WIND SPEED /MSEC^{-1}	WIND DIRECTION	OBSERVATIONS
Site # 1	51.6	1.2	SE	Area was quite except for birds singing in the background
Site # 2	51.6	0.53	SE	
Site # 3	68.6	0.25	SE	Traffic density was light
Site # 4	53.7	0.2	SE	Traffic density was light
Site # 5	72.3	0.75	SE	Traffic density was light to moderate
Site # 6	72.8	0.80	SE	Traffic density was light
Site # 7	61.7	1.45	SE	Traffic density was moderate
Site # 8	73.3	2.5	SE	Traffic density was moderate
Site # 9	71.3	3.5	SE	Traffic density was moderate to high
Site # 10	51.6	2.6	SE	Heavy vehicles travelling the highway was clearly heard from this location
Site # 11	63.5	7.0	SE	Traffic density was very light. The equipment from the near by construction site was clearly heard from this sampling site.
Site # 12	51.6	1.5	SE	Apart from the occasional singing of birds or the chatter from the team, the area was really quite.
Site # 13	51.6	0.4	SE	A construction site is located ~200 meters away from the sample site. Danielle Town Road which runs parallel to the property featured a light traffic density

Noise nuisance is largely as a result of traffic as there were no heavy duty equipment on the site during the assessment and the neighboring worksite was fairly quiet. This noise nuisance can be mitigated by the use of sound barriers such as the planting of vegetation along the roadways.

The noise level and concentration of carbon monoxide (CO), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) were taken along the property border and in the interior of the property.

5.2 Biological Environment

Data sets for biological baseline assessed are displayed in Appendix VI.

5.2.1 Dry Limestone Forest

Acreage assessments conducted using Google Earth images of the site (circa 2003) revealed that, of the property's 72 hectare area, approximately 66 hectares was occupied with virgin to partially disturbed Dry Limestone Forest vegetation. Additionally, approximately 5 hectares of the property's pre-existing forest was severely disturbed (Appendix VI, Plate 1). Note, however, that since 2003, passageways (Plate 5.2.1a) into the forest had been cleared with a bulldozer in order to facilitate the collection of borehole data for geotechnical assessments. Approximately 2100 meters of these passageways were traversed during the process of finding caves known to be on the site. With the passageways being estimated at up to 5 meters wide, it was estimated that a minimum of 1.5 Hectares of additional severe vegetation disturbance had occurred since the Google 2003 coverage of the area (Appendix VI, Plate 2).

5.2.1.1 Flora

The site slopes to the north where it borders the north coast highway. The upland soils are thin and dominated by frequent outcrops of limestone rocks. The vegetation consists of disturbed limestone woodland from a forest assemblage previously described as Tall Open Dry Forests (Camirand and Evelyn, 2004). This forest assemblage is typically an "open natural woodland or forest with Deciduous/Semi-deciduous trees. Trees are at least 5 m tall and crowns not in contact with each other". The western section of the Florence Hall Estate property has been cleared of vegetation and new houses are being constructed. The proposed site displays evidence of extensive recent cutting. There is a general gradient in the level of disturbance of the vegetation where northern and eastern halves of the proposed project site appears less disturbed.

This forest type is typically found within altitude ranges of 0 – 400 m above sea level and possesses natural indicators of such assemblages including the Red Birch Tree (*Bursera simaruba*) (Plate 5.2.1.1) which comprises much of the upper canopy along the northern slopes of the site. A complete list of the plants identified within the property boundaries is given in Appendix VI. A total of 101 species of plants were recorded at the proposed project site, representing 47 families and including large trees, small trees, herbs, shrubs and vines. Six of the plant species were identified as endemic. There was also a member of the

Zamiaceae family, a species of *Zamia* which is not yet identified but is also possibly an endemic species. Research into the taxonomy is currently underway.

Plate 5.2.1.1 The Red Birch trees commonly encountered on the project site (note the recently cleared passageways through vegetation)

The vegetation canopy is somewhat open and is dominated by the Red Birch tree *Bursera simaruba* and Guineps *Melicoccus bijugatus* along with the occasional Guango tree *Samanea saman*. These species comprise much of the upper canopy particularly along the northern slopes of the site. The upper canopy is followed by a secondary canopy layer which is almost completely closed and comprised of many other common tree species including Dogwood *Piscidia piscipula,* Braziletto *Caesalpinia violacea,* Bull Hoof *Bauhinia divarcata*, Logwood *Haematoxylum campechianum* and Burnwood *Metopium brownii.*

The under storey is a mass of various shrubs and vines which are all but impenetrable except for the many well used trails and paths networked through the bush. The trees occasionally support small epiphytes, mostly the cacti *Hylocereus triangularis* and the orchid *Broughtonia sanguinea.* There were a few *Hohenbergia* Bromeliads (Tank epiphytes) found on the site but most were growing on the ground or on the sides of limestone rocks. It is possible that a generally dry climate in the area means that these epiphytes survive droughts better while protected under the thick secondary canopy.

5.2.1.2 Fauna

(i). Birds

In total 59 species of birds were observed during the field visits with 32 of those occurring during structure counting periods. This however, represents a fraction of the species likely to occur in nearby habitats. Thirteen of Jamaicas 28 extant endemic species were observed, the Jamaican Woodpecker (*Melanerpes radiolatus*), the Jamaican Vireo (V*ireo modestus*), the Jamaican Euphonia (*Euphonia jamaica*), the White-chinned Thrush (*Turdus aurantius*) and the Jamaican Lizard Cuckoo (*Saurothera vetula*) were the most common of the endemics. None of the endemics represented are endangered or rare, (in the appropriate habitats).

Several other resident species were detected in the site visit, the overall abundance and diversity of birds was low however, the Columbids were well represented and there is evidence of some bird shooting on the site. A local informant reported that many hunters shoot on the site during the hunting season. No threatened or rare land bird species were detected on the site

A complete list of the birds observed is given in Appendix VI.

(ii). Butterflies

Eight species of butterflies were identified on the site in the dry limestone forests. This was due to the fact that the site visit was conducted in the afternoon and most butterfly species would have already become less active. None of the butterflies observed were range-restricted or threatened in Jamaica.

5.2.2 Wetland Ecology

A small mangrove wetland (approximately 5 hectares) occupies the north eastern corner of the proposed project site. The wetland was once contiguous with those located north of the highway at Mountain Spring Point and is now connected by two main drains traversing the highway. However, with subsequent roadway construction, and with further development of the roadway into the North Coast Highway, the only remaining connections between both wetlands are two main drains traversing the highway (Appendix VI, Plate 3). During the rainy season extensive collections of standing water (Plate 5.2.2) was observed along the north of the wetland, however during the drier seasons no standing or ponded water was seen.

Plate 5.2.2 Standing water in the wetland during the wet season

The wetlands north of the North Coast Highway are known to be tidal and it is likely that the wetlands on the southern side of the highway (which includes the 5 hectares from the project site) were similarly influenced in the past, particularly during Spring tides. The presence of relatively mature Red Mangroves tree at the vicinity of the cross-highway drains supports this hypothesis as well as the salinity of the waters sampled from this wetland (Section 5.1.8, Table 5.1.8a) which suggests saline influence.

5.2.2.1 Flora

Four varieties of Mangrove plants were observed within the wetlands of the project property (Appendix VI). A percentage coverage assessment of the various mangrove plants found at the site was not completed due to the inaccessibility of the inner portions of the wetland. However, traverses of the northern fringe of the wetland (facing the North Coast Highway) suggested that Black mangroves (*Avicennia germinans*) apparently dominated in area coverage, with White mangroves (*Laguncularia racemosa*) exercising secondary dominance (Appendix VI, Plate 3). It is possible, however, that a reversal of dominance could occur within the drier sections of the wetland, with White mangroves predominating. Other wetland species included the Swamp Fern *Achrostichium aureum* and the epiphytic vine *Rhabdadenia biflora.*

5.2.2.2 Fauna

(i). Birds

The globally threatened West Indian Whistling Duck *Dendrocygna arborea* was observed in wetlands adjacent to the site and is likely to roam throughout all the wetlands in the environs. A pair of adult birds accompanied by six chicks was seen. These birds are currently facing the loss of an important habitat area as nearby wetlands have been destroyed and converted to alternate uses.

Several other water bird species were detected mainly in the mangrove area. The Northern Waterthrush *Seiurus noveboracensis,* Northern Parula *Parula americana* and the American Redstart *Setophaga ruticilla* were the most common neotropical migratory species that were observed. The Antillean Nighthawk *Chordeiles gundlachii* and the Black-crowned Night Heron *Nycticorax* nycticorax and the two owls (Jamaican Owl *Pseudoscops grammicus*, and Barn Owl *Tyto alba*) were the only night birds observed on the site.

A complete list of the birds observed is given in Appendix VI.

(ii). Crustaceans

Fiddler crabs (*Uca sp*.) were observed in scattered numbers along the northern fringe of the wetland. Additionally, burrow-holes of approximately 10 cm in diameter and larger were observed in the wetland soils at the site (Plate 5.2.2.2). These were attributed to the burrowing activities of the Great Land Crab (*Cardisoma guanhumi*).

Plate 5.2.2.2 Holes in the wetland area possibly made by the Great Land Crab

5.2.3 Cave Ecology

Four of the eight known caves recorded at the project site (Section 5.1.4.1, Figure 5.1.4.1) were assessed at site visits, with three being accessed internally (Caves 1, 2 and 4, Appendix VI, Plates 4, 5 and 7). All of the caves assessed exhibited similar geo-physical characteristics, in that they all represented underground voids with collapsed roofs. Some of the caves had small antechambers while others had large sinkhole entrances with other smaller light holes.

5.2.3.1 Cave Fauna

Nests belonging to the Cave Swallow (*Petrochelidon fulva*) were observed in Cave 1 (Appendix VI, Plate 4) while actual observations of the Jamaican Fruit Eating Bat (*Artibeus jamaicensis)* were made at Cave 2 (Appendix VI, Plate 5). This cave is host to a colony of bats which have deposited significant amounts of guano on the cave floor. Mixed in among the guano were thousands of partially eaten seeds of the West Indian Almond fruit. This is the largest cave and had several large chambers that interconnect and at least two additional entrances. The cave was dry at the time of the survey however, the presence of solution holes and deposition features such as stalagmites and stalactites suggest that water flows down through the cave in periods of wet weather.

Cave 3 was inaccessible (Appendix VI, Plate 6). Cave 4 had a shallow pool at the bottom (Appendix VI, Plate 7). A local informant advised that in times of wet weather the water level could raise a few feet. The floor of the cave appeared to continue into additional channels underwater but it was difficult to determine the extent of the hole as the water was turbid. No aquatic species were observed in the water of this cave however, several Cave Swallows *Pterochelidon fulva* were seen flying around the entrance and into several solution holes in the sides of the cavern.

Faecal droppings and organic pellets observed at all three cave sites led to the opinion that all the caves examined were occupied at some point in time by at least one species of fruit-eating bat and/or the Cave Swallow. A pile of Insect remnants was observed in Cave 1, suggesting that it may be inhabited by at least one variety of insect-eating Bat. However, no visual confirmations were made.

5.3 Socio-economic Environment

5.3.1 The Socio-economic Context

Falmouth and the communities neighboring Falmouth close to the Florence Hall Estate have grown modestly over the period 1991 to 2001. STATIN data reflects an overall population increase of 1.85% for the Falmouth Special Area for the 10 year period. Commercial activity, agriculture and tourism have been important economic generators. It is likely, based on existing and planned development, that this area, including the communities surrounding the Project, will reflect increased levels of population in the 2010 census. 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 tourism activities such as rafting which along with the services sector is becoming its primary generator of jobs, and income.

Agriculture, though declining in importance, is an important employment generating activity and fisheries offers some contribution. Considerable hectares of potential agricultural lands lie idle. In the communities in the immediate Project area development has mainly centered on construction induced in part by the expansion of tourism and more recently by the completion in this sector of the Northern Coastal Highway. Pen-keeping and market gardening on a limited scale takes place, and some charcoal production. Tourism as represented by two main hotel properties and several small hospitality centers represent the area's main contributor to Gross Domestic Product (GDP). The more recent Greenfield Stadium complex is expected to increasingly play a contributory role.

Housing development in this part of Trelawny is related to the employment/urbanization process, as many persons who work outside of the area have taken up residence in the area. Results from the socio-economic analysis reveals that Martha Brae, Hague Rock, Daniel Town and Coopers Pen are all dormitory communities to larger urban townships (Falmouth and other main towns) where employment is centered. Unofficial sources obtained from data used in preparing the pending new Parish of Trelawny "Development Order" estimates new housing requirements for the Greater Falmouth Area as approximately 700 units per annum.

The Project is well poised to complement these trends and contribute further to the improving development prospects of this area.

Social infrastructures are improving but still stressed due to increasing population. Health and Public Safety Services appear better able to cope with demands placed on them than for example in Montego Bay. A new Fire-brigade station is in place in Falmouth. Notwithstanding, hospital and health services are still challenged by lack of personnel and resources. Similarly traffic congestion remains a challenge in Falmouth. Police services are reported by key informants as managing the crime situation. The Parish of Trelawny is served by a number of primary, secondary and all age schools.

From a planning perspective the general Falmouth area is well endowed with water resources, road access and reasonably adequate utility infrastructure. Falmouth is targeted for tourism development centered on a deep water cruise ship pier and hotel development, and is the focus of at least two new housing developments including the Project. Challenges remain however, in the need for sewagering Falmouth and also in improving solid waste management across the parish.

5.3.1.1 Demographics

The relatively slow parish population growth is reflected in STATIN census data in Table 5.3.1.1a.

Table 5.3.1.1a Parish of Trelawny Population Data 1970-2001

YEAR	TOTAL POPULATION	ANNUAL AVERAGE GROWTH
1970	60,500	0.76
1982	69,500	1.16
1991	71,204	0.27
2001	73,066	0.26

Source: Statistical Institute of Jamaica.

The population of Falmouth was 8,188 at the time of the 2001 Census and its population had grown by only 1.85% over the 10 year period from the 1991 census. This compares with a 51% change in the population of Ocho Rios and a 13% change in the population of Montego Bay over the same period. Similarly this growth rate is very modest in comparison with the national population growth rate of 5% over the same period. Existing and planned developments will probably result in higher growth rates being reflected in the 2010 Census. This has been the pattern in other coastal parishes that have experienced rapid tourism

development. For example, between 1991 and 2001 there had been a net loss of about 7, 100 persons from the parish mainly to KMA, St. Catherine and St. James. This movement is likely to be considerably slowed if not reversed given the north coast tourism corridor that has developed. The population is almost evenly divided between males and females and comprises mainly youth and the under 35 age group, In relation to the general Project area STATIN data puts the 2001 population of the 3 Electoral Divisions containing the entire coastal strip including Hague and Martha Brae as 1,600.

As reported by key informants and community members themselves, unemployment in the communities bordering the Project (see below) is seen as a major social and economic challenge. In each community visited, the lack of employment opportunities was constantly referred to. Observation suggests that underemployment is also a feature of the labour force which is mainly engaged in low to mid level occupations. The main occupations engaged in are reflected in the following Table (5.3.1.1b), based on the rapid appraisal survey.

Table 5.3.1.1b Main Reported Occupations of Community Members

Main Occupations	Number of Persons *	Percentage of Total
Construction/building	60	30.0
Farming	60	30.0
Mechanic	36	18.0
Craft vendor	28	14.0
Small business	27	13.5
Taxi operators	26	13.0
Tourism	24	12.0
Domestic	21	10.5
Teachers	12	6.0
Total Interviewed	200	100.0

* The responses express the perceptions of respondents to the main occupations found in their communities. The responses are not mutually exclusive and exceed 100% of the sample size since multi responses per community members were permitted. The results are useful mainly to indicate the most frequently occurring occupations identified by the 200 persons sampled.

5.3.2 Zone of Immediate Influence

The socio economic influence of a housing scheme is mainly a function of the impacts its residents export to the local and external community. In the case of Florence Hall, the external community can reasonably be defined to include a geographic zone extending westward to Montego Bay, northward to Clarks Town and Stewart Town and eastward to Runaway Bay.

It is also the case that the project's residents will be impacted by the immediate socio economic environment into which they have been relocated. At this pre project stage, these two-way impacts are difficult to define beyond the more immediate environs of the project. The focus of this section will therefore be limited to the Projects' zone of immediate impact (Figure 5.3.2), since it is within this zone that the project concept most clearly points to these two-way impacts. Similarly it is within this zone that existing communities and neighborhoods have a clearer and more useful perspective on how the project will impact them.

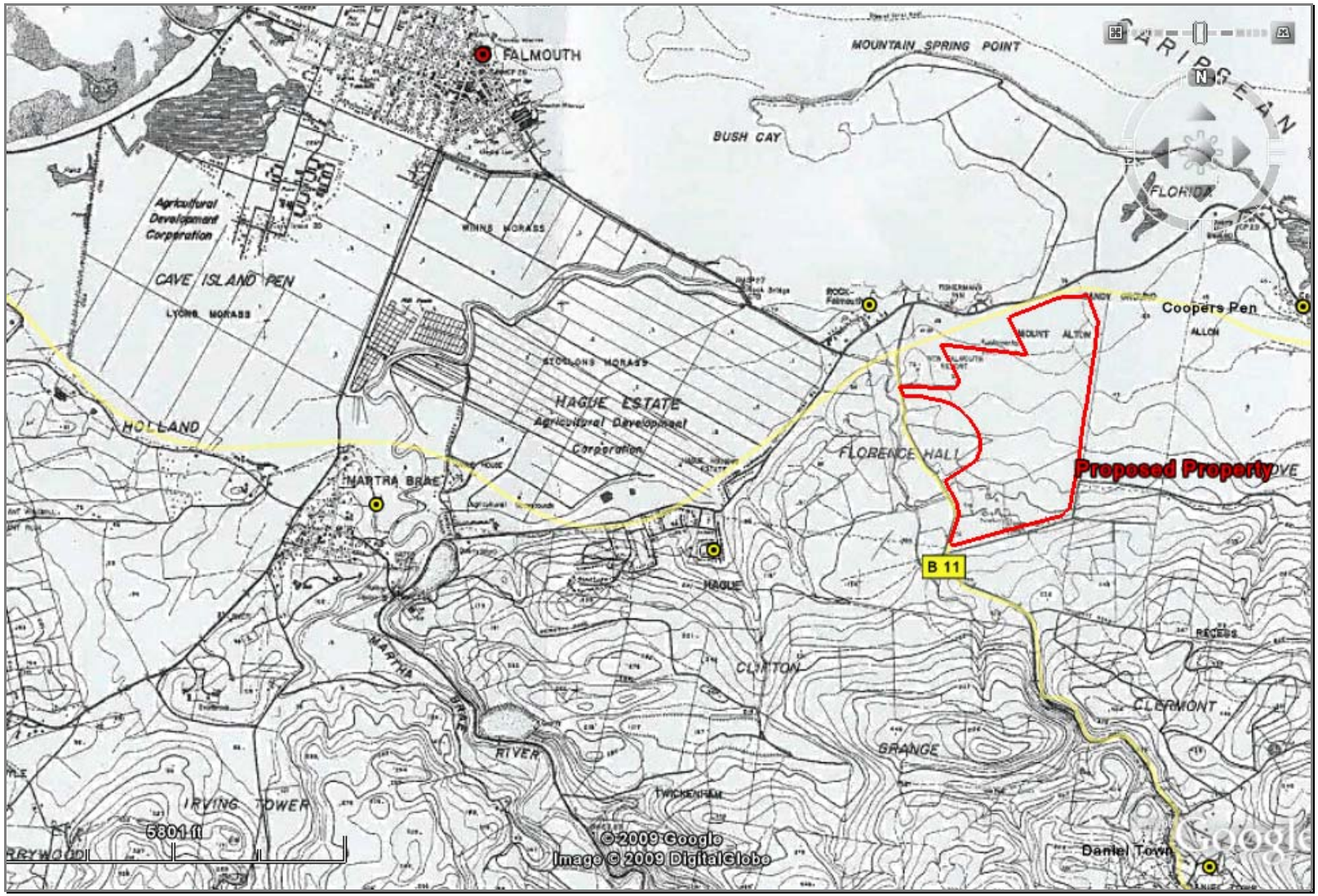

Figure 5.3.2 Site and zone of immediate influence

5.3.2.1 The Communities around the Project

The communities of interest are:

- Coopers Pen
- Rock
- Hague
- Martha Brae
- Daniel Town
- Falmouth

1. Coopers Pen

Coopers Pen is a seaside village located adjacent to the 350 room Starfish Trelawny Hotel and about 3 miles east of the Project site.

The population could number about 350 including a neighboring unplanned settlement. Coopers Pen is of a relatively 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 Starfish 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 sub standard 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. Unemployment is reported as being very high. Those finding permanent employment do so largely in tourism. The presence of Starfish provides an important source of income for the community, as tourism spending filters down through food vending and transportation.

A small NEPA licensed fishing beach supports a small population of fishermen who are affiliated to the Falmouth Fishermen's Co-operative.

Lying between the community and the Project area is FDR Pebbles, operated by the FDR chain of hotels. This property comprising, 96 rooms, employs approximately 250 staff, mainly drawn from outside of the community because of the hospitality skills needed.

2. Rock

This unplanned community lies less than two miles to the north west of the proposed development. Formerly an important port serving Martha Brae when it was the parish capital, it now supports a number of small and micro businesses, a fishing beach, but is essentially a residential dormitory of Falmouth (Plate 5.3.2.1a).

From observation and information offered by residents, the population is about 500, with the majority of households headed by females.

Plate 5.3.2.1a The community of Rock in Trelawny

The main land use in Rock is residential, although there is a small fishing beach that also provides temporary berthing for occasional pleasure boats. The community lies along the original main road, with a ramp up onto the Northern Coastal Highway. Like Coopers Pen, the village comprises a mix of poorly presented shops, entertainment venues and eateries, but also includes auto repair shops, barbering and hair dressing establishments.

As Rock is an established lower income community fairly close to the project, it will be the prime focus of new temporary settlers during the project construction phase. The majority of these new settlers will

probably be construction skill related and others seeking income earning opportunities associated with major housing construction site. Fishing, construction work and tourism were stated as the main sources of livelihood but unemployment and underemployment were reported as being very high.

The Rock Fishing Beach

This licensed fishing beach, which anecdotal evidence puts at over 100 years of fishing, comprises a small sandy beach berthing about 12 fishing boats. A small board jetty extending about 25 feet into the Bay is its main infrastructure. Currently it is reported that about 22 fishermen are connected to the beach. The fishermen interviewed were supportive of the project while also voicing a general concern that greater efforts need to be taken by the authorities to protect the Bay. The fishermen stated that the bay is under great stress. They indicated that at low tide, the Bay is so shallow (average of ~4-6 ft deep), that they cannot lower the outboard motors of their fishing boats within half the distance to Bush Cay. They also point to a finger of land being built up as a result of deposition which they say has been deposited within the last 30 years (Plate 5.3.2.1b). The Bay is therefore becoming more shallow and narrower due to poor uplands / upstream management.

Plate 5.3.2.1b Rock Fishing Beach (arrow points to mass of land formed from sediment deposition from upstream)

The Project is not expected to impact the fishing beach negatively and could become an important source of demand for fisheries.

A number of hospitality properties are located east of Rock, such as Fisherman's Inn (Plate 5.3.2.1c) and Glistening Waters. These properties offer visitors a mixture of accommodation, boating and fishing, and dining. Discussions with their owners reflected a welcoming attitude to the project, coupled with the expectation that it would be managed and monitored to ensure no negative impacts on the Bay.

Plate 5.3.2.1c Fisherman's Inn (Looking across Oyster Bay to Bush Cay)

3. Hague

This residential community lies about 1 mile south west of the Project site, on the old road to Martha Brae. The community is centered on the Hague Housing Scheme, which comprises about 200 lower middle income units. The community is a dormitory community of Falmouth, and like the other communities within Falmouth's proximity, relies upon it for nearly all social services. It is best known for once presenting a vibrant annual Agricultural Show, which in recent years has been trying to recover its former status as a showcase for agricultural produce in the western parishes.

The population of this community is estimated at approximately 600 with 60% of households headed by females. The profile Hague presents is one of a relatively under serviced lower middle income community, with pockets of low income settlements.

The main land use is residential. Land use density within the community is dominated by the large housing scheme mentioned above. Agricultural production or showcasing appears to be of minimal importance to the community, though the large agricultural show ground is maintained. There are two important manufacturing entities located in the community. The largest is Windmill Garment Manufacturers & King Pepper Products 954-4462 (a food processing establishment). However, employment in these companies is mainly drawn from other areas of the parish and not necessarily within the community. Most housing scheme residents are employed outside of the community. However there is a growing pool of unemployed youth, centered mainly on Hague Settlement, a once Operation Pride Project, which lies southwest of the housing scheme. This comprises a population of about 250 low income residents in an upgraded squatter community. There is a former PRIDE housing project at Cave Island, above and to the eastern side of the Hague housing scheme. If and when fully completed, it will provide fewer than 400 upgraded lots. It represents another housing initiative that will contribute to upgraded housing conditions in the project area.

As with other communities already mentioned a possible threat to the community posed by the Project, could be an influx of construction workers and post construction workers seeking housing accommodation in the two PRIDE schemes. Hague Settlement, the former PRIDE project, already shows the potential for reverting to a predominately squatter community. However the completed Northern Coastal Highway has shortened the travelling time between near urban centers and the project site which facilitates the movement of labor.

4. Martha Brae

Martha Brae is another dormitory residential community to Falmouth. It lies about 4 miles south west of the Project area. Travel time to the Project is less than 5 minutes. The community is of historical importance, being the former capital town of Trelawny, and considered the site of a Spanish settlement called Melilla. It is one of the main gateways to southern Trelawny, an agricultural and heritage endowed part of the Parish. The community itself is surprisingly compact and lacking in civil infrastructure, belying its well known name and historical associations.

The resident population of this community is approximately 1,000. The population is reported by members, to comprise mainly the middle aged and the very young. Young adults tend to leave the community for more developed urban centers.

The main land use is residential. Members characterize the community as one in which “outsider workers” come to find accommodation. There are no important manufacturing entities located in the community and only a few small, sole proprietor service type businesses. The National Water Commission operates an important treatment complex on the outskirts of the community. Falmouth, Duncan's and Montego Bay are cited as the locations in which community members seek work. However, unemployment is reported to be high among the labouring class, which comprises mainly construction and domestic type skills and other *hustling* occupations.

The center of an important tourism activity, rafting, lies on the outskirts of the community. The main attraction is a 90 minute 3-mile raft ride on the Martha Brae, as it winds through the Martha Brae river valley on its way to the lagoon (Oyster Bay). Rafters Village, which is the starting point of the journey, is a spacious parkland, offering a variety of attractions to the visitor. According to management, it has resources to accommodate up to 140 visitors on the river, at any one time. It is an important source of employment in

this part of Trelwany, providing income earning opportunities to about 35 raft captains and about as many supporting personnel.

The William Knibb Memorial High School, the largest high school in Northern Trelawny is located at the border of the community. Holland High School is also located in Martha Brae.

As with other near communities a potential threat from the Project could be the influx of construction and post construction workers seeking housing accommodation in the squatter community of Zion. This large and growing settlement is located west of Martha Brae. The new Highway now gives it easier access to the Project site, and if such an influx is not managed properly could further exacerbate attempts at managing this squatter community.

5. Daniel Town

This growing but still relatively small community is located roughly north of the project area and comprises about 500 residents. It is an unplanned community which lies on an older inland route to the former sugar growing estates that once flourished in northern Trelawney. Its profile is of a lower income community which mainly serves the residential requirements of workers finding employment in Falmouth and other near coastal townships. One impact of the Project on Daniel Town is likely to be traffic congestion during peak periods in the vicinity of the Project entrance and also at the highway interface.

6. Falmouth

Falmouth is the parish capital, and as the administrative and commercial center it will probably be the community most positively involved with the Project.

The population of Falmouth was 8,188 at the time of the 2001 Census. Between 1991 and 2001 its population had grown by only 1.85 %. This compares with a 51 % change in the population of Ocho Rios over the same period and a 13% change in the population of Montego Bay. Growth in population, even allowing for the redefinition of some boundaries, must be viewed as relatively slow, when compared with Jamaica's overall rate of growth of 5%. It is likely that population growth will increase more rapidly as tourism development in the parish takes place, as has been the pattern elsewhere. Between 1991 and 2001 there has been a net loss of about 7,100 persons from the parish mainly to the Kingston Metropolitan Area

(KMA), St. Catherine and St. James. The population of Falmouth (and Trelawny in general) is typically a young one with the higher percentage of the population being below 30 years of age.

Land use in Falmouth is shared between commercial and residential activities. It is an important market center for produce distributed throughout the parish, and as earlier mentioned is the administrative capital of the parish. Employment covers the full spectrum of large town occupations. Tourism is not the main source of its revenues. Some tourism traffic transits the town on the way to Ocho Rios or Montego Bay. This trend is likely to be intensified once the plan for deep water pier and port facility comes on stream.

5.3.2.2 Social Infrastructure

In this and subsequent sections, issues pertinent to the Project, but shared in common with the communities are discussed.

1. Waste Management

Sanitary conveniences are mainly a combination of pit latrines and flush toilets. In Coopers Pen, for example, the juxtaposition of the squatter community which slopes towards the sea, and the reported degraded algae covered fringing reef as reported by the fishermen, suggests the impacts of nutrient loading of that bay.

In Rock 100% of toilet facilities run to pits, the degraded wetlands bordering the area which might otherwise have offered some filtration, suggests that this may be all source of nutrient loading into the lagoon. There are only limited sewage treatment plants operating in the Falmouth area. One which was built to serve Falmouth Gardens (a housing scheme of about 150 units) but now the hospital and food market have also been connected. The other is for the Greenfield Stadium. The remainder of the town uses flush toilets. Again, because Falmouth itself is at sea level (some anecdotal reports place it below sea level), sewering the town is an urgent public health priority.

Garbage disposal and solid waste management is managed by Western Parks & Markets. 0ne garbage truck however serves the entire parish, and disposes of waste in St. James. Service is therefore somewhat unreliable and garbage piles up on occasion which increases the outbreak of rats and other pests in the parish. Also of concern is the garbage from the market in Falmouth. The low water table and the impact of

excreta disposal poses a particularly problematic challenge in areas where there is illegal construction in the mangroves resulting in contamination of the marine water

2. Public Health Facilities

The Falmouth Health Centre (Type 4) presently serves the health needs of close to half of the communities in Trelawny (Cooper's Pen, Retreat Heights, Daniel Town, Rock, Hague, Falmouth proper, Martha Brae, Granville, Salt Marsh, Davis Pen and Scarlett Hill) and as far as to Lilliput in St. James. The centre has therefore outgrown the capacity for which it was built. An additional increase in the population at Florence Hall (New Falmouth) will add to the already overwhelmed services at the health centre. No plans have been made for expansion to date. The main health concerns in the general project area are:

- Chronic diseases e.g. diabetes, hypertension
- HIV/AIDS
- Child Health and welfare particularly in relation to teenage pregnancy
- Maternal health services

Public health officials spoken to expressed the following concerns for public health as a result of the project:

(1) The effect of the effluent from the proposed sewage treatment plant on the luminescent lagoon

(2) Adequate recreational facilities – the concern is that the green areas are left undeveloped, no park benches or recreational facilities and as such these designated areas are never used by the residents of the community

Falmouth also has a Type C Hospital. The improved travel time to the Cornwall Regional Hospital has been a positive outcome of the completion of the Northern Coastal Highway in Trelawny.

3. Fire & Police

The Falmouth fire station is the only one in the parish at present with two fire trucks (one for service and the other response). Fire services must be considered totally inadequate in the event of there being a significant occurrence, not to mention a multiple event. Considering Falmouth's heritage assets, this situation is deplorable. However, because of pending tourism and potential for sports development in the parish, plans are underway for upgrading the facility.

The Superintendent has recommended a total of 45 fire hydrants for the Florence Hall Housing Development. The main concern for the project is that the facilities are actually put in place and activated. It was reported that on several incidents fire hydrants are placed in housing developments but have not been connected to the pipe system. Both police and fire services for the communities are centered in Falmouth.

4. Roads & Traffic

The road network serving the zone of impact allow for the orderly flow of traffic in the surrounding communities. The network is centered on the Northern Coastal Highway which impacts Traffic in the Florence Hall area. Local Traffic Authority reports that the New Falmouth area is generally not a congested area, except when events are held at the Greenfield Stadium. Usually three lane traffic is used for flow of traffic to and from the stadium. Presently the intersection of the Daniel Town road with the NCH is not traffic lighted (Plate 5.3.2.2). The speed limit on the highway is 80 Km however the average speeds used by motorists is approximately 110 Km. With the completion of the project, a traffic congestion problem in not envisaged by the authorities, but some measures will be necessary to curb the speeding on the highway.

Plate 5.3.2.2 The North Coastal Highway's intersection (looking east) with Daniel Town Main Road to right

In the opinion of traffic management personnel of the local Jamaica Constabulary Force, a large signed entrance to the Project and the use of traffic lights on the highway would be adequate to quell speeding and any increased traffic. The Consultants recommend that a traffic management plan be undertaken at both the project entrance on the Daniel Town main road and the Daniel Town main road intersection with the highway. In relation to the latter it should consider the introduction of a left-on lane for traffic entering the Daniel Town main road off the Highway from the east. Unfortunately a corresponding left- off when leaving

the Daniel Town main road, does not appear feasible due to drainage works at that intersection. However traffic onto the highway could be prevented from making a right turn and be required to do a turn-around at the Martha Brae intersection. Retaining the existing right hand turning lane from the highway onto Daniel Town main road seems the most practical option.

5. Utilities

◊ *Water*

The communities are supplied water by NWC and in each community the service is regarded as adequate as reflected in the results of the rapid appraisal community surveys (Table 5.3.2.2a). Most dwellings are reported to be metered.

Table 5.3.2.2a Adequacy of water supply in communities within the project location

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Adequate	177	88.5	92.7	92.7
	Inadequate	3	1.5	1.6	94.2
	Sometimes adequate	11	5.5	5.8	100.0
	Total	191	95.5	100.0	
Missing	System	9	4.5		
Total		200	100.0		

Some 88.5% of respondents rated their water supply as adequate. The remainder rated it either sometimes inadequate or inadequate. Trelawny is regarded as having more than adequate water resources. These resources exist in the Martha Brae River Basin, from which the parish satisfies its needs but also exports water. The following figures (Table 5.3.2.2b) are based on the National Water Resources Master Plan for Jamaica 2nd Draft 2005 (Water Resources Authority). These figures, though accepted as accurate are, to date, not considered official by the WRA.

Table 5.3.2.2b Annual Average Water Balances 2005

Water Management Units	Reliable Surface Yield	Safe Ground Water Yield	Total Supply	Water Demand (10^6 m^3/ 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
Total	386.9	458.1	881	25.3	9.8	6.2	174.2	215.7	665.3	641.6

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

The NWC maintains two main treatment plants. Old Treatment Plant #1 (as it is referred to) is located at Hague. It is responsible for supplying treated water to Rock, Coopers Pen including some hotel properties along this part of the coast. 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. Roughly half of which is sent along the coast into St. James as far as to Montego Bay with the balance serving the environs of Falmouth area. It is the current source of treated water to the Greenwood Stadium and water supplied to the Project will be from this plant. Other than the Martha Brae the other main sources of water to the parish are tapped from the Dornoch River and 3 operating wells in the Queen of Spain Valley. The Rio Bueno/White River contributes marginally to the water resources available to Trelawny.

The water consumption projected by the Project is estimated to be 240,000 imperial gallons/day based on 250 gallons per household for the 828 units. The National Water Commission (NWC) has confirmed that it can meet the Projects requirements (Appendix I.)

5.3.2.3 Land Use

The main land use in the more limited zone studied is settlement followed by commercial activity and tourism. Some agriculture, mainly market gardening and pen keeping is practiced. This is reflected from the community membership's perception of land use in the project area as reflected in Table 5.3.2.3a. Consistent with observation, the main land use identified by the respondents was residential (64%) followed by Commercial Activity (48%) and Agriculture (32%).

Table 5.3.2.3a Main land use in communities surrounding the project location

Main Land Use	Number of Persons	Percentage of Total
Farming	60	31.7
Commercial building	91	48.1
Recreation	26	13.8
Housing	120	63.5
Mining	4	2.1
Not utilized	3	1.6
Hotel	24	12.7
Total	189	100.0

The main centers of residential and commercial land use are Coopers Pen, Rock, Daniel Town, Hague, Martha Brae and Falmouth itself. The project is bounded to the immediate north east by the 150 x 2 bedroom units Stonebrook Estate under construction by Kemtek (Plate 5.3.2.3).

Plate 5.3.2.3 Stonebrook Estate neighboring the proposed project site on the west (developed by Kemtek)

On the coastal strip several tourism establishments exist such as the 1800 room Oyster Bay Hotel development on Florida Key (to be completed within the next 12 months). The all inclusive 350 room Star Fish Trelawny Hotel and the 96 room FDR Pebbles Hotel are also located along this strip.

Oyster Bay Lagoon, home of the famous luminescent dinoflagellate population *Pryodinium bahamene,* also lies along the coastal strip and is a potential focus of concern by the environmental community, in relation to the project. To its west is the 25,000 seat Greenfield Stadium complex which is 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.

Agricultural land use is centered mainly to the south and south west of the project but outside of its immediate zone of impact. 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 fishing beach to the project is at Rock.

A major planned development is the Falmouth Cruise Terminal, a project of the Ports Authority of Jamaica. The project includes the development of berthing and other landside facilities to accommodate 2 mega line size cruise ships in the Genesis class designed for delivery in 2009. The terminal marine works will include the construction of a finger pier with the capacity to handle a maximum of 6, 360 passengers and a 2,100 crew per vessel. The finger pier will be in the order of 350 m long by 30 m wide. This major tourism development will be an important compliment to the landside expansion of the existing tourism hotel infrastructure which currently is centered on the following existing and planned developments (Table 5.3.2.3b). Other important resorts include Silver Sands which comprises 41 villas of various room sizes.

Table 5.3.2.3b Current & Planned Hotel Properties in Trelawny

Property	No of Rooms	Percentage (%) of Total Rooms
Grand Lido Braco	186	2.6
Star Fish Trelawny	350	4.9
FDR Pebbles	90	1.3
Oyster Bay (Projected)	1,800	25.3
Harmony Cove (provisional)	4,700	65.9
Total	7,126	100

The main planning issues confronting this part of the Parish are therefore the expansion of supporting physical infrastructure (waste management, including proper sewerage being a priority) social infrastructure

(health and safety being also a priority) and housing infrastructure to ensure orderly accommodation of tourism expansion.

In the project land-use context, the New Falmouth area (within which the Project falls) has been approved for residential use. The Ministry of Local Government and Environment is therefore supportive of the use of this property for residential development and has notified the Developers accordingly (Appendix I).

In relation to the communities, and based on the rapid appraisal survey, 54% of community members preferred no other land use, while 26 % would have preferred a factory and 19% a school.

A new Development Order has been drafted for Trelawny but has not to date been officially gazetted. The Development Order in place therefore remains The Town & Country Planning (Trelawny Parish) Provisional Development Order 1980.This Development Order identifies Florence Hall on its list of sites and buildings of architectural or historical interest. The order requires that *"such sites be preserved in the carrying out of permitted development works and in the absence of intended developments be preserved."* Mitigation measures recommended in Chapter 6 are consistent with this order.

5.3.2.4 Flooding

Flooding is not considered a serious problem in this part of Trelawny.

5.3.2.5 Community Opinion on the Project

The rapid rural Appraisal approach used to inform the socio economic section included a survey of 200 community residents and business owners as well as persons in community leadership positions. Though not designed to be a statistically representative survey, standard rapid appraisal technique for interviewing was refined to capture individual respondents' perceptions of what the general community attitudes are concerning the issues probed. It is this probing of collective attitudes, which, in the opinion of the consultants, give reliability to the results.

The community was asked to rate the acceptance of the project concept (2 bedroom residential housing development comprising 825 units). An architectural design concept of the unit was shown the respondents). The results are tabulated below (Table 5.3.2.5a).

Table 5.3.2.5a Community approval of the Project

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Highly approved	62	31.0	31.0	31.0
	Approved	128	64.0	64.0	95.0
	Not highly approved	2	1.0	1.0	96.0
	Unapproved	8	4.0	4.0	100.0
	Total	200	100.0	100.0	

The project received high rating by respondents with 95% of them feeling that the community would highly approve or simply approve the Project. In addition to approving the Project the communities were asked to rate its importance. The attributions of importance to the project by respondents were that 40% thought it very necessary and 56% simply necessary (Table 5.3.2.5b). The concerns of the minority opinion (4%) was centered on the fact that they did not think that the project would benefit the community and that too many houses were already in the area and also that poor people will not be able to afford the houses anyway.

Table 5.3.2.5b Perception of community views in respect of the Project

Opinion	Frequency	Percent	Valid Percent	Cumulative Percent
Very necessary	80	40.0	40.0	40.0
Necessary	112	56.0	56.0	96.0
Not very necessary	2	1.0	1.0	97.0
Unnecessary	6	3.0	3.0	100.0
Total	200	100.0	100.0	

Some of the reservations expressed about the project included migration into the area of undesirables (16%) and a fear that community members might be overlooked for project employment (10%) (Table 5.3.2.5c).

Table 5.3.2.5c Fears or reservations regarding the Project (from public consultations)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	None	122	61.0	64.2	64.2
	Overcrowding	5	2.5	2.6	66.8
	Environmental hazards	5	2.5	2.6	69.5
	Community members may not benefit from Project jobs	20	10.0	10.5	80.0
	Strangers coming in may tarnish reputation of community	32	16.0	16.8	96.8
	Community may not benefit from housing	6	3.0	3.2	100.0
	Total	190	95.0	100.0	
Missing	System	10	5.0		
Total		200	100.0		

Overall the Project was perceived to potentially confer major benefits by the community members. Chief among these were employment opportunities (72% of respondents), recognition for the communities (4.5%) and increased patronage for community based businesses (8%) (Table 5.3.2.5d).

Table 5.3.2.5d Expected benefits from the Project

Benefits of Project	Number of Persons	Percentage of Total
No response	5	2.5
Employment opportunities	144	72.0
None	38	19.0
Recognition	9	4.5
Better houses for residents	2	1.0
Improved infrastructure	7	3.5
Businesses in community will benefit	8	4.0
Troublemakers will be kept outside	2	1.0
Total	200	100.0

5.3.2.6 The Business Community

Thirty interviews were conducted among business establishments within the surrounding communities of the project's location. The establishments accounted for a total of 100 employees with 47 % employing only one person and 3.5 % employing eight. Some 37.7 % of employers are in approval of the Project while 4% indicated that they did not approve the project highly. No employer indicated out right disapproval of the project.

While 77% of employers had no reservations about the project, some 20 % expressed concern in relation to the project. The reservations were threefold, with the most common fear being the concern of overcrowding in an already crowded area. Another fear expressed by 7 % of the informants expressed that there will be greater competition for their goods and services due to the influx of small businesses that are likely to be established near to the project site. And finally thirdly 3% fear that outsiders may become a threat to their community.

However 40% of employers thought that the main benefit to the business community lay in increased purchases and sales. As an alternative to the proposed housing development 63% of employers could think of no better land use for the intended site, 10% felt that farming would be a better use of the land and 10% felt that a shopping centre/plaza would be more practical to meet the needs of the existing communities.

Structured interviews were held with some 22 key informants from whom a variety of comments was received. All key informants were supportive of the project in relation to the perceived need for housing solutions, but it was evident that the protection of Oyster Bay was of paramount importance to them. All informants were concerned about the impact of the development on the dinoflagelate (*Pryodinium bahamene*) population in Oyster Bay particularly in relation to the proposed sewage and waste water treatment.

The Member of Parliament Dr. Patrick Harris was of the opinion that the Developers might wish to explore the possibility of undertaking a central sewage treatment plant that could tie-in with future downstream developments in the area. His reason is that the area lends itself to gravity flow as an alternative to the use of pumps. Further the entire area has been zoned for housing in the proposed Development Order for Trelawny. He further indicated that his discussions with technical expertise suggested that such an undertaking could be feasible.

Pleasure boating enthusiasts and also bird shooting enthusiasts, who were asked to pass an opinion on the proposed project, supported the observation of the fishermen that Oyster Bay was rapidly being silted. This they partially attributed to the underground rivers which emptied into the lagoon, one of which they opined routed beneath the Florence Hall property. They voiced some ambivalence about the Project mainly as it impacted on bird shooting activities since the Florence Hall Estate had the best shooting stands in Trelawny. They also felt that it housed important populations of Partridges, Ball Pate, White Belly, and Blue Pigeons among other indigenous and visiting species (including winter migrants).

His Worship the Mayor was supportive of the Project, subject to the overarching need to protect Oyster Bay. He confirmed that beyond those reported on elsewhere, there were no major projects planned for the Greater Falmouth Area, other than a proposed housing scheme.

5.3.3 Archaeological and Cultural Heritage

5.3.3.1 Literature Research

The National Library of Jamaica, Jamaica National Archive and the Jamaica National Heritage Trust in addition to other sources were consulted for information on the site.

Trelawny became a parish in 1770 and was named after Governor William Trelawny. Before that it had been part of the parish of St James and was governed from Montego Bay. Trelawny developed late as a sugar producing area and had 88 estates in 1770. This late development probably accounts for the fact that it was increasing in prosperity when the rest of Jamaica's sugar industry was in decline. It was also probably due to this increasing wealth that the area became an independent parish when it did.

However, the wealth of Trelawny was not all produced by sugar manufacturing. The whole stretch of the north coast from Seville in St Ann (east of Florence Hall), to Florence Hall was also an important cattle raising and pimneto growing area.

A map drawn in 1766 (Appendix VIII, Plate 1) to resolve a dispute about the ownership of a section of Florence Hall estate used a survey drawing of 1676 as its base line. In 1676 the estate consisted of three hundred (300) acres and belonged to a Mr. James Bowman. This suggests that the area occupied and

developed under the Spanish as a cattle raising and sugar producing area, had quickly attracted the attention of the English invaders who had quickly distributed it to its own people.

Although Florence Hall is alluded to as an estate, it was more of a cattle pen and a producer of pimento as seen from the historic records. Table 5.3.3.1 below gives a summary of information about the estate between 1676 to 1938 and Figure 5.3.3.1 illustrates the set-up of the estate at that time.

Table 5.3.3.1 Size, ownership, value and produce of the estate over approximately 260 years

DATE	SIZE	OWNER / IN CHARGE	VALUE	WORKER POPULATION	PRODUCE
1676	300 acres	BOWMAN, James			
1766	600 acres				
1818				272 (enslaved)	51 Stock
1821		CAMPBELL, Charles		275 (enslaved)	288 stock
1832		Heirs of George Campbell		203 (enslaved)	138 stock
1838	Map does not show the total size on the estate but it includes the size of the saite divisions which amounted to 678 acres in all divided as follows: 1. Cane land – 135 2. Guinea grass -605 3. Mangrove – 22 4. The planter's house and sugar works (34 acres)	CAMPBELL, Charles Irving			
1882	993 acres divided into: 1. Guinea grass – 400 acrea, 2. Pasture and pimento – 110 acres, 3. Wood and ruinate – 483	CARVALHO, Henry			Average produce - 1879 - 1881 40 bags pimento; 1883 – 20 bags pimento
1920	Seperated into Florence Hall Mountain – 300 acres and Florence Hall estate - 693 acres.	PILLINER, Albert G.	2,000 pounds		Grazing
1938	668	DALRIMPLE, AJ and HS.	1,925 pounds		Pasture

Figure 5.3.3.1 Map of Florence Hall (1838) showing the planters house, sugar works and African Jamaican worker's village. Line in bold indicates the present western boundary of the proposed development area

The grave of Emiline Isobel Pilliner who died on May 12, 1923, located in the historic works to the north of the present planter's house testifies to the presence of the Pilliners (Appendix VIII Plate 2).

Although the estate had extensive sugar works during the 18th century (Figure 5.3.3.1) and there is mention that sugar cane cultivation in 1838 was approximately 20% of the total there is no mention of how much sugar was in fact produced. The real production of the estate seems to have been cattle, its by-products and pimento.

It would also appear that sometime between 1838 and 1882 the Florence Mountain property was added to Florence Hall. In 1920 Florence Mountain was again seperated from the estate.

5.3.3.2 Oral History

The informants and guides provided for the survey were Calvin Muckler and Anthony Foster (Appendix VIII Plate 3). Both grew up on the estate and are knowledgeable about the locations of various elements. However they were both too young to know much of its history.

Two interetsing points were gleaned from Mr. and Mrs. Miller, the present caretaker/overseer of the property and his wife. He pointed out that the present house was the second planter's house on the property the first being about one mile to the east of it and in ruin. Mr Miller also pointed out that the current house had been in good repair until 1988 when winds associated with Hurricane Gilbert blew the roof off. Since then it had never been repaired allowing the rain and sun to cause much damage to the extensive wooden elements of the structure. Mrs Miller indicated that up to recently there had been a riding tour from the Trelawny beach hotel which traversed the property three times a day, stopping at the house for a tour of it and refreshment. This tour ceased when the condition of the house had deteriorated to the point of being a danger to visitors.

Discussions indicated that there were older folk who had worked on the estate and who knew something of the history of the place (Personal Communication, Mrs. Muckler and Foster). There was no time to visit these persons as they lived a distance away and of the property.

5.3.3.3 Description of the Existing Cultural Heritage Environment

Unfortunately most areas of the site, including the roads that were cut previously, are colonized by both thick grass undergrowth and prickly bush that it was impossible to see much of the ground. As a result it was difficult for the consultant to see much evidence of the Taino remains said to be located close to the Greenfield property. However, there were two artifacts that are possibly Taino (Appendix VIII, Figure 1).

The 1838 map below (Figure 5.3.3.3a) shows a number of features on the estate at that time including:

- The planter's house – section 68. This house is to the west of the present Development area boundary road.
- The sugar works to the east of that – section 69
- An African Jamaican village to the north of the works – section 70
- A pond to the south of the works – section 8
- A well to the south of the house – section 7

Figure 5.3.3.3a: A section of Florence Hall showing the original house and works, a well and pond

In addition Figure 5.3.3.3b below shows other features that might have predated the house shown in Figure 5.3.3.3b. The features shown are located to the south of those in Figure 5.3.2.3b and are set along the southern boundary of Florence Hall as it abuts the northern boundaries of Clermont and Clifton estates:

- Graves in section 13
- An old house in section 15
- Another house in section 19

Figure 5.3.3.3b: A section of the southern boundary of the estate showing graves, and two houses

Informants indicated that the present house is not the original one. It is an assumption that the house shown in the 1838 map is the original house but the shape of the map's house plan does not conform to that of the existing house. In addition the roadway marked with a bold line on the map in Figure 5.3.3.1, and, is the

present road from the highway east of the Greenfield site to Daniel Town. This road dissects the Florence Hall Estate and the original house is to the west of the proposed development area and the Sugar Works is to the east of the present house. It might be that the property to the west is the Florence Mountain Estate that was separated from Florence Hall and necessitated the construction of a new planter's house on Florence Hall. This would fit in with the fact that there is a pond adjacent and to the north of the present house which is said to be lined with flat stones - whether natural or man made has not been determined (Appendix VIII, Figure 4). The area shown as being the Sugar Works represents a complex that is spread over a wide area, exactly as the 1838 map indicates that it should be. The only suggestion of buildings lies in the traces of the foundations and the presence of rubble especially of cut stone (Appendix VIII, Figure 5).

The major feature on the site at this time is the planter's house which has become badly degraded but has enough of its original structure left to indicate its architectural beauty and careful design. The walls are made from cut stone wrapped with verandahs of wood (Appendix VIII, Figures 6 - 9). As a result the main structure of the house is well preserved and intact while the wooden members including the roof are rotting and falling into disrepair (Appendix VIII, Figures 10). Windows are the glass sash type framed by wooden jalousie louvers (Appendix VIII, Figure 11). The kitchen which has an oven with a chimney, and an attached dining room is intact minus the roof (Appendix VIII, Figure 12). The back of the house has cut stone walkways connecting the entrance through the fence, the kitchen and an outside store room to the main house (Appendix VIII, Figure 13). The entire house is enclosed by a very ornate cut stone fence (Appendix VIII, Figure 14).

The entrance to the property leading to the house consists of a guard house with cut stone walls running along either side of the entrance along the main roadway for approximately 50 meters (Appendix VIII Figure 15 - 18). On the northern side of the property road between the entrance and the house is a cattle or horse pen (Appendix VIII Figure 19) and property fence (Appendix VIII Figure 20) made from cut stone.

To the north of the planter's house are the remnants of several buildings including a well (Appendix VIII Figure 21), a trough presumably for watering cattle (Appendix VIII, Figure 22), connected to a tank which is fed from the well by a short cut stone aqueduct (Appendix VIII, Figure 23 - 24), a circular cut stone structure that is reminiscent of a cattle mill foundation but is out of place within the context of the other structures (Appendix VIII, Figures 25 - 26), the grave of Emeline Piliner (Appendix VIII, Figure 2) and a second smaller grave (Appendix VIII, Figure 27). Several pimento barbeques testify to the importance of pimento production to the estate (Appendix VIII, Figure 28). An overseers or farm house with an outside latrine (Appendix VIII,

Figures 29 - 30) and associated graves to the east of the house complete the inventory (Appendix VIII, Figures 31 – 32).

The 1838 map also shows an indication of an African Jamaican enslaved workers village. Unfortunately the high thick grass that covers much of that area made it impossible to observe if there were any artifacts or other foundation features on the ground. One of the significant elements however that is indicative of the African Jamaican presence in this area are the calabash trees connected with small grave sized and shaped grooves of other types of trees (Appendix VIII, Figures 33 - 34) – islands of trees in a sea of grass. Calabash trees were often used by African Jamaicans as grave markers.

The informants indicated that there are a number of caves/sink holes on the property. The consultant was unable to visit more than one which is some 60 meters to the east of the house. The roof of the cave has collapsed leaving two exposed chambers with overhangs of rock shelters (Appendix VIII Figures 35 - 36). As a result of the path into the cave being blocked by bush it was not possible to gain access to it. Other caves are sited further to the north and have been numbered 1– 6 in Appendix VIII, Figure 37. The informants indicate that caves 1 and 2 have very small mouths and drop vertically for 60 m before opening out into their chambers. Features 3 – 6 are collapsed caves, called depressions on the site maps (Appendix VIII, Figure 37). Two of these, 5 and 6, are filled with water, and 6 has two chambers.

5.3.3.4 Artifacts

The informants indicate that on numerous occassions while walking the site they have come across various types of artifacts including white clay pipes, wine bottles, and white ceramic (chalk) plates. Some of these artifacts are shown in Appendix VIII, Figures 38 – 40.

A number of artifacts were found including slate used for roofing, pearware shards, stoneware storage bottles and green wine bottles. All of the dateable artifacts relate to the post 1780 period which fits in with the assumed date of the second house.

6.0 ISSUES IDENTIFIED, POTENTIAL IMPACTS AND MITIGATION MEASURES

6.1 Issues Identified

Several issues have been identified for the proposed Florence Hall housing development that must be taken into consideration at the design, construction and operation phases. These issues have been explored in light of the potential impacts of the project on the existing environment, as well as the environmental attributes and how they may affect the project. The main issues that have been identified are shown in the Table 6.1.

Table 6.1 Summary of the main issues and potential impacts of the development on the environment

NO.	MAIN ISSUES	POTENTIAL IMPACTS
1	Water Resources Management:	
	(i). Groundwater	Reduction in ground water, interruption of flows, contamination
	(ii). Drainage and surface run-off	Flooding, infrastructural damage, siltation of receiving waters
		Inadequate treatment, odours and other aesthetics, pollution of receiving waters
	(iii). Sewage Treatment	Inadequate treatment, odours and other aesthetics, pollution of receiving waters
	(iv). Wetland	Water pollution, habitat and species destruction, ecological changes in the Glistening Waters Lagoon
	(v). Potable water supply	Insufficient supply and inadequate quality
2	Geology	Collapse of caves, voids, and sinkholes and wells
3	Air quality	Dust nuisance
4	Noise	Noise nuisance
5	Soils	Erosion and contamination of soils
6	Natural hazards	Flooding
7	Hazardous materials	Individual public health problems, contamination of water resources
8	Ecology:	
	(i). Habitats	Changes in forest, wetland and cave ecology
	(ii). Endangered Species	Changes and/or loss of habitats and species
9	Socio-economics:	
	(i). Demographics	Changes in demographic profile
	(ii). Traffic	Increase in traffic, ingress and egress problems
	(iii). Public Health	Introduction of hazardous materials during construction
	(iv). Safety	Collapse of caves, wells and voids during construction and operational phases
10	Solid Waste Management	Improper disposal with aesthetic impairment, increase in vectors and nuisance species
11	Heritage	Destruction of heritage elements

6.2 Potential Impacts and Mitigation Measures

6.2.1 Groundwater, Drainage and Surface Run-off

This section evaluates the potential for the project-related activities to affect ground and surface water quantity and/or quality. Due to the karstic nature of the site these features are interlinked and must be considered holistically. Table 6.2.1 provides a summary of the potential effects resulting from the interactions of the proposed project expansion with surface water and/or groundwater, including those past, present and likely future events.

Table 6.2.1 Potential project interactions with surface and ground water

Project Activities and Physical Works	**Potential Environmental Effects**	
	Change in Groundwater/ Surface water Quality	**Change in Groundwater/ Surface water Quantity**
Site Clearing and Construction		
Site Clearing	✓	✓ (Mostly surface water)
Site Water Management		✓(inappropriate disposal of waste water)
Operation of Sub-Division		
Surface water drainage and run-off Waste water discharges	✓	✓
Site Waste Management	✓	
Maintenance of Infrastructure (drainage ponds, caves, depressions to minimize blockages)	✓	✓
Accidents, Malfunctions and Unplanned Events during Construction		
Hazardous Materials Spills (fuel storage, batching plant, etc)	✓	

6.2.1.1 Potential Impacts

(i). Site Clearing and Construction

Site clearing and construction activities that have a potential to affect surface and groundwater quality include:

- Site preparation activities
- Site water management

The clearing of land may lead to increased runoff and as such surface runoff from cleared areas is likely to mobilize sediments during rainfall events. This in turn leads to increased turbidity and sedimentation of surface waters.

Fly-tipping at the on-site well as well as to open voids could lead to groundwater contamination and interruption in groundwater flows.

(ii). Operation of Sub-Division

Activities associated with the long-term maintenance of the sub-division that has the potential to affect ground and surface water quality and/or quantity include:

- Surface water management;
- Site waste water management; and
- Maintenance of infrastructure

Given the large dependence of the drainage system on storage, any malfunctions of these storage devices could result in significant increases in the runoff that is generated at the site and the ability of the storage systems to adequately convey the stored water safely which could lead to localised flooding. Additionally, given the likely increase in short, intense rainfall events in the future, consideration should be made within the overall drainage design to ensure that they are adequately constructed to minimize the duration of any flooding during such atypical events.

Other issues due to the development relate to increases in solution failures. Karst failures from the engineering literature are often related to the introduction or removal of water, into or out-of the karst environment. Hence, the key to minimising sinkhole failures in karst is the proper control of water flows so as to not increase or decrease the existing flows.

(iii). Accidents, Malfunctions and Unplanned Events during Construction

Malfunction and accidents that could potentially affect groundwater quality include hazardous material spills during construction, and operation of the proposed concrete batching plant. Hazardous materials include fuel oil and associated input materials (cement) used in the concrete batching processing. Hazardous materials spilled onto the ground may leach into the groundwater contaminating the resource.

(iv). Potential Cumulative Environmental Effects with Other Projects

One other proposed development of significance (Stone Brook Developments) is within 500 m of the project footprint and the possible interaction between this project and the proposed project on groundwater and/or surface water is considered likely. It is critically important that surface flows from each development be isolated and adequately managed.

6.2.1.2 Environmental Effects Analysis and Mitigation

(i). Site Clearing and Construction

During the stage of proposed expansion, several activities could result in a change in both the groundwater and surface water quality or quantity. Some of these activities include site preparation, and liquid wastes management. Table 6.2.1.2a below evaluates the potential residual environmental effects resulting from the interaction between construction activities and surface and groundwater bodies, and proposed mitigative strategies.

During construction erosion control systems will be in place to manage runoff from the construction area, minimizing the amount of runoff that occurs. Several generic measures that can be taken to minimize sedimentation and erosion potential include: construction sequencing to minimize soil exposure; retaining existing drainage routes as long as possible; diverting runoff from the denuded areas; intercepting sediments on site; and inspecting and maintaining control measures. Erosion control measures can include erosion control fencing and sedimentation control ponds.

Plugging of the existing well should be undertaken to close the direct migration pathway to the aquifer created by this well. This can be done by filing the well to within 1m of surface with limestone boulders won from the site and sealing the upper 1 m with concrete slurry and raising same 0.25 m above the existing ground. This is to ensure that if there is ponding around the well

and that the seal is sufficiently thick to omit any contaminants migrating to the aquifer. The same approach should be taken with voids that will have to be opened up and filled to create secure infrastructure foundations. This should be done in accordance with the instructions of the geotechnical engineer, or engineering geologist that has experience in karst terrains.

Waste generated during site clearing and construction will be handled by the portable septic management systems and the effects on the aqueous environment are not considered to be significant.

Table 6.2.1.2a Environmental effects matrix for ground & surface waters (site clearing and construction)

Project Activity	Potential Positive (P) of Adverse (A) Environmental Impact	Mitigation	Evaluation Criteria for Assessing Residual Environmental Effects				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological Context
Site Clearing	Change in surface & groundwater quality (A)	-erosion and sediment control will be taken to reduce surface runoff -prevention of releases to the soil/water environment during concrete batching -implement an Environmental Protection Plan (EPP)	1	1	1/1	R	1
Site Water Management	Change in groundwater quality (A)	-manage site as per EPP and any other applicable permits -septic management installed in accordance with NEPA, EHU and the WRA codes	1	1	1/5	R	2
	Change in groundwater quantity (A)		1	1	1/2	R	2

Key:

Magnitude:
1: Low: eg affecting the available quantity or quality of ground/surface water resources, such that these resources are indiscernible from natural variation or existing background levels.

2: Medium: eg limiting the available quantity or quality of ground/surface water resources, such that these resources are occasionally rendered unusable to current users for periods up to two weeks at a time

3: High: eg limiting the available quantity or quality of ground/surface water resources, such that these resources are rendered unusable or unavailable for current users during the life of the Project or for future generations beyond the life of the Project.

Ecological Context
1: Relatively pristine area or area not adversely impacted by human activity

2: Evidence of pre-existing adverse environmental effects or human activity

Geographic Extent:
1 : <1km^2
2 : 1-10km^2
3 : 11-100km^2
4 : 101-1000km^2
5 : 1001-10,000km^2

Duration:
1 : <1 month
2 : 1-12 months
3 : 13-36 months
4 : 37-72 months
5 : >72 months

Frequency:
1: <11 events/year
2: 11-50 events/year
3: 51-100 events/year
4: 101-200 events/year
5: continuous

Reversibility:
R= Reversible
I = Irreversible

(ii). Accidents, Malfunctions and Unplanned Events during Construction

The evaluation of key potential project interactions for accidents, malfunctions and unplanned events is summarized in Table 6.2.1.2b below. The main issue related to ground water is a potential hazardous material spill.

The release of hazardous material into the environment may result from leaks from machinery used during construction, from fuel and cement/concrete transportation accidents, or from leaks from storage tank facilities. The accidental release of a large quantity of a hazardous liquid onto the ground could render groundwater unusable for a long period of time. However, the likelihood of malfunctions and accidents of this magnitude occurring is considered low as the implementation of proper housekeeping activities and environmental protection plan (EPP) should reduce occurrences. Additionally, the 11,350 L (3000 gallon) fuel storage facility near the wetland will be bunded according to NEPA requirements.

Based on consideration of the potential effects of an accident, malfunction, or unplanned event involving the release of a hazardous material to groundwater or surface water, the proposed mitigation (e.g. EPP with spill containment plan) and the residual environmental effects significance criteria, the environmental effects on the aqueous environment by these accidents are not rated as significant if the best practice mitigation measures are implemented.

Table 6.2.1.2b Environmental effects matrix for ground & surface waters (accidents, malfunctions and unplanned events)

Project Activity	Potential Positive (P) of Adverse (A) Environmental Impact	Mitigation	Evaluation Criteria for Assessing Residual Environmental Effects				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological Context
Hazardous Material Spills	Change in groundwater quantity (A)	-implementation of emergency environmental response plan in the event of a spill and coordinate with NEPA spill response programme -remedial action as necessary to restore impacted soil or groundwater or surface water to acceptable levels	2	2	2/1	R	1

Key:

Magnitude:
1: Low: eg affecting the available quantity or quality of ground/surface water resources, such that these resources are indiscernible from natural variation or existing background levels.

2: Medium: eg limiting the available quantity or quality of ground/surface water resources, such that these resources are occasionally rendered unusable to current users for periods up to two weeks at a time

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3: 51-100 events/year
4: 101-200 events/year
5: continuous

Reversibility:
R= Reversible
I = Irreversible

(iii). Operation of Sub-Division

The following provides an evaluation of the key potential project and aqueous environment interactions during the operational phase of the project and is summarized in Table 6.2.1.2c below.

Operation of the sub-division is expected to continue for a minimum of 50 years upon completion of the construction phase of the project.

There are four integrated elements related to the satisfactory management of ground and surface waters in the proposed development. These are:

1. Maintenance of the integrity of the underground aquifer to prevent contamination and interception of necessary flows
2. Appropriate design and management of the drainage system and run-off to the receiving wetland to prevent flooding and shock discharges to the Glistening Waters Lagoon
3. Appropriate design and management of the sewage treatment system to achieve acceptable effluent standards and prevent adverse ecological changes in the receiving wetland
4. Monitoring and maintenance of the receiving wetland to ensure ecological and hydrological integrity

The achievement of these requirements throughout the life history of the proposed development is critical to its sustainability and that of its immediate and adjacent environments.

Table 6.2.1.2c Environmental effects matrix for ground & surface waters (Operation)

Project Activity	Potential Positive (P) of Adverse (A) Environmental Impact	Mitigation	Evaluation Criteria for Assessing Residual Environmental Effects				
			Magnitude	Geographic Extent	Duration/Frequency	Reversibility	Ecological Context
Water Management (human)	Change in groundwater quality (A)	-Install an approved sewage treatment plant	2	2	1/2	R	2
Water Management (runoff)	Change in surface water quantity (A)	-design and install practical and maintainable storm water drainage system. Ensure existing and created detention features are kept clean year round	1	2	1/1	R	1
Water Management (Wetland)		- Ensure wetland ecology and hydrology can accommodate surface inflows and monitor water quality inflows and outflows	2	2	2/1	R	1
Maintenance	Change in surface water quantity (A)	-implement an annual maintenance programme for the existing and created detention feature to reduce blockages	2	1	1/1	R	1

Key:

Magnitude:
1: Low: eg affecting the available quantity or quality of ground/surface water resources, such that these resources are indiscernible from natural variation or existing background levels.

2: Medium: eg limiting the available quantity or quality of ground/surface water resources, such that these resources are occasionally rendered unusable to current users for periods up to two weeks at a time

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4:101-200events/year
5: continuous

Reversibility:
R= Reversible
I = Irreversible

6.2.1.3 Water Resources Environmental Protection Plan

The aqueous environment should be monitored both during and post construction to ensure that national water quality objectives for groundwater and marine environments are achieved and demonstrated to be achieved. Sites for monitoring should include the storm water discharge points, groundwater and the sea.

The Project Construction Phase

- Precautionary engineering measures (outlined above) should be implemented to reduce run-off and prevent it from reaching existing drains and the Glistening Waters. Nothing which could cause pollution, including sediment-laden water, should be allowed to enter any such watercourse or groundwater.
- All temporary fuel, oil and chemical storage must be sited on an impervious base within a bund and secured. The base and bund walls must be impermeable to the material stored and of an adequate capacity.
- Waste streams removed from the site immediately and disposed of via a licensed waste disposal contractor or in conjunction with the local authority.
- Human waste during construction should be kept within portable sanitation units (Port-a-potty).
- Washings from concrete mixers, paint or paint utensils should not be allowed to flow into any drain, groundwater or watercourse.

The Project Operation Phase

1. Ground Water

In order to maintain integrity of the groundwater it is essential that the aquifer not be contaminated by solid or liquid discharges to the caves, voids or the well. Hence the caves should be left intact with a buffer zone of vegetation and other natural features at least 10 m wide around their entrances.

Voids should only be opened up and filled where it is essential to secure sound foundations for infrastructural development such as roads, drains and conduits. The preliminary engineering estimate is that no more than 10-15 voids will need to be filled for this purpose. A description of how this should be done as illustrated in Figure 6.2.1.3a.

Each void that has been located on the Florence Hall site will either be excluded from the development or it is proposed to fill the voids in with suitable material. Figure 6.2.1.3a below

illustrates the hypothetical arrangement of voids found on the proposed development site. Where the area is to be developed the void will be opened up to a sufficient extent to allow for work to take place in the void as shown in Figure 6.2.1.3b. The on-site well may be filled and capped in a similar manner.

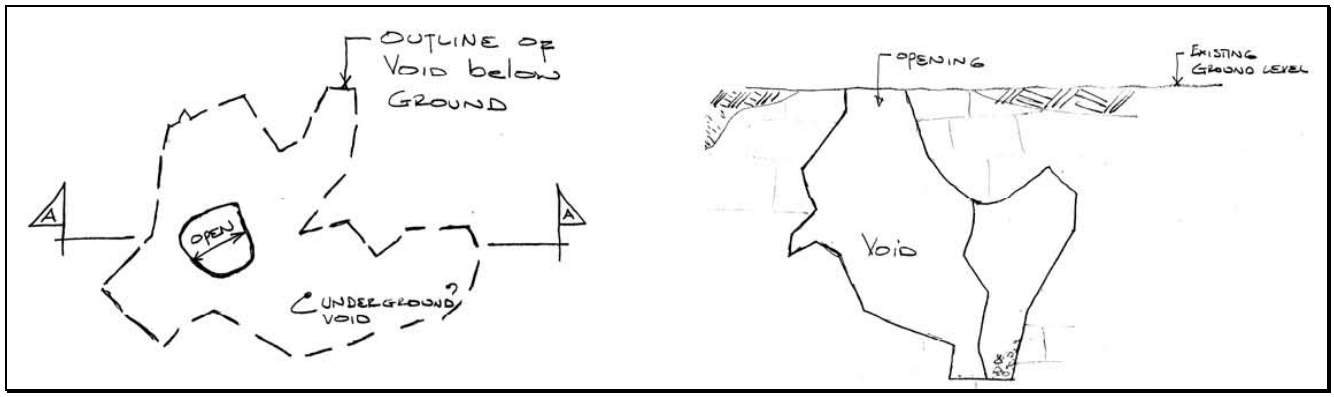

Figure 6.2.1.3a Left: Possible plan of void; Right: Assumed cross section of void

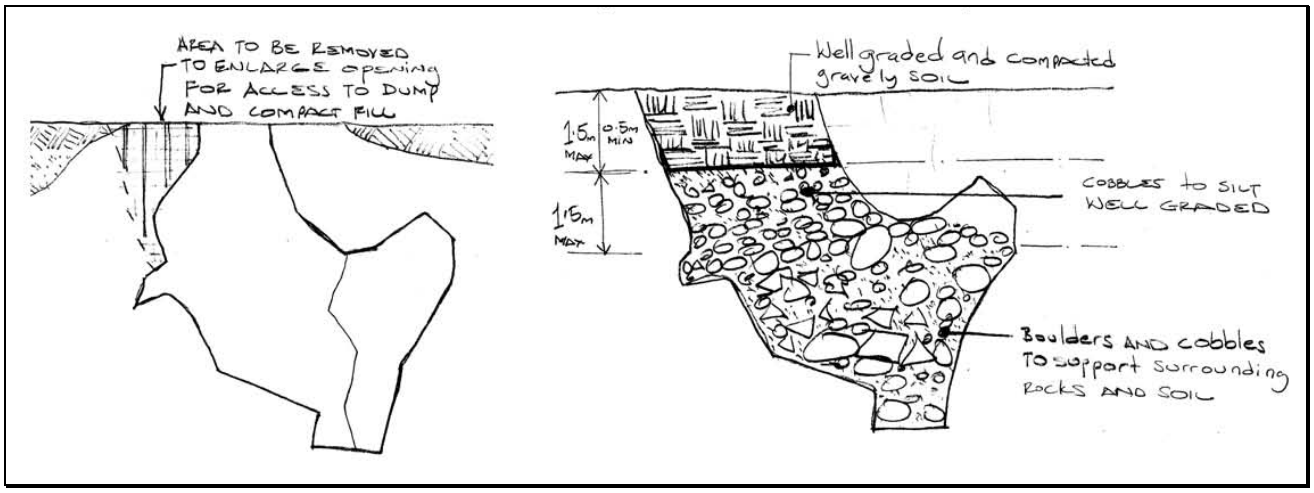

Figure 6.2.1.3b Left: Possible plan of void; Right: Void filled with granular material

As shown in Figure 6.2.1.3b above different fill materials are proposed for the various elevations in the voids so as to achieve free drainage through that part of the stratum, thereby satisfying the recommendation from the Geological report to maintain the movement of groundwater through the areas of the voids. Boulders and cobbles will be the predominant particle size placed at the lowest

levels in the void while more densely compacted granular materials are proposed for the upper levels of the fill. This will allow for free flow of groundwater through the filled void. Closer to the surface well graded soil from cobbles to sizes that will be retained on the No 200 sieve will be used to fill the upper most parts to complete the filling of the void.

PVC pipe that provides for some flexibility will be further enhanced by adding couplings where the pipe passes through the filled voids. Proper bedding and backfill procedures will enhance the robustness of the underground services.

2. Drainage System and Run-Off

The drainage system for the proposed project includes facilities to retain surface runoff flows in excess of the 2 year flows in the central playfield area and in the depression area close to the Great House. The layout plan for this system is illustrated in Figure 6.2.1.3c.

The depression toward the south of the proposed development lands close to the Great House presently receives flows south of the project lands and this will be maintained. However, for other areas where sinkholes are located, surface flows will be excluded from them. This will be done to slow the dissolution process and limit the development of new sinkholes.

To improve the quality of storm water that will leave the proposed development lands, water quality management procedures will be incorporated in the design. The goal of surface water run-off sizing criteria is to capture and treat the majority of pollutants in storm water runoff, while maintaining a reasonable cost for storm water treatment practices. The run-off volume criteria are equal to the storage required to capture and treat approximately 90% of the average annual storm water runoff volume. The specific rainfall event captured is the 90% storm event, or the storm event that is greater than or equal to 90% of all 24-hour storms on an annual basis.

The storm filtering system will capture and temporarily store the run-off and pass it through a filter bed of sand, organic matter, soil or other media. Filtered run-off may be collected and returned to the conveyance system, or allowed to partially filter into the soil.

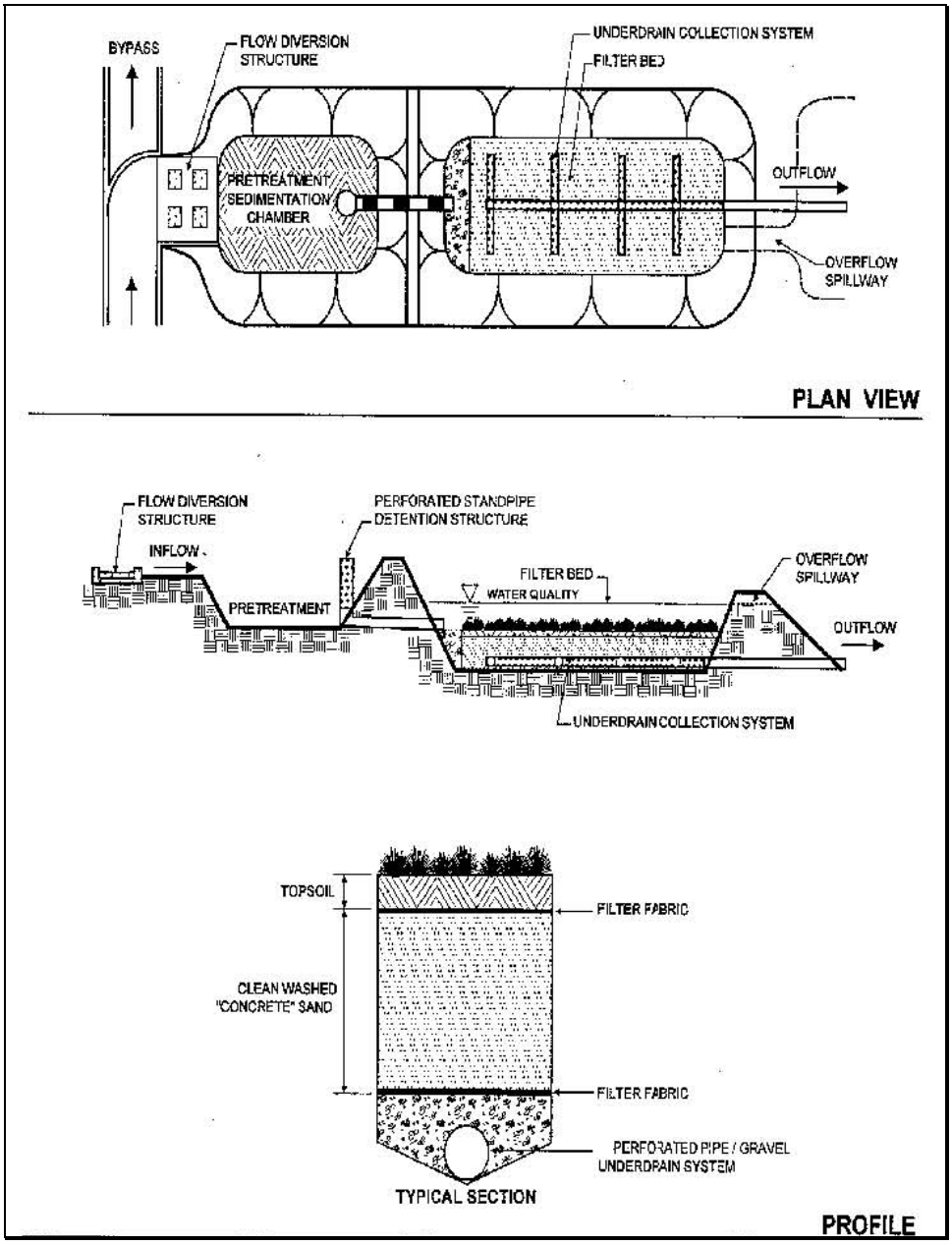

Figure 6.2.1.3c Surface sand filter system

Storm water sand filters are proposed for the various areas throughout the subdivision. Those areas are:

i. Upstream the south west depression
ii. South east of the basic school on open lands
iii. Within the central play field area
iv. South of the wetland area in the north east of the proposed development

Additional storm water quality improvement is expected to take place in the receiving wetland north east of the proposed development before it discharges under the north coast highway to Oyster Bay. Surface water from the western areas of the proposed subdivision will flow through the central playfield area and the rate of discharge is controlled by a weir proposed to be constructed there. The intention is to limit the rate of discharge to the pre-construction levels. This feature as well as the wetland bounded by the North Coast Highway will limit the rate of discharge from the proposed development. Details of the proposed drainage system, run-off and water quality are given in Appendix III.

3. Sewage Treatment

Various wastewater treatment processes have been considered for the proposed Florence Hall Wastewater Treatment facility including mechanical oxidation ditch, stabilization ponds and subsurface flow wetlands.

The subsurface flow wetland has been chosen as the recommended treatment process because of the advantages when compared with the other systems. The disadvantages of Mechanical Plants are:

1. Complexity in operation
2. Energy needs
3. Cost of maintenance

For a modified extended aeration system such as a modified oxidation ditch the main operating systems are the aerators and return activated sludge (RAS). The control of oxygen in the ditches and the removal of sludge from the system have to be carefully monitored and controlled to ensure that the process is in equilibrium and the quality of effluent remains good. Breakdown in those operations can result in extended periods of compromised effluent quality if the plant is not well managed.

The National Water Commission is one of, if not the largest user of electricity in Jamaica and, where possible, alternative solutions are being sought.

To keep a mechanical plant operating during all weather conditions and at all times capital cost for stand by power is costly and spare parts have to be stocked to ensure that equipment maintenance and repairs are speedily completed. The cost of inventory therefore is significant.

Wastewater stabilization ponds have been used successfully in Jamaica. They, however, require large areas of land as the long retention times upward of 15 days are required at fairly shallow depths if aerobic conditions are to be maintained. The setbacks that are needed and the area required for the treatment places a great demand on the land resource for development.

Stabilization Ponds seem better suited for regional facilities where many developments are served by a single facility. Advanced treatment usually requires additional components such as reed beds to bring the effluent quality to the required standard.

The use of the subsurface flow wetland option has been proposed based on the low energy cost and simple operation of the system.

The main disadvantage is the sludge handling from the septic tanks. It is proposed to include a screen to remove the trash from the wastewater prior to it entering the septic tanks. The septic tanks are to be cleaned twice annually and the septage will be treated in the Montego Bay facility. This option requires maintenance procedures that are rudimentary with little specialist training required. A description of the system is given in Appendix III.

4. The Wetland

The wetland located in the north east section of the proposed development property is deemed a suitable environment for receiving discharges from normal run-off, storm water flows and the sewage treatment plant because of its general ecology and hydrological characteristics. Its natural water exchange and flows is to the larger wetland on the northern side of the North Coast Highway and eventually to Oyster Bay.

The vegetation of the wetland is primarily mangroves (Black Mangrove *Avicennia germinans*, White Mangrove *Laguncularia racemosa*, Red Mangrove *Rhizophora mangle* and Button Mangrove *Conocarpus erectus*) and the fauna is typically marine and estuarine as a result of tidal exchanges.

However, it receives frequent fresh water flows following heavy rains and is capable of withstanding considerable storm inflows.

Present water quality and volume indicate that with a retention time of one day or less, water quality from off-land flows can be significantly improved by dilution, sedimentation and aeration. By these measures it is expected that it will have a final polishing effect on all the development discharges. This includes not only surface run-off but also any residual effluent emerging from the sewage plant wetland system.

To ensure and enhance this final polishing it is proposed that the wetland be maintained by the following methods:

(i). Keeping all flow channels open and depths maintained to facilitate good water circulation and aeration

(ii). Monitor water quality and report any deterioration if it takes place to improve the maintenance of the development's drainage and sewage treatment systems (NEPA effluent standards to be met or exceeded at all times)

(iii). Ensure no destruction of or enhancement of any part of the wetland

Oyster Bay / Glistening Waters Lagoon is known for its Bioluminescence and it is well documented that a delicate water chemistry exists that promote the growth of the luminescent dinoflagellates. Already there are data that shows that there is some elevated nutrient, oil and grease and bacterial levels in the Bay and further increases in any of these levels could adversely affect its bioluminescence. For this reason the role of the Florence Hall wetlands as a retention and final polishing agent for terrestrial run-off and treated sewage effluent is critical.

5. Potable Water System

The National Water Commission (NWC) has indicated both the volume and quantity of potable water required will be adequate for the development. No adverse impacts are expected from the potable water supply and no special measures other than due diligence and care, will therefore be needed.

6.2.2 Geology

The potential impacts on geology of the proposed development site relate primarily to integrity of the karstic environments, including both the surface and sub-surface features. The surface features are expressed in the rugged rock faces, steep escarpments, cave and void openings and sinkholes. The sub-surface features are expressed in the cave structures and expanses, the void spaces and underground water storage and movement.

All of these features, to some extent, can be impacted by construction and operation activities. However, with due planning, design and construction considerations, these impacts may be mitigated to a great extent.

6.2.2.1 Potential Impacts – Construction Phase

The potential impacts from construction relate to site clearing, road and haulage tracks, batching and storage areas, void filling and waste disposal. It is critical that caves not be destroyed, or too many voids be filled in, or natural sink holes extended and that waste is not discharged to voids. The landscape should be sufficiently open to allow recharge of aquifer.

6.2.2.2 Mitigation Measures – Construction Phase

- ◊ Caves, voids, sinkholes and major escarpments should be carefully and accurately mapped
- ◊ Planning and landscape should allow for 10 m buffers around major features. Escarpments should be left in natural vegetation
- ◊ Haulage roads and tracks should be constructed away from these features
- ◊ Batching and storage areas should be carefully located to prevent collapse of surface features
- ◊ There should be no waste/discharges (liquid or solid) in voids, sinkholes and caves
- ◊ Voids should only be filled as necessary to ensure secure foundations for infrastructural development (presently 10-15 voids)
- ◊ Close on-site monitoring during construction should be carried out to ensure no breaches of these requirements

6.2.2.3 Potential Impacts – Operation Phase

The potential impacts during the Operation Phase are very similar to those of the construction phase. However, additional impacts may result from inadequate maintenance of the drainage system, the roadways and other infrastructural works, and also from building expansion of existing houses by residents.

6.2.2.4 Mitigation Measure – Operation Phase

- ◊ The mitigation measures from the construction phase should be carried over into the operation phase
- ◊ The developers should provide residents with clear guidelines on how to construct future additions to their houses. In particular these should relate to the type of foundations required for building over areas with voids. The Parish Council in Falmouth should not approve inappropriate building designs

6.2.3 Air Quality

6.2.3.1 Potential Impacts – Construction Phase

During the construction phase air quality is expected to decline as a result of an increase in levels of fugitive dust from cleared land, cut and fill operations (earth moving activities), stockpiled earth materials, dusty roads and gaseous emissions from vehicular exhaust.

Respirable particulate levels are elevated at some sections of the project area consequent to the aggregate and charcoal burning operations in the area. The site is bounded by a major roadway and this also contributes road dust and some emissions. Respirable particulates are a public health hazard and may otherwise create considerable nuisances to the public.

6.2.3.2 Mitigation Measures – Construction Phase

- Phasing of vegetation clearance to coincide with phasing of construction activities.
- A monitoring programme for dust is recommended.

- Watering of un-vegetated areas and stripped road surfaces along which construction vehicles and trucks travel should control dust emissions by up to 70%.
- A watering truck should be maintained on site for watering road surfaces as needed to minimize fugitive dust emissions. Over-saturated conditions, which would cause outgoing trucks to track mud onto public streets, should be avoided.
- Watering would not be necessary on days when rainfall exceeds 2.5 mm.
- Stock piling of earth materials for construction should be carried out within temporarily constructed enclosures to limit fugitive dust. Vehicles transporting earth materials should be covered en route. Stockpiles of fines should be covered on windy days.
- Mixing equipment should be sealed properly and vibrating equipment should be equipped with dust removing devices.
- A monitoring program for dust is recommended to assess the effectiveness of control measures in meeting ambient air quality standards. The cost for monitoring particulates on a monthly basis would be included in the overall cost of the monitoring program.
- Dust masks should be provided for workers.
- Measure levels of respirable particulates as required and ensure conformance to standards.

No negative impacts are predicted during the operation phase of the proposed development.

6.2.4 Noise

6.2.4.1 Potential Impacts – Construction Phase

During construction noise levels will increase consequent to the use of heavy duty equipment on the worksite. Noise nuisance related to construction may affect communities within a radius of 160 m. In particular the new housing scheme at Stone Brook and existing communities such as Hague may be affected. The 160 m zone is based on the physical property of sound whose energy is inversely proportional to the square of the distance. At a distance of approximately 160 m and starting from a noise level of 95 dB the sound level would have been reduced to 68 dB. The recommended WHO standard is 70 dB for daylight hours. No negative impacts are expected in the Operation Phase.

6.2.4.2 Mitigation Measures – Construction Phase

- ◊ This noise nuisance can be mitigated by the use of sound barriers such as the planting of vegetation along the roadways.
- ◊ Vehicles should be properly maintained and the exhaust systems should be muffled as required.
- ◊ The movement of heavy equipment should be restricted to standard working daytime hours.
- ◊ Adequate communication with residents of neighbouring communities is recommended.

No impacts are expected from dust or noise during the Operation Phase of the proposed development.

6.2.5 Soils and Landscaping

The nature and extent of soils and ground cover in a residential development is a critical element in the protection and enhancement of the overall environment. The impact of landscaping may be adversely negative or positive, depending on how it is planned and implemented.

Native soils at Florence Hall are thin (few centimetres) with high clay/silt content and the vegetation is typical of a Dry Limestone Forest. Indiscriminate removal of forest cover could lead to increased erosion and sediment loads in the run-off. Importation of soils for landscaping could increase this load if not properly managed, especially during construction.

The proposed development is planned with the following landscaping features:

i. Escarpment and other steep topographic features will be left in natural vegetation thus creating a number of green belts throughout the development
ii. Caves will be protected by at least a 10 m buffer zone of natural vegetation
iii. A nature park and two playing fields will be created for open space recreation. These areas will be appropriately contoured and grassed to prevent erosion
iv. A water feature with a permanent pond will be maintained near the Great House
v. The wetland in the north eastern section of the development will be maintained in its entirety
vi. A green belt will be maintained around the Sewage Treatment Pant

vii. Small neighbourhood green areas will be established near clusters of houses

In addition to the above measures, it is expected that residents will establish and maintain their own green spaces around their houses.

6.2.5.1 Potential Impacts – Construction and Operation

i. Indiscriminate removal of natural vegetation cover could lead to increased and sediment loads in the run-off
ii. Scraping of soil for construction and poor temporary storage may result in increased erosion
iii. Improper stockpiling of imported soil could also add to the sediment run-off
iv. The caves and wetlands could be impacted by increased sediment loads
v. The application of fertilizers for landscape vegetation could result in increased nutrient loads to the wetland resulting in eutrophication
vi. Inappropriate use of pesticides for landscaping could also lead to chemical pollution of the wetland
vii. Invasive species could overtake the natural forest species if exotic plants are introduced for landscaping without due care

6.2.5.2 Mitigation Measures – Construction and Operation

i. Natural vegetation that will be left intact should be clearly identified and marked off before construction begins. Failure to avoid destruction of these areas should be a breach of the contractors' contract with attached penalties.
ii. The same should be applied for caves and other features of interest
iii. Suitable sites and conditions are to be established for the temporary stockpiling of soils (and other aggregates)
iv. The use of fertilizers and pesticides should be managed by the establishment of guidelines for landscapers and residents and by water quality monitoring of the wetland.

6.2.6 Natural Hazards

6.2.6.1 Potential Impacts – Site Preparation and Construction Phase

◊ Impacts during site preparation or construction relate to the effect of flood events and storm water run-off on the project site and surrounding areas. Flooding is a major natural hazard to be considered and the major impact is derived from the effect of increased storm water runoff from the site due to changes in the natural drainage pathways.

◊ Tropical storm or hurricane force winds could induce flying debris and particles from stored materials and partially finished buildings.

◊ With respect to man-made/technological hazards, accidents can occur as a result of construction activities directly on-site and as a result of activities off-site, such as transportation of equipment and materials.

◊ Health and safety aspects must be considered with respect to workers during both the Construction and the Operation Phases particularly in relation to caves, voids and sinkholes.

6.2.6.2 Mitigation Measures – Site Clearance and Construction Phase

◊ Site preparation and construction schedules should take account of the traditional rainy season between May and October and of the hurricane season from June to November, during which tropical systems are likely to attribute flood rains and hurricane force winds.

◊ Buildings should be constructed to adhere to hurricane and earthquake resilient design standards.

◊ A safety management plan including traffic handling and equipment management procedures should be developed as part of the construction scheduling.

These mitigation measures are the responsibility of the developer.

6.2.6.3 Potential Impacts - Operation of the Subdivision

◊ During the operation phase the mitigation measures incorporated in the engineering design (Appendix III) should prevent flooding or ponding on the site and surroundings.

◊ Hurricane force winds can affect utility lines.

◊ Storm water run-off could possibly exceed pre-construction run-off and hence increase the likelihood of flooding on the property.

◊ The possibility of earthquake events may produce an overall adversely negative effect on any house or infrastructures beneath or adjacent to voids, sinkholes or other below-surface features without surface expression.

6.2.6.4 Mitigation Measures – Operation Phase

◊ Appropriate design will minimize damage to structures. Utility lines should be buried as far as possible.
◊ An Evacuation Plan must be developed for response to events such as earthquake, fire, or other similar hazard.
◊ Adequate Entrance / Exit facilities must be maintained.
◊ An Emergency Vehicle Entrance / Exit must also be available for use by ambulance, police or fire vehicles.

6.2.7 Hazardous Materials

6.2.7.1 Potential Impacts - Construction Phase

Worker health and safety, as well as the environment can be impacted by the improper storage and handling of hazardous material.

6.2.7.2 Mitigation Measures - Construction Phase

- All temporary fuel, oil and chemical storage must be sited on an impervious base within a bund and secured. The base and bund walls must be impermeable to the material stored and of an adequate capacity. Storage at or above roof level should be avoided.
- Leaking or empty oil drums must be removed from the site immediately and disposed of via a licensed waste disposal contractor.

Washings from concrete mixers, paint or paint utensils should not be allowed to flow into any drain or water course.

6.2.8 Ecology

6.2.8.1 Habitats and Endangered Species

Potential Impacts - Construction and Operation Phases

◊ *Dry Limestone Forest and Caves*

The green spaces proposed for the development site includes approximately 9 hectares of vegetated space that will be retained throughout the proposed development (Appendix VI, Plate 8). This includes vegetation buffers around the locations of caves and escarpments on the property, suggesting that of the 64.5 hectares of dry limestone forest approximately 55.5 hectares will be impacted in the short term (particularly during the construction phase). Impacts related to such removals include loss of habitat and natural vegetation diversity (inclusive of endemic species), impacts on infiltration capacity, water run-off and siltation.

Additionally, natural vegetation loss, coupled with expected additional loss in the long term with successive developments, will ultimately create islands of biodiversity isolated from other natural areas. Such fragmentation of habitats results in a lack of connectivity and hence loss of the various ranges of faunal habitats throughout the property. This could lead to further degradation, since faunal elements associated with the natural forests may not be able to range freely, ultimately depleting resources within their biological islands.

Vegetation and physical works disturbances will also have implications for faunal populations at the site. The most critical faunal types likely to be affected by disturbances to the natural vegetation are Avi-fauna, comprising Birds and Bats.

With at least 13 of the country's endemic birds present at the proposed site, it is clear that the loss of significant amounts of this habitat would undoubtedly have impacts on the populations of such species. Where Bats are concerned, both their underground roosting habitats and their primary feeding habitats could be affected by the development, resulting in the reduction of native mammalian diversity within the area.

The reduction of both faunal groups could have impacts on natural forest survival throughout the entire area at New Falmouth. Both animal groups, and in particular, fruit-eating Bats, are important seed-dispersing agents in the tropics. Because they generally defecate in flight, seeds are dispersed away from the parent plant, thus increasing a seedling's chances of survival and further increasing the potential for forest coverage increase.

◊ *Wetland*

It is not envisaged that significant vegetation loss will occur at the wetlands. In fact, the routing of both storm drainage and treated effluent to the wetlands, along with the proposed reed bed construction, may have a positive impact due to the expansion of wetland vegetation and standing water, with additional support for waterfowl being afforded. The maintenance of this wetland is vital for the control of nutrient, suspended solids and run-off from the property to the adjoining coastal wetlands and Oyster Bay. However, it is likely that there will be approximately 3 hectares of Dry Limestone forest loss due to the construction of reed beds for the sewage plant (this area has been incorporated into the 55 Ha of estimated vegetation loss outlined earlier).

Mitigation Measures

- The pace of vegetation removal should be matched with development implementation so as to ensure that bare, unprotected expanses of ground are avoided.

- A proper balance between natural vegetation removal and preservation must be managed to ensure that biologically isolated "islands" of natural vegetation are not created.

- Specific efforts should be made to locate, recover and re-introduce endemic plants into the new landscape.

- Landscape management must be exercised so as to ensure that occupants utilize both favourable naturally occurring plant species and appropriate alternative horticultural examples so as to re-create a sound vegetative environment. Emphasis should be placed on the employment of trees and shrubs to replace the infiltrative capacities, habitat and feeding support that will be lost with total vegetation removal.

- Green-space allocation must be designed so that it incorporates the need to have open spaces for recreation and sports, limited access space to facilitate biological continuity with nature-based attractions and closed access space to facilitate the preservation of important ecological areas.

- The considerations outlined for vegetative control as well as drainage control considerations for caves will ensure the survival of these faunal types during the construction phase of the development as well as promote their further development in the long term. Additionally, all cave accesses should be restricted through the maintenance of both natural vegetation cover buffers and prohibitive fencing set at least 10 m away from the limits of the cave entrances.

6.2.9 Socio-economic Impacts

6.2.9.1 Demographics

Potential Impacts – Construction Phase

◊ Migrant skilled construction and unskilled labour workers in search of unavailable employment as well as those engaged in hustling occupations, is the main expected negative impact during construction of the development. Arising directly from this is the corollary threat to an acceleration of the sprawl already being experienced in the Project area.

◊ This increase in the number of persons entering the area for labour will, in the short term, alter the character of the area. Concerns have been raised by members of adjacent communities

that this could affect the security of the area. These impacts may be major for the short term but are reversible as they will end when the construction phase ends.

◊ However, the project will deliver direct and indirect employment (approximately 250-300 jobs) and incomes growth benefits. Construction skills are available within the Project area and construction site related occupations will benefit. The project will also contribute to the experience of the skills employed, in preparation for the intensification of construction activities foreseen for this part of the tourism corridor.

Mitigation – Construction Phase

◊ Pre recruitment planning, preferably with the direct involvement of the developer, contractor, Ministry of Labour officials, representatives to the trade unions and local government as well as the Member of Parliament (MP) for the constituency, is recommended for identification of pragmatic steps to mitigate this threat.

Potential Impacts – Operation Phase

◊ The main negative impacts of the project will relate to issues arising from the rapid acceleration of population densities in any given area.

◊ Similarly unless employment opportunities increase commensurate with population density, a transfer of unemployed persons into the project area is expected.

◊ The proposed project is expected to contribute to meeting the need for housing solutions in both the Greater Falmouth area and the parish of Trelawny.

◊ An employment and incomes benefit will also arise in the post construction home improvement phase.

Mitigation Measures – Operation

- ◊ Mitigation of the negative impacts described are directly a function of state agencies capacity to respond and must originate in the heightened requirements of physical and social planning that must accompany any hope of real and sustainable development in this part of Trelawny.

6.2.9.2 Traffic

Potential Impacts – Construction Phase

No road improvement related construction is planned for the proposed project and therefore there are no foreseen impacts to traffic flows during the construction phase of the proposed development.

Potential Impacts – Operation Phase

- ◊ Increasing ownership and possession of motor vehicles in the proposed development, along with a similar trend in the general project area, is likely to result in traffic congestion in the New Falmouth area.

Mitigation Measures – Operation Phase

- ◊ A Traffic Management Plan should be implemented by the Developer (as referenced in Section 5.3.2.2) which will inform issues of vehicle flow management along the public roads, egress and ingress to the proposed development, on and off site heavy duty and ancillary mobile equipment movement, parking, construction worker off loading areas, signage and the appropriate additional highway furniture requirements to ensure minimum congestion and maximum safety to workers pedestrians and road users in general.

6.2.9.3 Public Health

(i) Potential Impacts – Construction Phase

- ◊ Throughout the entire construction period, *t*he proposed project will probably make claims on the already over burdened public health facilities serving the Project area. An increase

in the incidence of respiratory infections including asthma can be expected in neighbouring communities as well as minor or serious site related accidents requiring off site attention. Other negative construction associated health threats, such as noise pollution and waste management on the construction site have already been mentioned.

(ii) Mitigation Measure – Construction Phase

◊ Public health facilities serving the Parish should be fully informed of the projects implementation schedule, so that appropriate preparedness can be encouraged.

◊ Construction site mitigation measures proposed elsewhere in this section, will contribute significantly to reducing community nuisance during this phase.

(i) Potential Impacts – Operation Phase

◊ It is likely that the public health services will continue to be incapable of delivering first class service to those it serves hence the proposed project will place greater pressure on an already over stressed health system.

◊ Accumulation of domestic wastes due to lag in collection of garbage is likely as the National Solid Waste Management System has only one garbage collection truck for the Parish. This may result in the increase in nuisance species and outbreak of disease as well as impairment of the ground water system in the proposed development.

(ii) Mitigation Measures – Operation Phase

◊ Acceleration for plans for upgrading the public health facilities arising from expected development along this part of the tourism corridor, should contribute to mitigating the impact of the Project on public health facilities.

◊ Similarly capacity building in the public cleansing agency will hopefully deliver a sustainable garbage removal service.

The Government is the main responsible party to implement these improvements.

6.2.9.4 Safety

(i) Potential Impacts – Construction Phase

◊ No adversely negative impacts are envisaged on the construction site if safety standards are conformed to throughout the construction period.

◊ The main safety threat relates to the influx of undesirable elements into the neighbourhood during this phase. This is perceived as translating into acts of house breaking and theft.

(ii) Mitigation Measures – Construction Phase

◊ Strong community awareness and preparatory planning has taken place in one community (Rock) for pre-empting or significantly reducing the incursion of undesirables. This should be modeled.

◊ Information should also flow periodically from the Developer to the surrounding communities via their citizens associations re the project completion schedule.

◊ Security services within the parish should also be similarly informed and engaged.

(i) Potential Impacts – Operation Phase

◊ The proposed project can be expected to contribute to a safer housing environment within the project area since acceptable safety standards form part of the project design.

◊ With a major increase in population density in a particular locale it is likely that there may be an increase in criminal activity and as such an overall increase in crime rates in the near communities to the proposed project is to be expected.

(ii) Mitigation Measures - Operation Phase

◊ The encouragement of the formation of active Citizens Watch Groups under the umbrella of strong Citizens Association where they do not already exist would be an important mitigation measure.

◊ The provision of a police post within the immediate project area would also be a positive step since the increasing population and development of tourism infrastructure would justify this. This is the responsibility of the Government of Jamaica.

6.2.10 Solid Waste Management

(i) Potential Impacts - Site Preparation and Construction Phase

◊ Solid waste generated from the site preparation and construction activities will include construction debris, vegetation, and solid waste generated at the construction camp.

(ii) Mitigation Measures – Site Preparation and Construction Phase

◊ Construction sites generate considerable waste and provision must be made for suitable separation and storage of waste in designated and labelled areas throughout the site and the site camp.

◊ Collection of waste by certified contractors and disposal at an approved site, as recommended and approved by the National Solid Waste Management Authority. Site closest to Falmouth area is the Retirement Site in St. James.

◊ Any hazardous waste should be separated and stored in areas clearly designated and labelled, for future entombing and disposal as directed by NSWMA.

◊ Worker training should include instructions on how to dispose of food and drink containers emphasizing the need to protect the ground water, the wetland and ultimately the coastal environment.

◊ Construction camps and work areas must be adequately equipped with portable chemical toilets.

- ◊ Portable chemical toilets must be provided, maintained and removed by a certified contractor.
- ◊ Consideration should be given to the establishment of an integrated Solid Waste Management Plan.

(i) Potential Impacts – Operation of Subdivision

During the operation of the sub-division the following impacts are likely:

- ◊ Dumping of garbage in caves and sinkholes on the property by residents.
- ◊ Increase in nuisance species such as rats as garbage is dumped on-site.

(ii) Mitigation Measures – Operation of Sub-division

- ◊ One mitigation measure is fencing the cave areas to preclude unauthorized entrance.

6.2.11 Heritage Impacts

6.2.11.1Potential Impacts

The historic development of the site as a sugar, pimento and cattle estate is both extensive and intensive. Development has already had a negative impact on the site through the cutting of roads that have damaged the sugar works and might have damaged the African Jamaican worker's village. In addition there are a number of potentially adverse impacts:

- The historic elements along both sides of the property road from the main road to the house will be removed to make way for housing units in those areas. These include the guard house and associated cut and packed stone fences along the main road, the cattle pen and a packed stone fence along the property road.
- While it is true that the planter's house will be saved together with the nearby pond all the other features to its north and to the east will be lost namely the cattle rearing complex to the north of the house and the remnants of the sugar mill to its east.

6.2.11.2Mitigation of Impacts

It is laudable that an effort has been made to preserve the house, ponds and the caves/depressions by turning these locations into green areas (Appendix VIII, Figure 37). The following mitigation measures are recommended:

1. All the historic features extant need to be surveyed unto the site map and properly identified
2. The remaining elements of the historic architectural ensemble should be preserved by extending the park/green area to enclose:
    - The guard house and walls at the entrance of the property road.
    - The cut stone walls and cattle pen walls along the eastern and western sides of the road leading to the house
    - The foundations, aqueduct, well, trough and graves to the north of the planter's house
    - The sugar works foundations and the African Jamaican worker's village to its east.

    In order to do this more in-depth and accurate mapping of the location of these features will have to be conducted.
3. The planter's house should be restored and might be used as a club house/community center for the Development.
4. The area which includes the historic features could be turned into a heritage park with features named and story boards indicating the value of each. It is possible that the riding tour from the local hotels through the property to the planter's house could be restored and become the seed of a community tourism project.
5. Given the lack of knowledge about the existence of Taino sites in the area it will be necessary to either conduct a more intensive HIA to attempt to identify any of these or to ensure that a watching brief is conducted on the site during construction activities to identify any sites and artifacts that might be discovered. It is within this context that the Archaeological exploration of the caves is urgent. The Taino are known for their use of caves as a result of their belief that caves are entrances to the 'under' or 'other' world. Although the caves are protected by inclusion in green areas the fact is that they will be opened up to the public as a result of the Development. Any remaining artifacts including Taino petroglyphs (a prehistoric drawing done on rock) and pictographs might be lost or stolen.
6. Finally it is recommended that if the decision is made to restore and preserve the above mentioned historic elements they should be protected by law through the Jamaica National Housing Trust

(JNHT) and a request made for a tax exemption facility for restoration work to be applied to the company.

A more complete HIA should be conducted before the development continues so as to attempt to identify any existing Taino sites and any of other historic elements that might be present. This investigation should include the use of aerial photographs. In addition an oral history research component can be implemented in order to identify the existence of any traditional technologies on the site e.g. fishing practices and crafts, and any examples of the intangible heritage such as festivals, religious observances, and songs such as fisher/agricultural folk songs.

7.0 POSITIVE IMPACTS

Several positive impacts are expected from the development of Florence Hall Development, as proposed. These positive impacts are discussed in the sections below.

7.1 Generation of Employment in the Construction Phase

During the construction phase employment will be generated for skilled and unskilled labourers as well as some professionals. Employment opportunities should continue for the duration of the project. Opportunities will be created for the supply of various types of construction materials which is expected to be 3 years.

7.2 Provision of Housing in the Operation Phase

In the operation phase 828 housing solutions will be provided in the Florence Hall housing development. Public perception sought in the communities close to the proposed area has indicated a need for the housing and anticipation for this new development. The planned development, meeting the requirements of current land use allocation for the region will be a positive impact, as it discourages the informal and unplanned settlements that have occurred elsewhere.

7.3 Education

Gore Developments will provide approximately half an acre of land to be given to the establishment of a Basic School, which is typically built, owned and operated by a separate entity.

7.4 Land Use Planning

In accordance with the recommendations of the Highway 2000 Corridor Development Plan (PIOJ, 2005), this proposed housing development will fulfill requirements for an area zoned for residential use. This will ensure that the land does not remain idle, become occupied illegally, or be used for any illegal activity.

Planned developments are also easier to police as road networks are structured and named, often with designated entrances and exits.

8.0 CUMULATIVE IMPACTS

In addition to the site specific impacts identified in Chapters 6 and 7 there are a few cumulative impacts that relate to the larger zone of influence of the project. These are grouped as:

i. Socio-economics
ii. Ecology
iii. Cultural

8.1 Socio-economics

8.1.1 Demographics

Construction of 828 residential units by Gore Developments Ltd. together with OVER 100 units by Kemtek will increase the population in the immediate area of Florence Hall by approximately 5000 persons. This will in turn result in an increased demand for all social services in the area as most incoming residents will likely be moving from areas beyond.

8.1.2 Water Supply

The first and obvious demand will be for water supply, cumulatively estimated at 300,000 imperial gallons per day. However, the NWC's new supply from its national storage facility of 6 MGD will be adequate to meet the demand of the new proposed development. The impact will hence be negligible.

8.1.3 Health Facilities

As indicated in the socio-economic section of Chapter 5 the health and emergency facilities in the parish are already under stress. Upgrading of these facilities will be necessary and the planning for meeting the increased needs should already be underway.

8.1.4 Education

The Ministry of Education has indicated that it will soon be phasing out the shift system which allows existing schools to cater to more students that their current design capacity would normally allow. Therefore, more schools must be built to accommodate the present and the expected increased student populations. Each new housing development including the present proposed project will increase the urgency of this demand.

8.1.5 Solid Waste Disposal

The Florence Hall proposed development and adjacent residential populations will create a new demand for an adequate solid waste collection and disposal system in the immediate area. Any inadequacy in the system could potentially lead to accumulation of solid wastes with contamination of the wetlands and built environment.

8.1.6 Traffic

Traffic flows are expected to increase with the introduction of some 5000 new residents into the immediate area. In addition, at times when the Greenfield Multi-Purpose Stadium/Complex is the host ground of any major event traffic flows are likely to peak even further leading to possible congestion. Traffic congestion in the area therefore needs to be examined by the Traffic Authority to ensure adequate free flows.

8.2 Ecology

The clearing of vegetation for the proposed Florence Hall development and adjacent developments is likely to impact the micro-climate of the immediate area, particularly by raising ambient temperatures. To a large extent this is unavoidable and irreversible, but may be mitigated to some extent by ensuring that no unnecessary vegetation removal takes place in these or subsequent developments.

Similarly increased run-off of water, soils and chemicals from the adjacent development could cumulatively impact the coastal wetlands and Oyster Bay. For this reason, each development should be required to have in place adequate water retention and polishing systems and be held to the highest standards of maintenance.

Statements on vegetation impacts take on re-enforced meaning once the concept of cumulative impact is examined. Plate 9 in Appendix VI illustrates existing or proposed developments occurring within a 2 kilometer radius from the centre of the proposed development, and which would have either been approved or implemented within the last 10 years. This would total five major projects occurring or to occur within this area over the stated period or a large-scale development every 2 years.

8.3 Culture

The cultural attractions of Trelawny are many and the present project has the potential to contribute to the parish in a significant way. Hence, the developers of Florence Hall should consider developing the Great House and other elements as a major attraction and to network with other cultural attractions in the parish to increase its visitor and tourism potential.

9.0 CONSIDERATION OF ALTERNATIVES

The proposed development at Florence Hall by Gore Developments Ltd. will help to satisfy the suggested housing needs of Trelawny for 700 new units per year over the foreseeable future. Hence its 828 units over the next two years will contribute to but not totally satisfy all the housing solutions required. More developments of this kind in and around the area are hence inevitable.

The positive impacts of the development are therefore obvious. The potential negative impacts are less so, but must be recognised and mitigated as far as possible. Some of these mitigation measures must be the responsibility of the developer but others, including many of the cumulative impacts measures, are largely the responsibility of the Government. If these measures are effectively carried out, the beneficiaries will be many.

One alternative to the proposed development is no development at all at the proposed site. This, however, would lead to the choice of another site which could present even greater impacts. No such site has been identified.

The consideration of the Florence Hall site for development with its appropriate mitigation measures is therefore highly attractive and would benefit from the closest dialogue between the developers and regulatory agencies. This should include agreement on the final design footprint and on all the required construction and operation mitigation measures as set out in any permitting instrument.

10.0 OUTLINE MONITORING PROGRAMME

If a permit is granted for the proposed development, and before site preparation and construction activities begin, a monitoring programme should be prepared for submission to NEPA, for their approval. The aim of the Monitoring Plan is to ensure the following:

- compliance with relevant legislation
- implementation of the mitigation measures provided
- conformance with any General or Specific Conditions as outlined in the
- permit
- long-term minimization of negative environmental impacts.

The Monitoring Plan should include the following components:

- Inspection protocol
- Parameters to be monitored, which should include
    1. Ambient air quality
    2. Water quality
    3. Perimeter noise
- Construction monitoring
    1. Worker health and safety
    2. Disposal of solid waste
    3. Disposal of hazardous material
    4. Disposal of liquid waste
    5. Draining and rehabilitation of sewage pond
    6. Caves, voids, sinkholes
- Materials handling and storage
- Covering of haulage vehicles
- Transportation of construction materials
- Deployment of flaggers and signposting
- Storage of fines and earth materials

The duration of the monitoring programme should be for the entire construction period, with monthly reporting.

The Monitoring Programme cannot be prepared in detail before the permit is received from NEPA as Terms and Conditions of the permit must be taken into consideration, and included in the monitoring programme as appropriate. The estimated cost of monthly monitoring is US$2,000.

LIST OF REFERENCES

Adams, C.D. 1972. Flowering Plants of Jamaica. University of the West Indies Press. Mona, Jamaica.

Brown, F. and B. Heineman. 1972. Jamaica and it's Butterflies. E.W. Classey Ltd. London.

Camirand, R., and Evelyn, O. 2004. National Forest Inventory Report 2003 - Volume 1 of 2 - Main Report & Appendices I to V. www.forestry.gov.jm/PDF_files/JA%20Forest%20Cover%20Change.pdf.

Downer, A. and Sutton, R. 1990. Birds of Jamaica – a photographic field guide. Cambridge University Press. United Kingdom.

Foreman, Chung and Sykes. 2008 a.

Foreman, Chung and Sykes. 2008 b.

Garraway, E. and A. Bailey. 2005. Butterflies of Jamaica. Macmillan Education, Oxford, United Kingdom.

Parker, T. 2003. Manual of Dendrology Jamaica. Forestry Department. Kingston, Jamaica.

Raffaele, H. (et al.) 1998. A guide to the birds of the West Indies. Princeton University Press. Princeton, New Jersey.

Verde, T. 1993. www.biobay.com. www.stjohnbeachguide.com/Vieques_HTML/Bioluminescent_Bay.html] and [Grasso in Verde, 1993. Last accessed on 15 January, 2009