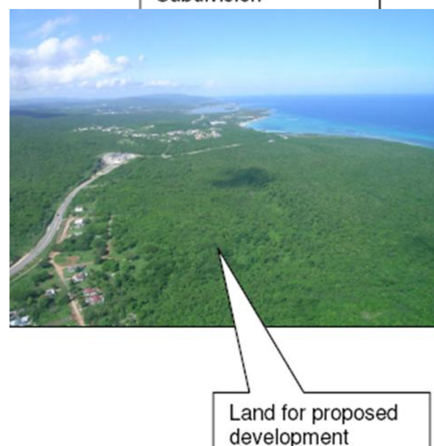
FINAL REPORT

Environmental Impact Assessment for Coral Springs Residential Development

Prepared for:
Gore Developments Ltd
2c Braemar Avenue
Kingston 10

Prepared by:
Environmental Solutions Ltd.
89 Hope Road
Kingston 6

Submitted: July 2012



environmental SOLUTIONS

PROPRIETARY RESTRICTION NOTICE

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

EXECUTIVE SUMMARY

In 2008 Gore Developments Limited (GDL) purchased 169 acres (68 ha) of land in the Coral Springs property in the parish of Trelawny from the Redevelopment Foundation. The project site is separated from the southern Dry Valley property by the North Coast Highway. The coastal property of White borders Coral Springs to the north. Both the eastern and western boundaries of the project site encompass forested private property.

The subject property was originally subdivided in 1964 and was slated for a 380 lot housing development, each of a minimum of 700 m^2 (8,000 ft^2). However the majority of the property was never developed. A total of 39 landowners were able to legally obtain property titles for their lots which most have now completed building while the others are empty lots. The remainder of the property was taken over by the Redevelopment Foundation.

GDL proposes to establish a residential development of 543 units in the Dry Limestone Forests surrounding the existing housing estate at Coral Springs. Of the 543 residential lots, 401 lots will be built by GDL to feature a single family, detached two bedroom dwelling in the flatter lands on the west and north. The remaining 142 lots will be service lots to be developed by each lot owner and are located on the two major hills on the eastern section of the property. The steep escarpment of these two hills will not be disturbed but retained in their natural state. Lands have been allocated in the development plan for a Basic School, Commercial Centre including a gas station, sewage treatment facility, recreational area and natural green areas.

Sewage Treatment Facility

It is proposed that the sewage treatment facility for the project will include the use of septic tanks and constructed wetlands. Each lot will be provided with its own septic tank which is designed to a two day capacity and capable of providing primary treatment for an average of five people per lot. The constructed wetlands are designed to provide for tertiary treatment. Each will have subsurface flow where water flows through a porous media (gravels or aggregates) in which the plants are rooted.

Subsurface flow systems are good for nitrate removal (de-nitrification). Each constructed wetland is designed based on an application rate of 90 l/m^2 to have a minimum hydraulic retention time of 4 days; this is required to reduce the oxygen demand and nutrient levels to NEPA standards.

The sewerage collection designs include four street main collection systems (and sewage pump station design where required), each terminating in a separate constructed wetland. The sewage effluent to be generated by the development will be treated in four separate constructed wetlands -the largest northern wetland for the northeastern lots; the smallest southern wetland for south eastern lots; a western wetland for the southwestern lots; and a central wetland for the northern lots.

The wetland areas will range from 500 to 2900 m^2. There will be three chlorination chambers. The effluent from the northern and eastern lots wetland will be chlorinated together. These sewage treatment wetlands combined with on lot septic tanks should provide an effluent which consistently meets NEPA 2004 standards. Final effluent will be discharged into the central sinkhole/depression on site.

Climate and Air Quality

The climate of the general Falmouth area, like the rest of Jamaica, is subtropical with northeasterly prevailing winds and land-sea breezes. Average daily temperatures vary from 23 ^{0}C in January to about 28 ^{0}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.

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

The highly vegetated nature of the site acts as a filter for any air pollution from the highway and other sources of pollution in the area. Baseline air quality data show values far below the national standard for ambient air (150 µm). The natural vegetation buffers of the proposed development are expected to be effective in providing this pollutant filtering ecosystem service to residents.

Topography and Physiography

The site elevations range from 76 m (249 feet) at its highest point along the eastern boundary (Spring Hill) to 9 m (29.5 feet) at its lowest point. The landscape is heavily fault-controlled with steep escarpments (>30 degrees) along the eastern perimeter of the central lowest area. This central low area is represented by a sinkhole/pond, a feature of significance from a hydrological and a geomorphological perspective.

Apart from particular steep sections, the majority of the Coral Springs property consists of gently undulated ridges with steep slopes separating the undulated and gentle areas.

Soils and Geology

The site forms part of the White Limestone Group, specifically the Coastal Formation. Geotechnical investigations carried out at the site indicate that the soils generally consist of dense calcareous gravels and sands in a clay/silt sized matrix (powder). The depths to bedrock in most areas appear to be near surface. The rocks vary in physical characteristics; highly weathered, moderately faulted and fractured. The rocks are classified as medium-hard limestone.

Mature karstification of the limestone at the site is evidenced by the central well defined sinkhole depression on the property. The surrounding landscape is dominated by repetitive conical limestone hills surrounded by smaller enclosed depressions, typical of the tropical Cockpit karst.

Drainage and Hydrology

The site's principal drainage direction is completely controlled by the central sinkhole which contains standing water up to 13 m AMSL (above mean sea level). This sinkhole drains a total area of approximately 315 Hectares of which 35.4 hectares (65%) of the project property drains into. The remaining 35 % of the site drains northward overland.

The Dry Valley property to the south accounts for the remainder of the sinkhole's drainage capacity. The North Coast Highway separates this southern catchment from the sinkhole forming a physical barrier to surface flow - currently channeled via a culvert beneath the highway to the sinkhole. Also draining to the sinkhole (through a concrete conveyance beneath the highway) is an unnamed perennial spring that emerges from the base of the hill south of the highway. There are several temporal springs that emerge at the base of the hills of Dry Valley that drain to the sinkhole during significant rainfall events. Similarly several temporal springs emerge from the base of the hills at Coral Springs and discharge to the sinkhole.

Hydrogeology

The geology underlying the entire site is classified as a Limestone Aquiclude. Groundwater levels based on a well sunk at Stewart Castle (1 mile east of site) averages about 6 m ±1.7 m above sea level (asl) based on readings from 1965 to 1967.

The unnamed perennial spring described above provides constant baseflow to the sinkhole. Its flow measured at the concrete U-drain under the roadway during site investigation ranged between 0.005 - 0.007 m^3/s.

Base elevation of the sinkhole is below the average groundwater table which as a consequence results in standing groundwater being permanently present within the sinkhole. This sinkhole is water-table dominated and geologically controlled (also known as a hybrid structural/baselevel polje). In effect the karst surface has been lowered to the regional water-table and forced by faulting.

Fissures and fractures form a network of secondary porosity within the limestone surrounding the sinkhole where groundwater flows within the limestone by a combination of fracture flow in the upper zones and conduit flow within the deeper zones. Typically in fractured limestone these upper fractures are not well connected to each other but are well connected to the larger and deeper conduits (or tubes) through which groundwater flows.

Hydraulic conductivity of the upper limestone is estimated at between 10^{-4}m/s to 10^{-3}m/s (360 mm/hr to 3600 mm/hr) using Kralyi's Nomograph. Nevertheless it is recognized that natural conditions are more complex than these modeled figures due to uneven openness, roughness of fractures and infilling of fissures/fractures with roots and soil detritus, etc. Scoping calculations based on ODPEM anecdotal information that the sinkhole drains within 1-2 days after heavy flooding, shows a higher hydraulic conductivity of 10^{-5} m/s to 10^{-4} m/s.

In conclusion the working conceptual model of the site suggests that stormwater runoff from both Coral Springs and Dry Valley are directed into the sinkhole and transmitted through the groundwater system through a network of interconnected conduits. When stormwater runoff exceeds the capacity of the sinkhole, flooding occurs. The output efficiency of the sinkhole appears to be controlled by the intersected water-table and the flow parameters within the subsurface conduit network. Maintaining the outlet efficiency of the sinkhole will be critical to stormwater management within the catchment.

Hydrological Assessment of the 100 Year Flood

Since the sinkhole is the main drainage control feature it is assessed in light of a 100 year flood. In assessing the potential of the sinkhole to accommodate the predicted runoff from the development the 100-yr frequency, 24-hour storm was applied as per international best-practice. Assumptions of the assessment that were used to define the 100-yr sinkhole flood elevation included pre-development site conditions, a plugged sinkhole outlet (0 outflow), and no evaporation (i.e. all rainfall becomes runoff) without flooding any structures.

The calculated incremental storage volume for the sinkhole was determined using the volume formula for the frustum of a cone. The areas at different elevations represent the areas at the top and bottom of the cone frustum and the storage calculated is the incremental volume storage between each elevation.

The 100 year floodplain elevation is determined by the cumulative volume that is equal to, or exceeds, the total watershed runoff of 138 ML. Results show that at the 16 m contour, outside the marked sinkhole lip, the undeveloped 100yr runoff is not contained within the sinkhole without overflow. Post-development the watershed runoff for Coral Springs only and both Coral Springs and Dry Valley are very nearly double and triple the cumulative storage of the 16 m contour. This demonstrates that the 100yr pre- and post-development watershed runoff would not be contained within the sinkhole without overflow or modification.

Sustainable stormwater management will be achieved by excavating the hard brown clay in the area above the standing water elevation (~13.3 m) and filling with compacted gravel and crushed limestone then the area will then be vegetated for use as a park. This is projected to reduce the flood levels up to 0.78 m in the 100 year storm.

Water Quality Assessment

The unnamed perennial spring that traverses into the sinkhole from Dry Valley to the south of the property was monitored for ambient water quality parameters (NRCA Standards). Two points (from the Dry Valley side and ~ 20 m before the spring enters the sinkhole at Coral Springs) were both sampled once in the dry season (February) and once in the wet season (May). The sinkhole was monitored at the northern and the southern ends in the same seasons.

The data suggests that there is some impact of the existing Coral Springs housing estate on key quality parameters. Most of note is the biochemical oxygen demand (BOD) which is very low on the Dry Valley side but then increases significantly after passing the existing houses on Coral Springs. Faecal coliforms were unusually high on the Dry Valley side where there is no evidence of recent human settlement in the area. Only nutrient levels are within the NRCA standards and were generally low.

Metals such as iron and lead were unusually high in the spring at Dry Valley, and also at the point just before the spring enters the sinkhole. The presence of excess heavy metals in surface water systems can be the result of both natural and anthropogenic factors. The houses in the existing Coral Springs housing estate are not connected to a central sewage treatment system but use onsite absorption pits. This is a potential source of pollution and contributing factor for the increases in certain water quality parameters in the spring after it passes the housing area.

Natural Disasters

Like the rest of Jamaica the site is vulnerable to a number of natural disasters such as flooding, hurricanes and earthquakes. Currently the existing housing estate on the Coral Springs property is flood prone and typically floods with heavy rainfall incidences. Hurricanes that affect this section of the island will be expected to impact the development particularly winds and heavy rains. The impact of storm surge activity is not expected to affect the site due to distance from the coastline as well as topography of the site and neighbouring properties well above sea level.

The site is located in a region of Modified Mercalli Intensity of VI which means moderate earthquakes of minimal damage. However the level of damage is dependent on the integrity of the structures. A well-built structure is expected to suffer minimal damages.

Ecology

Flora

The vegetation on the land is similar to that of the adjoining properties, primarily dry limestone forest. The survey done determined four major habitats:

1) Domestic Cultivated Species – As expected this habitat is found within the existing developed area and closely surrounding the houses. The species included popular plants such as mango, guango, bougainvillea, among other fruit trees and flowering plants typically cultivated by Jamaicans.
2) Closed/Thick Dry Limestone Forests – These were found mainly on the flatter lands and predominantly the western and northern sections. It exhibits typical dry limestone characteristics composed of a mixture of herbs, shrubs, vines and displaying a thick canopy of trees. The area is dominated by Red Birch, with high abundance of Burnwood, Bullhoof, and Logwood. The dense presence of shrub and herb species occupying the lower half of the forest was composed of at least 40 (identified) species.
3) Tall open dry limestone forests - The steep slopes to the eastern section of the property are dominated by these forests with the main species being the Red Birch. The habitat is composed of a mixture of shrubs and vines and displays a thick canopy of trees. The area showed a less dense arrangement of

trees than the Thick/Closed Dry Limestone Forests, and a lower scattered shrub presence. Several Epiphytes and Bryophytes are also dominant in this habitat.

4) Riverine Forests – These were seen surrounding the central sinkhole/pond and consisted of bamboo species as well as almonds, sweetsop, breadfruit and ferns and vines.

Fauna

In terms of fauna some 264 individual birds were observed throughout the site. A total of 38 bird species consisting of endemics, natives and migrants were observed and recorded. Of the 38 species, 13 were endemic species, three were endemic sub-species and another 12 were resident species. A total of eight winter migrant species were observed.

Most observed species were seen throughout the property including the proposed development sites. Endemic species such as Jamaican Tody, White Chinned Thrush, and Jamaican Lizard Cuckoo were observed in Thick/Closed Dry Limestone Forests, and are forest dependent species. The areas within the Tall Open Dry Limestone Forests are dominant bird feeding areas as they provide easy access to fruits, with ground and flying insects for the birds to feed upon.

Migratory species observed such as American Redstart and Black Throated Blue Warbler are typical of the Dry Limestone Forest. Other observed species such as Black and White Warbler and Northern Parula were observed in the forest areas with little disturbance. The Osprey, a large non-breeding migrant, not very commonly seen in Jamaica during the winter season was also observed at the site.

Other faunal species observed included 14 butterfly species of which two species are endemic, lizards, Rat bats, Termites, Wasps, Lampyrid Fireflies and the Indian Mongoose. One Jamaican Slider Turtle was seen in the water of the central sinkhole/pond.

Evidence of both bird shooting and charcoal burning were clearly seen in the forests onsite.

Cultural and Archaeological Assets

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

Only three features or areas of potential historical value were observed:

1. A cut stone wall that lines the inside perimeter of the sink hole/pond along with two structures that appear to bring storm water into the pond.
2. Pack stone walls on the eastern and western boundaries of the property.
3. A concrete square-wall structure that has troughs on two sides, possibly a cattle watering facility.

Investigation did not reveal any sign of Taino settlement. The terrain and floral densities and condition suggest a site that would not be mainly conducive to Taino habitation The assessment of the property presented little evidence of any significant cultural and archaeological value/assets.

Socioeconomic/Built Environment

Although the 2011 census data are not yet available, it can be expected that the Falmouth Special Area has grown over at least the last five years due to the increase in development in the area. The North Coast Highway, development of the capital as a tourism destination including the new deep water cruise ship terminal/port, as well as new housing developments, has attracted movement of people into Falmouth now than in previous times.

The major communities of focus for this development are Cooper's Pen, the existing housing estate at Coral Springs, Stewart Castle and the town of Duncans. The proposed development does not present any major challenges to these communities except Coral Springs. Current residents of the existing housing estate rely on a sense of peace in a quiet and small neighbourhood.

Community Opinion on the Project

The project received high rating by respondents with 96% feeling that the community would highly approve or simply approve the Project. The negative opinions (4%) related to the high number of intended units. In terms of importance of the project 65% thought it very necessary. The minority opinion (6%) that the project was not necessary was largely based on the fact that most persons thought the project should be in Stewart Castle instead of Coral Springs.

Some 33% of the sampled population saw the introduction of crime as their greatest fear resulting from the development while sewage disposal was the next highest ranked. Pollution and noise accounted for the majority of the remaining responses.

As it relates to the benefit of the development to the community employment, community development and better educational services were reflected in the majority responses. Employment was perceived by the majority of respondents (72%) as the main benefit of the development to the communities followed by better housing ownership possibilities (26%) and better educational services (10%).

Social Infrastructure

In Falmouth social infrastructure has seen improvements but is still considered stressed due to increasing population and variable financial resources. For instance Health and Public Safety Services appear better able to cope with demands placed on them than for example in Montego Bay. However, hospital and health services are still challenged by lack of personnel and resources. In terms of fire services a relatively new Fire Brigade station is in place in Falmouth. It is however under-resourced in terms coping with anticipated return period emergencies. Police services are reported by authorities as managing the crime situation. Communities in the immediate project zone of impact do not identify crime as a major problem.

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

Impact Assessment

Construction Phase Impacts

Construction of the project will produce the typical impacts associated with construction activities. These activities are discussed below and correlated with the environmental resources that are expected to be impacted by each.

1) <u>Air Quality</u>

Site preparation and construction activities (such as blasting, rock crushing, open cuts and earthmoving operations) have the potential to generate fugitive dust which will directly impact areas less than a half a kilometre from the site. The existing residents on the Coral Springs property are likely to be most impacted by this nuisance. Due to the nature of the site topography this impact can be minimized by ensuring phased vegetation clearance so that vegetation buffers can filter out some of this dust. Also the practice of dampening down exposed surfaces during dry periods should be implemented as part of the site activities during construction. Construction crews will be impacted by the fugitive dusts and should be provided with the appropriate safety gears.

2) <u>Geology and Topography</u>

The geology of the site will be impacted mainly in terms of the areas to be re-graded and / or leveled for house foundations and roadways. This will reduce the permeability but will increase immediate contribution to groundwater in the vicinity of the sinkhole.

Regarding the topography of the site, very little change will occur except again for the leveling of surface bumps and the re-grading of shallow slopes. However, within the drainage basin further re-grading will take place to lower certain areas and increase the holding and percolation capacities of the pond areas. These impacts will be inevitable but minor.

<u>Slopes</u>

Based on the results of the geotechnical investigation the slopes will be suitable for infrastructure and house construction.

The steep escarpments that define both Spring Hill and the southeastern slope should not be disturbed during site clearance and construction activities. It is recommended that the construction manager be present on site to ensure that no removal of vegetation occurs and that the site is developed as per the development plan. Roads and parking areas, shall designed so that land disturbances will not result in excessive erosion. Both the vertical and horizontal alignment of vehicular facilities should be so designed that hazardous circulation conditions will not be created.

The geotechnical investigation has indicated that the use of isolated conventional shallow pad and beam foundation appears suitable across the site. However, in instances where evidence of localized solution cavities have been encountered deeper foundation types should be used. For cuts and fills the soil information suggests that a generalized guideline can be recommended. Fills shall be properly stabilized and cuts supported by retaining walls or other appropriate structures when found necessary depending upon existing slopes and soil types. Anomalous areas e.g. where loose colluviums are encountered during construction should be addressed accordingly.

3) <u>Hydrology and Drainage</u>

Construction practices such as inadvertent sinkhole infilling, blasting and inadequate erosion control and sediment control may alter the karst terrain and increase the potential for flooding. Blasting can change the geometry of the sinkhole throats and underground cavities, blocking outflow pathways. Lack of erosion and sediment control measures can increase the potential for silt and other debris to accumulate within fissures/fractures and effectively reduce outflow efficiency. Encroachment within the sinkhole rim could also reduce the storage volume available to contain stormwater runoff. If output efficiency of the sinkhole is reduced it could be difficult to rectify or regain.

Mitigation Measures

During construction there should be minimal disturbance of the immediate area around the sinkhole. The use of mechanized equipment near the sinkhole should be controlled as the underground system of cavities and streams is dynamic and explosions in the vicinity can alter or block underground drainage passages changing the output efficiency beyond current understanding of the system.

To maintain the integrity of the drainage system no spring, or spring entombment, should be filled. Conduits, channels or caves encountered during site development should not be infilled or covered over.

Based on the storage evaluation, the obvious throat of the sinkhole, the history of flooding and the existing encroachment within the sinkhole floodplain, a no-fill zone is recommended to ensure the proper management of the sinkhole and the local stormwater system. The area encompassed by this 14 m contour shall be the no-fill zone meaning that no construction, vegetation removal/modification, stockpiling or storage of any kind should be allowed in this zone. Any fill added to the sinkhole floodplain outside this no-fill line must be compensated for by an equal volume cut outside of the no-fill zone.

4) <u>Surface and Groundwater Quality</u>

The main water body on site that would be affected by construction activities is the central sinkhole. This means that any impact on the pond water quality will likely impact ground water quality. The typical ways that waters become polluted on construction sites is usually due to run off from site activities, waste waters from washing of vehicles and improper and inadequate sewage disposal facilities.

Vehicles

Vehicles should not be serviced or maintained in the drainage basin nor should waste water from such activities be channeled into the sinkhole.

Stockpiles

Materials such as sand and soils from stockpiles may be washed or carried away into drains with heavy rainfalls. This can result in blocked drains and may eventually lead to flooding in the local area. Covering of stockpiles and storage away from drains will reduce migration of these materials.

Building of a drainage canal around the stockpile areas can serve to divert the surface run-off from stockpiles.

Fuel and Chemical Storage

Fuel and chemical stores at the construction site pose another possible source of contamination to surface and ground waters. Typical mitigation measures include the use of precautionary bunding/construction of dikes and oil-water separators to prevent contaminated water from reaching the central sinkhole.

Domestic Waste Water

Wastewater produced from construction site sanitary facilities as well as lack of facilities can impact groundwater quality if not properly contained and disposed. Construction camps and work areas must be adequately equipped with portable chemical toilets which should be maintained and removed by a certified contractor.

5) <u>Ecology</u>

Site clearance and construction activities associated with the housing development will entail the inevitable removal of a substantive portion of vegetation from the site - approximately 150 Ha. However, 17.6 Ha of vegetation on the steep escarpments will be preserved as nature reserves.

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

As the removal and establishment of trees is a lengthy and potentially expensive undertaking it is recommended that wherever possible, clear-cutting should be avoided and the larger trees of the property should be strategically marked/flagged for conservation.

6) Socio-economic Impacts

Employment

The construction phase will draw on the local labour pool for construction workforce which although short term does provide a positive benefit to the local communities of the Greater Falmouth area.

Traffic

With the need for materials and equipment, traffic in the Coral Springs area is expected to be impacted negatively when heavy vehicles are entering and leaving the property for deliveries, etc. This is expected to be intermittent and short term but will potentially be a nuisance to the existing Coral Springs residents.

Solid Waste

Construction sites generate considerable waste from the various materials that must be used in each stage of the house and road construction process. Solid waste generated from the site preparation and construction activities will include construction debris, vegetation, and solid waste generated at the construction camp. Some mitigation measures include:

- Making provision for suitable separation and storage of waste in designated and labelled areas throughout the site.
- Collection of waste by certified contractors and disposal at an approved site, as recommended and approved by the National Solid Waste Management Authority. The one closest to project area is the Retirement Site in St. James.
- Separation of hazardous waste and storage 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 packaging in containers provided.
- Consideration should be given to the establishment of an integrated Solid Waste Management Plan.

Noise

Any blasting activities associated with construction will generate noise of varying intensity based on location from the source of noise. Also the noise of operating machinery is likely to present a noise nuisance.

It is expected that standard operating practices for constructions within a residential area will be adhered. Some of these include restricting the time of day that such activities are undertaken such as during work hours when most residents will normally not be home to face disturbance. Weekend works should also not be practiced. Servicing of vehicles and use of noise buffer where possible is also recommended.

Worker Health and Safety

Worker health and safety are conventional issues on large scale construction sites where several persons are contracted to undertake heavy duty works in an environment with large scale equipment.

Worker safety should be protected by contractual undertakings to implement safe site practices. Sanitary practices in regard to providing potable water and the disposal of human waste should be enforced to safeguard worker health as part of the construction contract.

Emergency Response

Construction activities involving the combined impact of use of heavy equipment, fuel and chemical storage, moving vehicles is likely to pose a safety risk and as such emergency response actions must be developed for response.

Operation Impacts

1) Hydrology, Drainage and Flood Impact

The basic hydrology and drainage of the Coral Springs site will be retained although enhanced. Two sub-catchment areas from the proposed development will flow northwards in natural channels in 600 mm to 900 mm wide open U drains. This post development drainage will be similar to the pre development situation.

Five sub-catchment areas covering almost the entire housing development to the west will flow to the sinkhole in a series of 600 mm - 900 mm diameter storm sewers and covered U drains.

Seven other catchment areas to the north-east, east and south east will flow into existing earth channels via several 600 mm drains and empty into the depression area.

Due to the potential increased run off from the housing development to the depression area, this area has been designed to expand the storage capacity of the depression and its infiltration potential. This will be accomplished by re-grading a part of the depression area above the standing water elevation (13.3 m), excavating between the 13.5 m contour and the 14.2 m contour to remove the hard brown clay. The area will be filled with compacted gravel and crushed limestone and re-vegetated for use as a park and recreational area.

This re-grading exercise will ensure that the post development flood elevation will not exceed the pre development flood elevation and reduce the flood levels in the existing Coral Springs Housing area by approximately 0.78 m in a 100 year storm.

These measures are estimated to significantly improve the drainage of Coral Springs site and the catchment area to the south (Dry Valley). However, it should be noted that flooding will continue to occur as it does at present over the improved park and recreational area.

It should be further noted that all subdivision lots and services, including the sewage treatment reed beds have been located above the proposed 100 year flood limit of 16.7 m.

The impact of the post development drainage system as compared with the pre development system will be positive. Hence, not only the proposed Coral Springs development itself, but also the existing housing estate will benefit from the improvements. These positive impacts will be permanent and irreversible once the infrastructure has been built and the depression area is properly maintained to allow for maximum percolation of the drainage water to underground.

2) Water Quality

Sewage Treatment and Water Quality

The wastewater treatment system designed for the Coral Spring development consists of the following basic components:

- Septic tanks for anaerobic breakdown of the organics.
- Constructed wetlands (reed beds) for further breakdown of the organics and uptake of nitrates and phosphates and *Coliform* bacteria.
- Disinfection (chlorination) chambers for effective elimination of the fecal *Coliform* bacteria.

Each house lot will be provided with its own septic tank to cater for a household of average 4.5 persons. Where occupancy significantly exceeds this average, it may be necessary for the lot owner to put in a second tank. The lot owner will also be responsible for the periodic emptying and disposal of the septic tank solids by a certified contractor.

From the individual septic tanks, the wastewater will flow by the sewage collection system to one of four constructed wetlands (reed beds) located generally around and above the drainage depression area. From the wetlands, the effluent will flow to three chlorination chambers. The northern and eastern lots wetland effluent will be chlorinated together.

Final disposal of the effluent will be via the sinkhole in the drainage depression area. Based on the quality of the effluent designed for (according to NEPA standards) and based also on two years' experience with a similar system at Florence Hall Housing Village, it is anticipated that the final effluent will be of equal or better quality than the surface drainage water. Hence, no contamination or water quality impairment of either the ponded water or groundwater should occur.

The overall impact of the designed sewage treatment system should therefore be positive and permanent.

3) Ecological Impacts

Change in Vegetation Cover

Most of the vegetation to be removed will be from the thick dry limestone forest on the flatter lands, but the open limestone forest will also suffer significant loss on the steepest areas reserved for service lots. The riverine forest will be mostly left intact but some cleaning up and clearing of fallen trees will be necessary. All these changes will affect bird and other faunal species, but the overall composition of the fauna will not be greatly altered, except on the flatter area where the majority of houses will be built.

Due to the nature of the development, the impacts on the ecosystem as a whole will be irreversible in the short and long term. Tree species composition within the residential lots will also most likely vary considerably from natural forest species and may be expected to be comprised of non-native fruit trees and ornamentals. The four endemic species of plants identified – God Okra, Bromeliad, Orchid, and Broom Thatch - will be preserved in the forested areas on the escarpments, but will likely be lost in the housing areas.

Because the proposed development is located within a larger forested area which is divided by the Highway adjoining the Coral Spring property, the wider expanse of limestone forest in the immediate area will remain a favourable habitat for all of the species encountered at the Coral Springs site. Hence the local and migratory species that are found at Coral Spring will continue to populate the general area.

Natural vegetation loss 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.

With the loss of native forest species in the housing area, new species will be introduced by various home owners for landscaping and other aesthetic purposes as is typical. It is critical that these species be non-invasive and so not compete with the natural vegetation.

Impact of Vegetation Change on Faunal Composition

The natural vegetation provides nesting for several of the bird species identified. With the loss of about 180 acres of natural forest, the nesting capacity for birds will definitely be reduced. This will include both the game (e.g. Bald Pate and White Wing) and non-game species. The loss of the former will be a major negative impact on the many bird shooters who frequent the Coral Springs site. As far as the non-game species are concerned, the majority are insectivores and the loss of so many trees on the site will also result in their reduction.

Significant vegetation removal will reduce the butterfly population and diversity, and other observed insects and the chiroptera observed. The mongoose population should also decrease due to the increase in open areas.

The enlargement and cleaning up on the pond area will lead to an increase in fish population in the pond surrounding the sink hole, and maybe an increased attraction for water birds and the Jamaica Slider Turtle (one was spotted in the pond).

In summary, the removal and other changes in the natural vegetation at Coral Spring will generally have a negative and irreversible impact on ecology. However there will also be some positive impacts as described above. The overall impacts should be no greater than those observed in similar housing developments in dry limestone areas, for example Florence Hall.

Mitigation Measures

The following standard practices are recommended for minimizing the ecological impacts at the site:

- 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.
- Green space allocation must be designed to incorporate 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.

4) Natural Hazards

Flooding

Surface water flooding, generated from trade wind conditions, tropical storm conditions and other weather phenomena is possible based on site location, the central sinkhole critical to local drainage, and surface water network. The 100 year evaluation of the sinkhole was undertaken in this study to determine appropriate no fill zones that would minimize flood levels.

Earthquake

Earthquake is a natural hazard risk to which all of Jamaica is vulnerable to varying degrees. Vulnerability to the effects of earthquakes particularly in the central and south western sections of this site is moderate due to the unconsolidated nature of the underlying strata in addition to high groundwater table, both of which accelerates earthquake forces thus increasing the liquefaction risk.

The geotechnical investigation indicates that the geological foundations, land slopes and surface soils are appropriate for the type of development and structures that are planned.

5) Socioeconomic Impacts

Employment

The project will deliver direct and indirect employment (approximately 250-300 jobs) and incomes growth benefits. Indirect employment will stem from the services required by the new home owners who will settle in Coral Springs and include domestic services such as house keepers, gardeners and construction workers for addition to houses.

Security

The expected increase in the number of persons living in the area as well as those entering for labour will, in the short term, pose some security concerns for the communities of interest, most so for the existing Coral Springs Housing Estate. This has been clearly expressed by residents who were consulted. These perceived impacts are long term and irreversible but are insignificant.

6) Housing and Development

Like the nearby Florence Hall and Stonebrook Housing Developments, the Coral Springs Housing Development is expected to contribute to filling the gap in middle income housing demand in the greater Falmouth area. There is a growing tourism trade in Falmouth and hence the increased opportunities for employment. In the past, provision of adequate housing of good quality restricted the movement of skilled professionals such as health care workers, teachers, among others, into the Greater Falmouth area for employment opportunities. With the growing stock of good quality middle income homes, more development opportunities are likely to be introduced into Falmouth.

7) Waste Management

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

- Dumping of garbage in the sinkhole on the property by residents.
- Increase in nuisance species such as rats if garbage is dumped on-site.

Mitigation Measures

- A warning sign should be erected in the vicinity of the pond/sinkhole.
- Garbage collection should be adequately facilitated by regular collection.

8) Impact on Neighbouring Communities

Socio Economic project impacts on the neighbouring communities comprise both positive and negative impacts. Beneficiaries will comprise households, public sector and private sector business interests. This benefit is likely to extend beyond the immediate project area to include the external community such as St. Ann's Bay in the east and to Montego Bay in the west.

An immediate benefit will be the job creation opportunities to skilled workers during the construction phase and in the post construction phase when additional home improvements are typically made. Local suppliers of hardware and electrical goods and appliances also benefit from large housing developments. Local haulage and public transportation services will be important beneficiaries, as too, other sub-sectors such as the household services trades.

Carrying Capacity

Water Supply

The National Water Commission (NWC) is the regulatory body with responsibility for the allocation and treatment of potable waters in Jamaica. Water consumption estimated for the Project is approximately 595 m^3/day. Discussions held with representatives of the National Water Commission (NWC) in Martha Brae confirmed that an adequate supply of water exists to meet the Project's requirements as it has done for other developments such as Florence Hall which reportedly did not have a significant impact on the availability of potable water. It is the management of water rather than availability that will be integral to the supply and demand for new projects in the Falmouth area.

Waste water treatment facilities will be provided for the development as there is no central system in Falmouth. The treatment facility is designed for an average of 4.5 persons per household and also incorporates use from the commercial zone.

Solid Waste Facilities

The current capacity of Western Parks and Markets is already overwhelmed by the ongoing growth in population in the Trelawny. An addition of some 500 houses and hence 3375 kg of daily waste will not significantly impact/overwhelm present solid waste facilities. Nevertheless it is clear that the need for long term waste management solutions in Jamaica is eminent.

Health Care Facilities

With the additional increase in the population at Florence Hall Estate, Stonebrook housing development and the Falmouth Cruise Ship Pier, the public health care system in Falmouth is already overwhelmed. An increase in the population of at least 2000 due to development at Coral Springs will further add to the stress of the facilities. However, the facilities have long outgrown the current demand placed on them. Upgrading and expansion is now necessary to facilitate the projected development of the next tourism mecca in Jamaica.

<u>Emergency Services</u>

Services such as firefighting are deemed as inadequate in Falmouth. One advantage that the development possesses is the provision of adequate fire hydrants throughout the development which should prove useful when such eventualities occur.

Cumulative Impacts

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. It is the combination of these effects, and any resulting environmental degradation, that is the focus of the cumulative impact analysis. The existing housing estate at Coral Springs along with the new housing developments in the area from Greater Falmouth to Martha Brae is considered in the cumulative impact assessment of this project.

<u>Noise and Vibration Effects</u>

Cumulative noise impacts are assessed in terms of traffic-related noise and a general increase in urbanization in the Coral Springs area. The commercial area will also add to this urbanization of the area particularly the proposed Gas Station which will generate much traffic due to the long distance, both east and west, of other existing gas stations. It is expected that the existing Coral Springs residents will no longer enjoy the levels of peace and tranquility that they have experienced for years.

<u>Air Quality and Dust Effects</u>

Implementation of the proposed project would result in short-term impacts to air quality associated with construction and long-term impacts associated with increased vehicle traffic. These will be most felt by the existing residents in the Coral Springs Housing Estate. Implementation of appropriate mitigation measures will reduce potential short-term impacts related to construction, however these will not completely mitigate for them.

<u>Traffic and Transport Effects</u>

The development will include only one entrance from the highway. This is likely to result in a cumulative impact of traffic over time as increasingly more residents move into the area. Development of all the several housing projects in the Greater Falmouth area also calls for modernization of the public transport system which will experience an overall increase in demand.

<u>Drainage and Hydrology</u>

The studies conducted to date indicate that the central sinkhole/pond is critical to drainage of the Coral Springs property as well as for the Dry Valley site to the south of Coral Springs. The proposed development is projected to result in an improvement to the overall drainage conditions in the Coral Springs property. However, any future developments at Dry Valley could result in a cumulative impact on drainage of the sinkhole/pond.

Fire and Police

The proposed project is expected to increase demand on police protection and fire and emergency services. The local government will need to examine and address the need for additional police services and recommend methods to maintain acceptable service levels.

Education

The proposed project, projects under construction in the Falmouth area, as well as foreseeable future projects, will contribute to the cumulative need for additional school facilities. This is particularly related to secondary level education which is already limited in the Falmouth to Martha Brae area. Most new developments have made provisions for basic school level education. Provision of additional primary and secondary educational facilities should be taken under consideration by local authorities in the long term development plan of this area as it is projected to develop even further.

Vegetation and Wildlife

Development of this project, combined with other developments in the woodlands surrounding Falmouth, will contribute to the loss of forests through land clearing and an increase in human presence in the area. Continued development in the area surrounding Coral Springs would extend bare areas once characterized by natural habitats and utilized by some endemic plant and wildlife species into housing and resort developments.

Although the development plan for the project allows for the retention of some woodland on the Coral Springs Estate, the construction of houses means loss, sensory alienation and fragmentation of habitat and direct mortality due to increased traffic.

Visual Impact and Aesthetics

The proposed project will contribute to the change in visual character of the Coral Springs area. While the project site presently represents natural forests in a mostly undeveloped site the proposed project of over 400 houses would incrementally contribute to the developed, suburban nature of the Coral Springs area. These visual changes will be most evident to the existing residents of Coral Springs. In conjunction with other existing, developing or planned developments, the project's contribution to the loss of a forested area would represent a cumulative impact.

Assessment of Alternatives

No Build Alternative

The no-build alternative would mean that the property is not further developed to provide the additional housing solutions required in the Greater Falmouth area. The proposed improvements in the drainage for the Coral Springs area that would reduce the flood impact to the lowlands surrounding the sinkhole/pond will not be achieved if the development is not constructed. Flooding may possibly become exacerbated as the impacts of climate change and variability continue to produce intense meteorological events.

Retention of Forested Slopes

As an alternative, the developer may consider leaving the slopes in their natural state with no consideration for subdivision of these sections of the site. The Forestry Division's Private Forestry Programme provides property tax exemptions for land owners who allow their forested properties to remain undeveloped. This would prevent any issues with poor slope development and resultant slope failure brought on by the new land owners who will often breach land clearance and development protocols agreed in sales contracts, etc.

Sewage Treatment Options

The developer may also consider allowing existing Coral Springs residents to have the option of connecting to the central sewage system. This could likely minimize the contamination that appears to emanate from the existing housing estate.

Outline Monitoring Plan

Environmental monitoring of construction activities relates to environmental legislation and regulations, permits and authorizations, erosion and sediment control, deleterious substance control, air, noise and water quality assessments, habitat management, site and habitat restoration, environmental management plans. Effective environmental reporting and diligent professional practice are of essence to the monitoring programme that is implemented at any major construction.

The Monitoring Programme will aim to ensure the following:

- compliance with relevant legislation
- implementation of the mitigation measures provided in the EIA submitted to the Client and regulatory agencies
- conformance with any General or Specific Conditions as outlined in the permit
- long-term minimization of negative environmental impacts

1.0 INTRODUCTION

1.1 Purpose

Gore Developments Limited proposes to construct a housing development at Coral Springs in the parish of Trelawny. This report presents the findings of the environmental impact assessment (EIA) that was conducted for the proposed development project. Environmental Solutions Ltd. (ESL) was contracted by Gore Developments Ltd. (GDL) to carry out the EIA as part of the permitting requirements stipulated by the National Environment and Planning Agency (NEPA) in respect of the proposed development.

In October 2011, GDL and their technical team were facilitated by the Development Assistance Centre (DAC) of the NEPA to discuss the feasibility of the project. In their correspondence to GDL following the meeting (Appendix I), the DAC confirmed that the project is approvable in principle and indicated that an EIA would need to be conducted for consideration in the permitting process.

1.2 Project Location

Coral Springs is located in Trelawny along the North Coast Highway. The project site is located some 8 km east of the parish capital Falmouth. The site is situated immediately north of the Dry Valley property (Figure 1.2). Coral Springs is also less than 1 km west of Stewart Castle and 2.5 km west of Duncans. The Coral Springs property is bordered to the north by the coastal property of White Bay. The project site is immediately bounded by forests in all directions except to the south where the North Coast Highway flanks the southern edge separating Coral Springs from Dry Valley to its south.

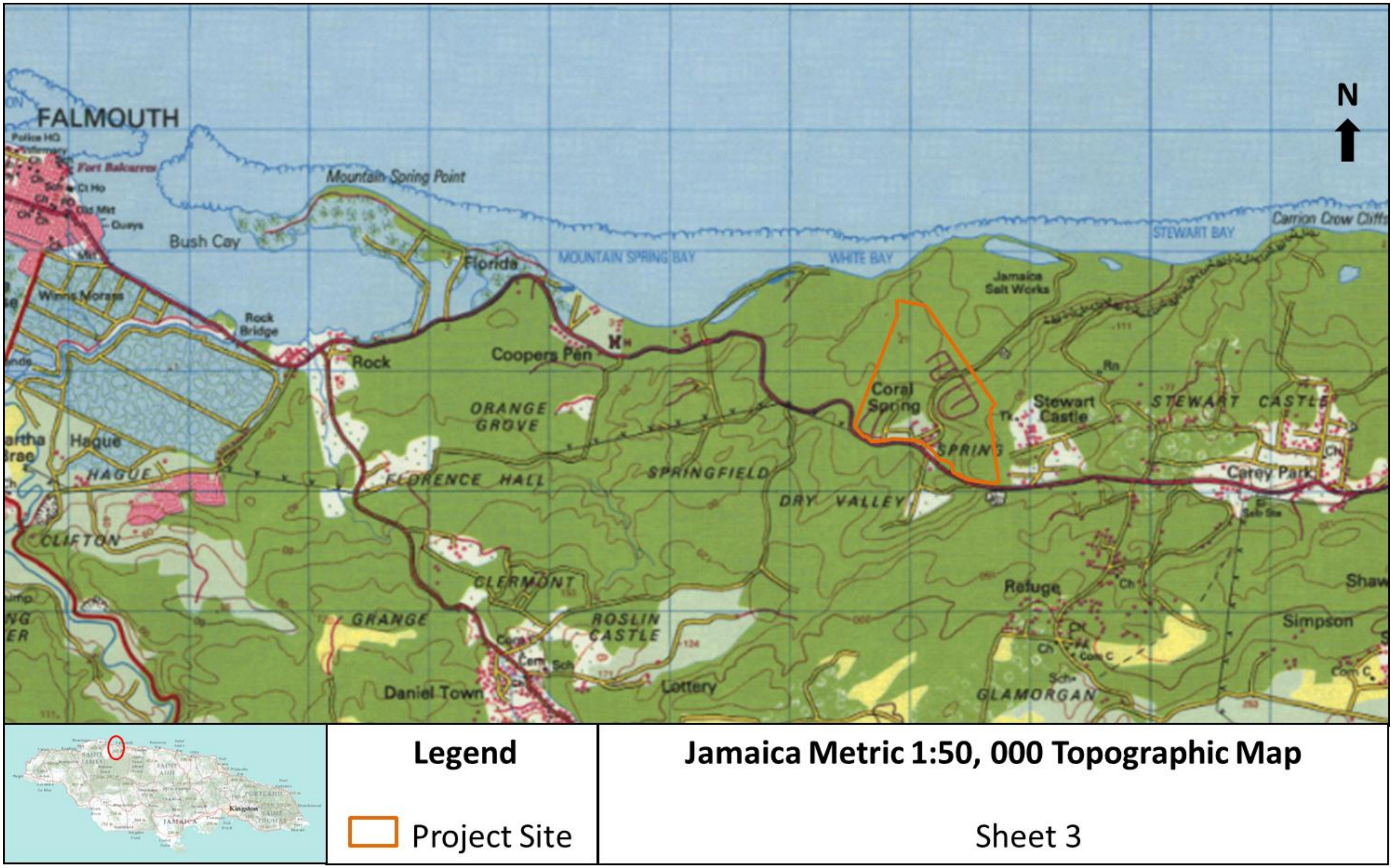


Figure 1.2: Location map of Coral Springs (Jamaica Map Series 1: 25, 000)

1.3 Background

The development concept conceived by the developers (GDL) is that of a housing development for families, individuals and senior citizens in a balanced environment. The developer understands the high importance of security for the inhabitants and in providing a regularized living with modern facilities, in a harassment free and healthy environment.

The Coral Springs property was approved for housing subdivision in 1964. It was slated for 380 lots of a minimum of 700 m^2 (8,000 sq. ft.). The project started along the highway with 39 lots being completed and handed over to the purchasers. Since then 26 lots have been built on while the others remain empty.

Soon after commencement, the project stopped for financial reasons and was never continued. Gore Developments purchased the land in 2008 from the Redevelopment Foundation, who had taken over the remainder of the property after failure of completion. The existing lots and houses are situated on approximately 16.8 acres (6.8 ha), while the remaining 169 acres (68 ha) of dry limestone forest is proposed to be developed for housing solutions by GDL. The current land use map is presented in Figure 1.3 and aerial photos in Plate 1.3 below.

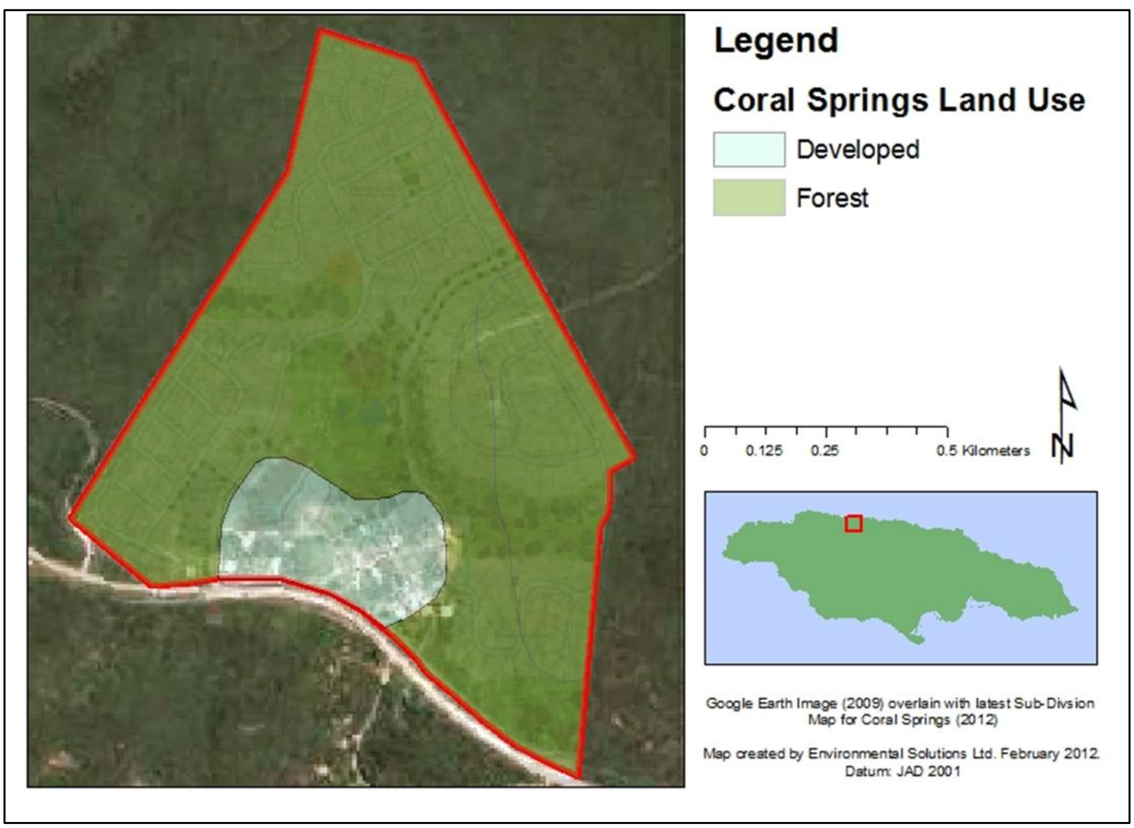


Figure 1.3: Landuse map of the Coral Springs property in 2012

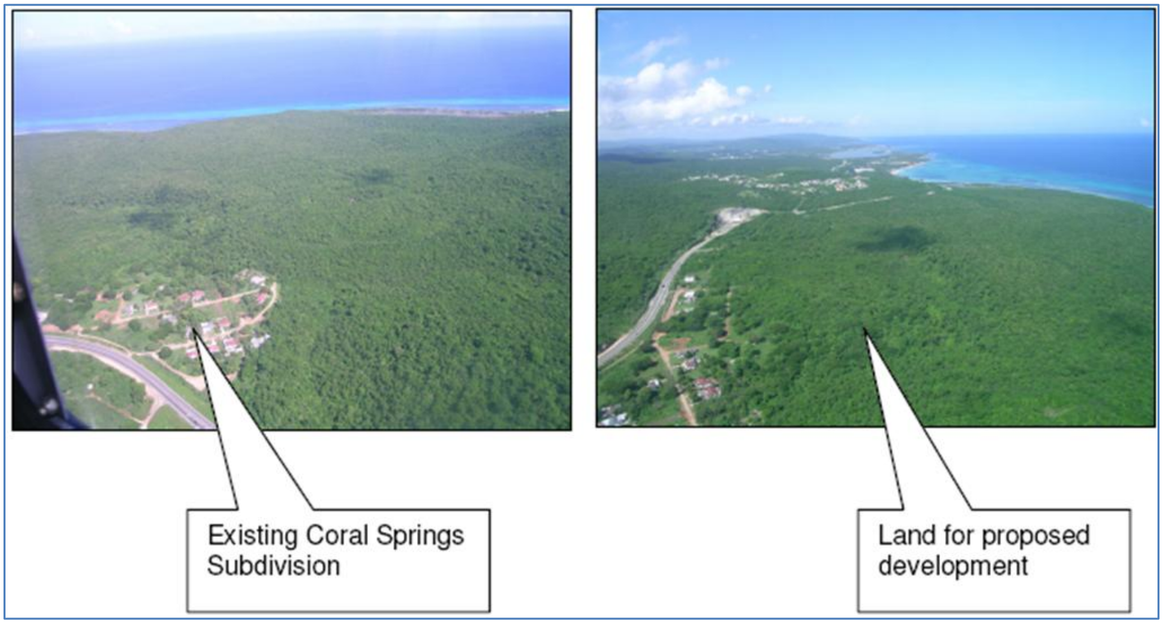


Plate 1.3: Aerial photos of the Coral Springs property (Left: Existing Housing Subdivision; Right: Land for development)

1.4 The Project Concept

The developers propose to create 543 residential lots, of which 401 lots will be housing solutions each featuring a single family, detached two bedroom dwelling. All lots will feature the required service connections of water supply, sewage treatment (some service lots will not be connected by the developer due to difficulties with the terrain, however the home owner will have the option of connecting), road access, overhead electricity supply and telecommunication services.

The main target group for the houses in this development project is the low and middle income market, including hotel and tourism related workers in light of the planned hotel and resort developments in this region. Some interest is also expected among the Jamaican diaspora and residents that have returned to Jamaica for retirement.

The community can be entered via the existing main entrance off the North Coast Highway, with a convenient turn at an 18 m wide road reservation and generous radii. This main boulevard will take residents and visitors into both the existing community and the new community.

Environmental and Planning Considerations:

The most conspicuous environmental feature on the site is a sinkhole, located centrally. It serves as the main control on surface drainage and acts as output control of the catchment system for Coral Springs and Dry Valley.

Further, a perennial spring located to the south of the North Coast Highway on the Dry Valley property provides constant flow to the sinkhole. The discharge from the sinkhole is via the groundwater system and through a network of interconnected conduits that discharge to the sea.

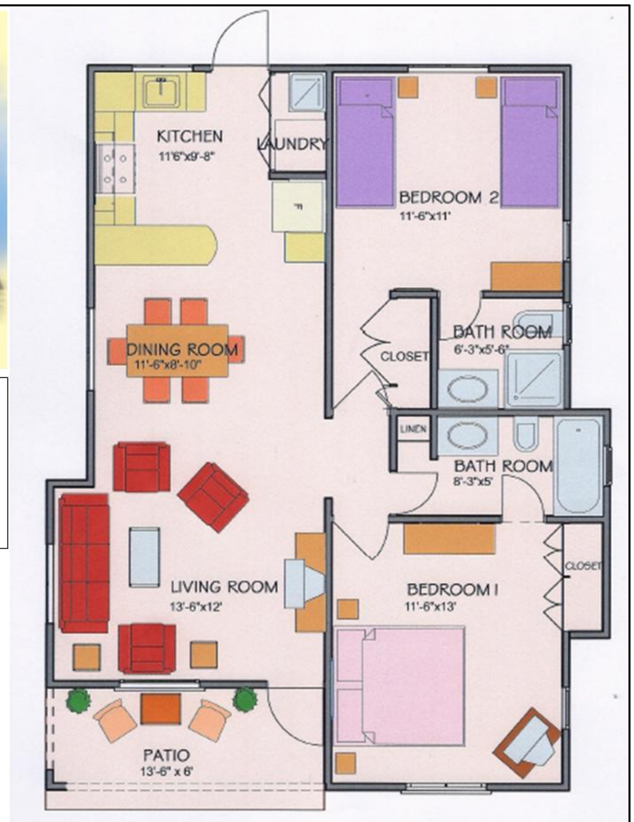
In order not to disrupt this crucial drainage network, the proposed development totally excludes the wider area around the sinkhole. A large green area allows for retention of surface water and undisturbed discharge.

Figure 1.4a: Subdivision Layout for the housing development at Coral Springs

The proposed layout (Figure 1.4) shows that the two major escarpments on the site will be retained in their original state. Environmentally, these undisturbed green areas will create buffers that serve to keep existing bird and vegetation population intact and provide a healthy space for people and homes.

The development features 40 acres of varying green and open spaces, whereas only 13 acres are required by the Development Manual for 543 houses. The community will enjoy a vast area of green buffers, ridges, hillsides and open spaces. Along with some centrally located landscaped parks allowing for a football field and other recreation, the development is proportionally very 'green' and of low density. In essence it will comprise four neighbourhoods separated from each other by green areas and topography changes.

Figure 1.4: Typical single family house (top) constructed by Gore Developments and floor plan of the proposed house (right).



1.5 Proposed Landuse

The proposed landuse for the project is presented as follows:

Property:		
Area of existing developed lots and houses:		
Total project area to be developed:	167.832acres = 67.9196ha	
Lots:		
Residential lots for 2BR houses: 4,500sqft (420m2) and larger	401)	533 lots
Service Lots 9,150sqft (850m2) and larger	132)	
Open Spaces:		
Parks and landscaped areas	26,956.65 m² = 2.695ha = 6.661ac	
Nature Reserves / Retention	130,186.06 m² = 13.018ha = 32.169ac	
Green Buffer	19,083.28 m² = 1.908ha = 4.715ac	
Total proposed Open Spaces:	17.622ha = 43.544ac	
Total required Open Spaces for 533 lots:	5.392ha = 13.325ac	
Road improvement and other Reserves:		
Reserves	13,750.66 m² = 1.375ha = 3.397ac	
Commercial Zone:		
Shopping Center	4,764.37 m² = 0.4764ha = 1.177ac	
Gas Station	1,987.63 m² = 0.1987ha = 0.491ac	
Total Commercial Zone:	0.6752ha = 1.668ac	
Basic School:	3,111.69 m² = 0.3111ha = 0.768ac	
Sewage Treatment Zones:	12,893.45 m² = 1.289ha = 3.186ac	

1.6 Project Infrastructure

1.6.1 Water Supply

The expected water demand for the proposed Coral Springs Development is 595 m^3/day (including the Commercial Complex). This is based on an average of 4.5 persons per lot. GDL has applied to the National Water Commission to allocate this amount of water to the project from the Martha Brae supply. The 16" distribution pipeline from this source runs adjacent to the project boundary in the North Coast Highway right of way.

1.6.2 Sewage Collection and Treatment

It is proposed that the sewage treatment facility for the project will include the use of septic tanks and constructed wetlands. Each lot will be provided with its own septic tank which is designed to a two day capacity and capable of providing primary treatment for an average of 4.5 people per lot. The sewerage collection designs include four street main collection systems (and sewage pump station design where required), each terminating in a separate constructed wetland. Effluent from the wetlands will be disinfected and directed to the central depression/pond onsite via an existing or newly constructed drainage channel.

Septic Tanks

The on lot septic tanks will have a minimum hydraulic retention time of 1.5 days; during which the COD and BOD will be reduced to 300 and 150 mg/l respectively. The septic tanks will also remove the majority of the TSS and fecal coliforms from the waste water (FCS Consultants, 2012b).

Sewage Effluent

The sewage effluent to be generated by the development will be treated in four separate constructed wetlands. The largest wetland will serve the northern lots and the smallest will serve the south eastern lots. The average sewage to be generated per lot is shown in Table 1.6.2a below.

Table 2.6.2a: Coral Springs Sewage Generation Estimate (FCS Consultants, 2012b)

No.	Description	Quantity
1	**South West Residential Lots**	**167**
2	Estimate of number of persons per lot	4.50
3	Population estimate	752
4	Water for commercial and light industry	125, 501 L
5	**Average sewage generation**	**178 m^3/d**
6	**North Residential Lots**	**229**
7	Estimate of number of persons per lot	4.50
8	Population estimate	1, 031
9	Estimate of Basic School demand	570 L/day
10	**Average sewage generation**	**222 m^3/d**
11	**East Residential Lots**	**87**
12	Estimate of number of persons per lot	4.50

No.	Description	Quantity
13	Population estimate	392
14	**Average sewage generation**	**84 m^3/d**
15	**South East Residential Lots**	**47**
16	Estimate of number of persons per lot	4.50
17	Population estimate	212
18	**Average sewage generation**	**45 m^3/d**

The level of sewage treatment being provided for this development is tertiary. The minimum expected influent and effluent quality is described in Table 1.6.2b. However, data from a similar biological treatment system at Florence Hall indicate that the level of treatment may regularly exceed these expectations.

Table 1.6.2b: Constructed Wetland Wastewater characteristics (FCS Consultants, 2012b)

Parameter	Units	Influent	Effluent
COD	mg/l	300	100
BOD	mg/l	150	20
TSS	mg/l	50	20
TKN	mg/l	35	10
P	mg/l	8	4
FC	MPN/100ml	10^5 -10^6	200

Constructed Wetlands

Constructed wetlands are engineered systems designed and constructed to utilize wetland vegetation to assist in treating wastewater in a more controlled environment than occurs in natural wetlands. The type of wetland chosen for sewage treatment at this site is subsurface flow. In subsurface flow systems, water flows through a porous media such as gravels or aggregates, in which the plants are rooted.

Plate 1.6.2: Constructed wetland at Florence Hall, Trelawny - May 2012.

Subsurface flow systems are most appropriate for treating primary wastewater because there is no direct contact between the water column and the atmosphere, hence eliminating any opportunity for vermin to breed. The system is therefore safer from a public health perspective. The environment within the subsurface flow bed is mostly either anoxic or anaerobic. Oxygen is supplied by the roots of the emergent plants and is used up in the biofilm growing directly on the roots and rhizomes, being unlikely to penetrate very far into the water column itself. Subsurface flow systems are good for nitrate removal (de-nitrification), but not for ammonia oxidation (nitrification), since oxygen availability is the limiting step in nitrification (FCS Consultants, 2012b).

Each constructed wetland is designed based on an application rate of 90 l/m^2 to have a minimum hydraulic retention time of 4 days; this is required to reduce the oxygen demand and nutrient levels to NEPA standards (FCS Consultants, 2012b). The reeds in the constructed wetland will be planted with one reed per square foot to ensure adequate plant density.

Nitrogen removal by wetland plants range from 0.2 to 2.25 g/ (m^2/day) using a removal rate of 1.1 g (m^2/day) over the total area (49 m^2). The Total Nitrogen in the effluent concentration will be below 10 mg/l.

Phosphorous removal by wetland plants ranges from 0.05 to 0.5 g/m^2/day. Using an average of 0.15g/m^2/day, the phosphorous will be below acceptable levels within the 4 days of retention. Phosphorous reduction will occur via plant uptake and sedimentation of PO_4.

Fecal coliform levels are expected to be reduced by an additional 2 logs in the constructed wetland. Chlorination of the final effluent will be undertaken since disposal is to open water.

The four constructed wetlands are all of varying sizes treating different amounts of effluent. Their locations are shown in Figure 1.4 above. The calculations for the sizing of the each sewage treatment wetland are included in Appendix III which describes the entire sewage treatment system.

The Constructed Wetlands will have a minimum area for 4.0 days retention. The Wetland areas will range from 500 to 2900 m^2. There will be three chlorination chambers. The effluent from the northern and eastern lots wetland will be chlorinated together. These sewage treatment wetlands combined with on lot septic tanks should provide an effluent which consistently meets NEPA 2004 standards.

1.6.3 Site Drainage

The project site is on hilly terrain with 65% of the property draining into an existing central depression which contains standing water up to 13 m AMSL (above mean sea level). This depression drains approximately a total area of approximately 315 Hectares (35.4 hectares of which is part of the project site). The remaining 35 % of the site drains northward overland towards the sea. The storm water will be conveyed via roadways and storm sewer to unpaved or stone lined earth drains that lead to the central depression. The sections of the site that drain northward will be directed into a naturally existing gully.

The central depression will be re-graded to mitigate against additional flooding of the site and hence increase its storage capacity and infiltration capacity. It is proposed that the hard brown clay that lies in the area above the standing water elevation (~13.3 m) be excavated (from the 13.5 m to 14.2 m contour area) and filled with compacted gravel and crushed limestone (FCS Consultants, 2012a). This area will then be vegetated for use as a park. Re-grading of this area is projected to reduce the flood levels up to 0.78 m in the 100 year storm. Hence post development flooding will not be increased

1.6.4 Communication and Electricity

Electricity will be provided by the Jamaica Public Service Company. The developer will ensure that overhead cabling is run within the subdivision from house to house.

The available private telecommunication providers in the region will be encouraged to supply the housing development with telephone, cable and Internet services.

1.6.5 Commercial Entity

It is proposed that a commercial area be developed near the western entrance to include a gas station which is believed to be much needed in the area (the nearest opportunity for gas is several kilometers away in eastern and western directions).

1.6.6 Education

A Basic School site is being earmarked for development by a private organization or church organization.

1.6.7 Recreation

The large central retention area doubles up as a floodplain as well as additional green area for use by residents. Several nature reserves will be left onsite: 1). between the northern and south western subdivision; 2). on the eastern escarpment of the eastern subdivision extending into the ravine that separates the eastern subdivision from the south eastern subdivision; 3). south of the south eastern subdivision.

1.6.8 Construction Practices

Concrete Dry Batching

The construction site will be equipped with a Concrete Batching Plant that combines various ingredients to form concrete during the construction phase of the proposed development. Some of these ingredients include 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.

Essentially the batching plant will consist of a weight hopper, conveyor, radial stacker, aggregate bin, and cement bin.

Plate 1.6.8a: Left - Concrete Batching Pant; Right – Mixer truck at a Concrete Batching Pant

The concrete batcher will store, convey, measure and discharge the constituents into a mixer truck for transport to each 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.

Also necessary for the efficient functioning of the batching plant is the need for a fuel dispensing facility. The client proposes the use of an Above Ground Storage Tank (AST) for the dispensing of diesel fuel for the concrete mixer trucks which will service the batching plant.

Diesel Storage Tank

The proposed diesel storage tank will have the capacity of 3000 gallons and will include a containment bund wall as stipulated by NEPA guidelines. The bund wall will be 3' 0" from ground level and the tank will be sited on a 6" thick well compacted marl and 6" thick C/C slab to support a pressure of 3000 psi. The slab detail includes a 6" block wall rendered, with each pocket filled with a 1:2:3 C/C mix.

Plate 1.6.8b: Example of a diesel facility used by Gore Developments

The leak detection system for the diesel storage tank will combine the following elements:

1. Daily visual tank and bund inspections. The storage area and fuel tank will be monitored daily to check for leaks or spilt fuel.

2. Stock reconciliation. Fuel gauges will be read daily to track stock levels and ensure losses are negligible. If a spill were to occur the capacity of the containment bund is sized to accommodate more than the volume of the fuel that is stored within the tank, and to restrict fuel contamination.

2.0 TERMS OF REFERENCE – HUMAN HABITATION PROJECTS

Background

Gore Developments Ltd has expressed a desire to establish a residential housing development at Coral Springs, Trelawny.

Further to consultation meetings through the Development Assistance Centre at the National Environment and Planning Agency (NEPA) a Technical Information Document (TID) was issued to the project proponents that indicated that given the location and scale of the proposed development and the sensitivities of existing environmental and ecological systems, and potential for natural hazard impacts, an Environmental Impact Assessment (EIA) would be required to support any decision regarding the proposed development.

A Draft Terms of Reference (TOR) was prepared by ESL following modification of the NEPA Generic TORs (Human Habitation Project) and submitted to NEPA (March 2012). After review of the proposed Draft Terms of Reference NEPA subsequently submitted their own Draft TORs (May 2012).

Following a meeting at NEPA on 18 May 2012 hosted by the CEO, the TORs were discussed, amended and submitted to NEPA. A subsequent review by NEPA requested further changes to the Draft TORs. NEPA agreed to the following TORs on 20 June 2012 (Appendix X).

1. Executive Summary

This section should allow for a clear, succinct understanding of the project proposal and summarize the significant results of the EIA study, e.g. positive and negative environmental, social and economic impacts, options considered, reasons for selection of the proposed option and the measures to be implemented to prevent or mitigate negative impacts or capitalize on positive impacts.

2. Introduction

Provide the context of the project and the EIA, the delineation and justification of the boundary of the study area, general methodology, assumptions and constraints of the study.

3. Legal, Policy and Administrative Framework

- Outline the pertinent legislation, regulations, policies and standards governing environmental quality, safety and health, protection of sensitive areas, protection of endangered species, siting and land use control at the national and local levels.

- The examination of the legislation should include the relevant international conventions, protocols and treaties where applicable (*inter alia* the Convention on Wetlands of International Importance and the Convention on Biological Diversity).
- All applicable legislation, regulations, policies and standards in relation to the construction and operation of the development should be highlighted, including but not be limited to other development permits such as Planning and Building.
- Describe traditional land use and prescriptive rights including public access rights.

4. Public Participation and Consultation

The proponent should consult with relevant entities and the public throughout the EIA process. Document the public participation. Describe the public participation methods, timing, type of information provided and collected from the public and stakeholder target groups consultations. Instruments used to collect the information must be included in the appendix.

Summarise the issues identified during the public participation process and discuss the public input that has been incorporated or addressed in the EIA.

Concerns that were raised by the public but not considered in the EIA must be justified.

Public Meetings shall be held in accordance with the Guidelines for Public Presentation at a time and location signed off by the National Environment and Planning Agency (NEPA).

Public meetings shall be held to present the findings of the EIA when it is completed.

5. Comprehensive Description of the Proposed Project

This should include but not be limited to the following:

5.1. The Proponent

This section should provide a description/profile of the company proposing to carry out the development project, profile of principals of the company, and business alliances of the company.

5.2. Project Concept & Description

This section should provide detailed description of the project including but not limited to:

- History and background of the project,
- Site location, site layout,
- Schematic plans,
- Description of project phasing,
- Proposed times of operation of the facilities,

- Construction methods and equipment,
- Construction materials

5.3. Project Infrastructure

Overview of the proposed infrastructure and structural components, including but not limited to the conceptual and preliminary design for:

- water supply & storage
- drainage
- sewage treatment and disposal
- solid waste disposal
- transportation systems
- communications & other utility requirements

5.4. Project Operations & Maintenance

Proposed operations and maintenance activities including but not limited to:

- equipment and machinery to be involved, and how these will be mobilized
- areas to be used for storage of machinery and material should be clearly indicated
- transportation systems or arrangement pre-, during- and post – construction
- health, safety and security systems

6. Description of the Existing Environment

An inventory and assessment of the natural resources in the study area will be conducted to indicate nocturnal, diurnal, seasonal, and annual conditions based on field studies and secondary data. The source of all data (existing or collected for the study) will be disclosed; who collected the information, when and where. All limitations and assumption made must be clearly stated.

The following aspects will be described in this section:

6.1. Physical

- Historical review of the area should be included
- Soils, geology and hydrology of the area, including but not limited to:
  - ✓geological structure & features – cave, fissures, sink holes, etc;
  - ✓flood impact assessment of the site
  - ✓faults on land and offshore as applicable
  - ✓bearing capacity
  - ✓slope stability
  - ✓permeability

- ✓assessment of the slopes
- ✓ Climate (wind and precipitation), run-off and drainage
- ✓ Air quality
- ✓ Water quality
- ✓ Identify source/s of freshwater, including potable water
- ✓ Existing built Infrastructure

6.2. Natural

Identify the potential for natural events to include but not limited to the following:

- ✓ hurricanes and storm surges
- ✓ earthquakes and tsunamis
- ✓ floods and landslides

6.3. Biological

Flora and fauna survey of the area and surrounding environment, detailed qualitative and quantitative assessment, including inventory (list) and distribution (map) of species.

A detailed description with qualitative and quantitative assessment of habitats and communities. Commentary on the ecological health and functions, threats and conservation significance of terrestrial and any significant marine habitats. Species inter-dependence, habitats/niche specificity and community structure and diversity must also be considered.

The field data collected shall include, but is not limited to:

- Species lists and distribution for each community (ecosystem) Migratory species, insects and micro-organisms should also be considered,
- A habitat map of the area

6.4. Heritage & Cultural

Conduct an assessment of the archaeological and cultural assets of the area –

- State whether the site is located in or adjacent to a protected area including heritage sites.

6.5. Social & Economic

- Demography, regional setting, location assessment and current and potential land-use.
- Description of existing infrastructure such as transportation, electricity, solid waste disposal; water and telecommunications, and public health and safety, recreational areas both passive and active, schools, commercial/shopping.
- Identify all existing resource users (including traditional users) ranging from subsistence utilization

of the natural resources to commercial activities.

- Public perception of the proposed project inclusive of potential impacts on social, aesthetic, historical and cultural values and any prescriptive rights for usage of the area.

7. Identification and Assessment of Potential Impacts

A detailed analysis of the various project components shall be done in order to identify the potential environmental impacts; negative and positive, direct and indirect, immediate and long term, reversible and irreversible, of the project at all stages - pre-, during- and post- construction.

The identified impacts must be profiled to assess the magnitude and importance of the impacts. The extent and quality of the available data shall be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. The impact must take in account the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Where possible, impacts must be quantified.

Each project activity or impact is to be assessed and ranked for both the magnitude and importance of the impact and presented in a weighted matrix for all the phases of the project, i.e. preconstruction, construction, and post construction/operational.

The impacts to be assessed shall include but not be limited to the following:

7.1. Physical

The impact of physical activities and elements on the environment are to be addressed:

- ✓ activities such as site clearance, earthworks and spoil disposal
- ✓ slopes
- ✓ source and use of raw natural materials
- ✓ land modification/change, e.g., sinkhole, drainage patterns
- ✓ operation and maintenance activities
- ✓ oil, chemical or hazardous material spills
- ✓ solid waste
- ✓ trade and sewage effluent; consider impact of proposal to discharge treated effluent in the storm water retention pond and impact on identified workable alternatives
- ✓ air quality
- ✓ noise
- ✓ Surface and ground water quality
- ✓ Impact on any supporting infrastructure
- ✓ Impact on access routes and transportation infrastructure
- ✓ Impact on visual aesthetics
- ✓ Impact on landscape

Demand/requirement of the following shall be described and also quantified:

- Water supply
- Drainage
- Sewage treatment and disposal; empirical data must be provided to show that the sewage treatment facility has the capacity to remove the nutrients to meet the National Sewage Effluent Standards;
- Solid Waste Disposal
- Communications and other utility requirements

7.2. Natural Hazard

- Impact of natural hazards: hurricanes, earthquakes, tsunamis, floods, landslides, etc., are to be analyzed.
- The natural hazard risk assessments must take into account climate change projections.

7.3. Manmade

Impact of manmade hazards on the environment and on operations of the development.

7.4. Biological

Direct and indirect impact on ecology and on the terrestrial habitats with emphasis on loss of any rare, endangered, and endemic species. This should include habitat loss, loss of special and natural features; and the impact of noise, vibration and light on fauna.

7.5. Heritage & Cultural

Impact on the heritage, archaeological or cultural use of areas identified in the assessment.

7.6. Social & Economic

- ✓ Effects on socio-economic status such as changes to public access and recreational use, impacts on existing and potential economic activities, contribution of development of surrounding communities and national economy.
- ✓ Safety and security arrangement
- ✓ Support staff needs

7.7. Carrying capacity

The impact on the carrying capacity for the proposed development is to be determined. Socio-economic and cultural assessment should examine the adequacy of the social facilities/ amenities in existing communities and impact of the development on them; it should identify the demand that will be created by the development; the facilities that will be required to cater to the demand created by the development should be stated.

8. Cumulative Environmental Impacts

The cumulative environmental impact shall take in account the carrying capacity of the area and the potential impact of related environmental issues.

In assessing the cumulative impacts of the development the EIA should examine possible impacts of the development on the surrounding area, i.e., physical, biological, social, etc.

9. Recommended Mitigation

- Mitigation and abatement measures shall be formulated for each potential negative impact identified.
- This will also include recommendations for the maximization and enhancement of beneficial impacts, energy conservation and the use of green technology

10. Residual Impacts

Identify any residual negative impacts for which no solution for mitigation has been proposed

11. Identification and Analysis of Alternatives

Alternatives to the site location, project design, scale, conditions of operation and technology shall be analysed including the “no-action” alternative. The examination of project alternatives should incorporate the use history of the overall area in which the site is located and previous uses of the site itself. These alternatives must be assessed based on the physical, ecological and socio-economic parameters of the proposed site. Justification for the selection of the chosen alternative(s) shall be included.

12. Environmental Management of the Project

12.1. Draft Environmental Monitoring and Management Plans

A draft environmental monitoring and management plan must be developed to detail the monitoring requirements for pre-, during- and post- construction and during the operational phases of the project; will include recommendations to ensure the documented implementation of mitigation measures and long term minimization of negative impacts and maximization of positive impacts; consideration should include soil erosion management plan based on the quantity of natural vegetation cover which may be removed.

At a minimum the draft monitoring plan shall include:

- ✓ Introduction outlining the need for a monitoring programme
- ✓ The activities being monitored and the parameters chosen to effectively carry out the exercise
- ✓ The methodology to be employed
- ✓ The sites being monitored. These should incorporate a control site where no impact from the development is expected
- ✓ Raw data to be collected and relevant Tables and Graphs to be used
- ✓ The frequency of monitoring and frequency of reporting to NEPA

12.2. Incident Response Plan

A plan for response to considered incident/s during and post construction that may have impact on the environment and or public health shall be prepared as appropriate.

12.3. Closure plan

A plan for closure of any proposed plants or system used during construction or during the operations of the development that may have effect on the environment and or public health shall be prepared as appropriate.

3.0 POLICY, LEGISLATIVE AND REGULATORY FRAMEWORK

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

- ✓ Wildlife
- ✓ Endangered species
- ✓ Sensitive habitats
- ✓ Environmental quality
- ✓ Rights of way
- ✓ Prescriptive rights
- ✓ Water resources
- ✓ Public health and safety
- ✓ Planning

<u>Policy</u>

- Draft Watershed Policy
- Draft National Environment Policy

Laws and Regulations

- The Natural Resources Conservation Authority Act (1991)
- The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996)
- Watersheds Protection Act (1963)
- Water Resources Act (1995)
- Quarries Control Act (1983)
- Wildlife Protection Act (1945)
- The Pesticides (Amendment) Act (1996)
- Clean Air Act (1964)
- Endangered Species (Protection, Conservation and Regulation of Trade) Act (2000)
- Trade Effluent and Sewage Regulations (1996) (Draft)
- Town and Country Planning Act (1958)
- Trelawny Development Order
- Land Development and Utilization Act (1966)
- Public Health Act (1976)
- National Solid Waste Management Authority Act (2001)
- Country Fires Act (1942)
- Land Acquisition Act (1947)
- Registration of Titles Act (1989)
- The Housing Act (1968)
- Draft Noise Standard

International Treaties

Name of Treaty	Date of Accession for Jamaica	Entry into Force for Jamaica
Convention on Biological Diversity, Rio de Janeiro, 1992	Jan. 6, 1995	April 6, 1995
Cartagena Protocol on Biosafety to the Convention on Biological Diversity, Montreal, 2000	Signed (June 4, 2001)	

4.0 METHODOLOGY AND APPROACH

4.1 General Approach

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.

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. The EIA team worked very closely with the Gore Developments Ltd project team members including the project manager, engineers and architects.

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

- Field studies
- Intrusive tests
- Analysis of maps, plans and aerial photos
- Review of reports (engineering, hydrology and geotechnical) and background documents
- Stakeholder consultations
- Laboratory analyses

4.2 Physical Environment

A definition of the study area was 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.

4.2.1 Climate and Air Quality

Long term climatological data for the Montego Bay Airport along with published literature on Trelawny climate were compiled and analyzed in context of the proposed development location.

Meteorological patterns such as wind direction in addition to topography and vegetation cover were used to determine the placement of air quality monitoring stations. The objective of the air quality monitoring exercise was to determine the baseline concentration of respirable particulates in the project area prior to construction works. Air quality measurements were taken at four sites in the project area. The sites are described in Table 4.2.1 and locations illustrated in Figure 4.2.1 below. The placement of monitors across the site was restricted by a combination of topography and thick vegetation that would limit realistic measurements.

The air quality assessment involved the measurement of ambient levels of respirable particulates, PM10 (<10 µm). Particulates were measured using Sensidyne (BDX 530) personal vacuum pumps (suction 2-3 L/min), attached to pre-weighed millipore filters. The pumps were placed at the approximate respiratory height of pedestrians for a 24 hour period at the four sites. 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 4.2.1: Air quality monitoring stations – Coral Springs

<table>
<tr><th>Sample ID #</th><th>Sample Location</th><th colspan="2">Description</th></tr>
<tr><td rowspan="3">AQ #1</td><td rowspan="3">N 18.48007
W077.58223</td><td colspan="2">~ 100 m up on Spring Hill (eastern hill slope) in the eastern end near the north eastern boundary; area cleared by surveying team.</td></tr>
<tr><td>February 7- 8, 2012</td><td>Dominated by tall open limestone forests; bird cries could be heard in the vicinity.</td></tr>
<tr><td>May 15-16, 2012</td><td>The area was much the same as the first visit.</td></tr>
<tr><td rowspan="3">AQ # 2</td><td rowspan="3">N 18.47566
W077.58086</td><td colspan="2">Top of south eastern slope ~ 10 m from southeastern border; tall open dry limestone forests</td></tr>
<tr><td>February 7- 8, 2012</td><td>adjacent to coal pits but no burning was observed</td></tr>
<tr><td>May 15-16, 2012</td><td>Coal burning and coal miners were observed in the pit downwind of the site to its west; coal burning was complete at the pit at the SE border (bags of coals seen)</td></tr>
<tr><td>AQ # 3</td><td>N 18.47577
W077.58677</td><td colspan="2">At the rear of second residential property in western section of original subdivision. The site conditions were unchanged on the second visit.</td></tr>
<tr><td>AQ # 4</td><td>N 18.47828
W077.58770</td><td colspan="2">In the western central section of the property ~ 100 m east of the western boundary. The site conditions were unchanged on the second visit.</td></tr>
</table>

Figure 4.2.1: Air quality (AQ) and water quality (WQ) monitoring site locations at Coral Springs

4.2.2 Drainage and Hydrological Assessment

The drainage and water supply studies were conducted by FCS Consultants, the engineering consultants on the project. Details of these studies are presented in Appendix V.

A hydrological and flood assessment was undertaken (Appendix V) with the objective of identifying the main hydrogeological controls at the site, with particular focus on the function of the depression/sinkhole and its impacts on site hydrology. The specific investigations carried out in the study included:

- Evaluation of the dimensional extent and genesis of the depression/sinkhole and based on the data available, its ability to repeatedly accommodate surface flows from the proposed development;
- Assessment of the factors controlling runoff at the site, from soil conditions, geology and the sinkhole;
- Identification of the depth to groundwater from published data and outline any impacts to groundwater from proposed development;
- Evaluation of any constraints imposed by the depression/sinkhole or otherwise geologically.

The assessment has been undertaken primarily using existing quantitative equations based on professional judgment and sinkhole management best-practice ordinances used in the United States and the United Kingdom on karst landscapes.

An assessment of the 100 year flood plain of the central sinkhole was also undertaken (Richardson, 2012).

The hydrogeological hazards were identified by overlaying the proposed development layout on the physical elements (such as soils, faults/earthquakes, depressions/sinkholes) that are known to exist at the site. From these essential strategic choices that need to be made as part of the decision-making process based on experience and professional judgment are outlined.

4.2.3 Water Quality

The water quality assessments were done to determine the baseline conditions of the water upstream of the sinkhole before it passes the houses, immediately before the drain enters the sinkhole after passing the houses, and two within the sinkhole itself. Typical parameters for ambient water quality such as organic loading, nutrients and bacterial levels formed the basis of laboratory analyses according to international quality standards. The methodologies for analysis of each parameter are described in Appendix VI.

The sinkhole is located at the lowest point of the site and is fully covered by heavy riverine/riparian vegetation. One sample was taken a few meters before the drain (the unnamed drain that comes from Dry Valley and passes through the existing housing scheme) enters the sinkhole and two samples were taken in the sinkhole at the north and south ends.

4.3 Natural Hazard Assessment

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 community and local agencies/authorities. 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.

4.4 Ecology

4.4.1 Vegetation Survey

Site visits to Coral Springs were conducted on Thursday, February 2 and Friday, February 3, 2012 to gather details on the terrestrial ecology of the site. Floral species were identified during these site visits which involved an exploration by vehicle and by foot of the borders, interiors and surrounding environs where accessible.

Species were classified using the DAFOR scale, a commonly used method for assessing plant populations combining subjective assessments of frequency and cover into five classes: Dominant, Abundant, Frequent, Occasional and Rare (Hill, 2005). Although DAFOR scales are subjective to each assessor, and therefore inaccurate for monitoring small changes over periods of time, it is an efficient method to gather general data on a large area (Hill, 2005). The species list is presented in Appendix VII.

4.4.2 Bird Count Methodology

For the assessment of Coral Spring area a total of 17 points was established to conduct bird counts. Six of these counts were conducted in the evening of February 10, 2012, and the remaining 11 were conducted the morning of February 11, 2012. To complement the fixed point counts, a total of five transect counts were conducted in the evening February 10, and another 4 transect counts conducted February 11.

The Fixed Radius Point Count Census method based on the principle of counting birds at a defined point or spot and determining the distance of each bird censured was employed in this survey. The method involves the random selection of a point followed by count of all bird contacts (seen and heard), with a determination of distance given (< 25 m or >25 m) for each contact. This was done for a predetermined time, 10 minutes, before moving to another point at a specified distance away (100 m – 200 m) (Bibby *et al.*, 1998). Points for this survey were no less than 50 m apart.

<u>Advantages of this method include:</u>

1. Greater concentration on the birds and habitats without having to watch where you walk (Bibby *et. al.*, 1998).
2. More time available to identify contacts (Bibby *et. al.* 1998)
3. Greater opportunity to identify cryptic and skulking species (Bibby *et. al.*, 1998)
4. Ease of relating bird occurrence to habitat features (Bibby *et. al.*, 1998).

Point counts are often preferred to other methods such as transects because (i) random points are easier to locate, whereas a transect route may bias the habitat sampled and (ii) habitat data can more easily be associated with the occurrence of individual birds (Bibby *et al*., 1992). Also, point counts offer an additional advantage in that birds are less likely to flee from a stationary observer. Thus, this method reduces the chance of overestimating the abundance of birds in open habitats (Douglas, 2001).

<u>Disadvantages:</u>

As with all survey techniques, there are weaknesses, which influence overall results. Below are some factors that affect the census technique aforementioned.

1. Time of Year – the change in behaviour of birds during the breeding and non-breeding seasons affect detection (Wunderle, 1994). This assessment was done in the non-breeding season when birds are less vocal.
2. Weather – factors such as wind, rain, fog and temperature affect the conduct of a census (Wunderle, 1994).

3. Summer Counts versus Winter Counts – dependent upon the time of year counts will incorporate not only resident species but also migrant species. During summer counts summer migrants (breeding or non-breeding) will be included, whereas winter counts will incorporate winter migrant species.

4.5 Human/Built 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 will have an important influence; similarly to examine the ways in which the local human environment might impact the project and can be supportive of it. The project was also examined within its wider regional setting.

4.5.1 Methodological Approaches

The methods employed included:

1. Desk Research
2. Rapid Rural Appraisal

Desk Research

The desk research involved review and analysis of all the relevant socio-economic data available from both recommended sources and other national sources in an effort to put the Project into its local context.

Included in the desk research were reviews of project specific documentation for example engineering and hydrological reports where they had been developed at the time of the study.

Rapid Rural Appraisal

This involved an initial reconnaissance, where the Consultants toured the project area to familiarise themselves with the site boundaries, landmarks and community locations. This also is critical as it presents the opportunity to meet key persons who are strategic in relation to the socio economic assessment and to note any features or establishments or activities that might warrant further investigation, such as: heritage elements, social capital, informal or unplanned settlements (including squatting), obvious forms of environmental degradation, tourism-related activity and business activity of significance.

Following the reconnaissance, the Consultants were then able to define a project zone of immediate influence based on the likely socioeconomic impact of the development in relation to:

- ✓ Its local environment and community setting
- ✓ The wider community it serves and will influence.

Stakeholder Interviews

This process involved 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 were conducted with targeted key informants. By untargeted it is meant that those respondents 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 in the order of 200 persons in total. This is normally more than sufficient to bring into focus those positive or negative impacts that the communities and stakeholders likely perceive of the project.

The survey tools are included in Appendix VIII.

4.5.2 Zone of Influence

In the case of Coral Springs the immediate zone of influence included the following near communities.

Main Towns

1. Duncans: This town is situated ~2.5 miles to the east of the project site and is the second largest town in the parish of Trelawny.
2. Falmouth: This is the parish capital and is not included in the individual descriptions of the impacted communities mainly because its size so diffuses any such impacts that they would be mainly speculative. Its impact on the project is likely to be beneficial in that as the parish capital, it provides goods and services and administrative control. The main negative social impacts by the project are related to its demand for social services.

Other Communities

1. Coopers Pen
2. Coral Springs
3. Retreat Heights
4. Stewart Castle
5. Carey Park
6. Refuge

The wider community in this instance included mainly the parish of Trelawny. Issues of land use, worker and residential population expansion and supporting social infrastructure were central to the investigations and interviews conducted.

4.6 Impact Assessment

The impact assessment was primarily on the basis of environmental components for the biophysical environment, and of socio-economic concerns in the case of activities, man-made structures, institutions or demographic-economic changes that may be brought about or needed by the project during construction and operational phases. Each potential impact for construction and operation of the development was assessed in terms of the following criteria that are internationally applicable:

- Magnitude of impact – this assessment measured the size of the impact
  - ✓ Significant
  - ✓ Insignificant
  - ✓ Major
  - ✓ Minor
- The nature of the impact – this explains how the environment will be affected and by what activities (site clearance activities, construction, operation).
- The spatial extent of the project impacts.
- The duration:-
  - ✓ Short term 0-5 years
  - ✓ Medium term 5-15 years
  - ✓ Long term – lifespan of the project
- Direction of impact:-
  - ✓ Positive
  - ✓ Negative
- Permanence:
  - ✓ Reversible
  - ✓ Irreversible

5.0 THE EXISTING ENVIRONMENT

5.1 Physical Environment

5.1.1 Climate

The climate of the general Falmouth area, like the rest of Jamaica, is subtropical with gentle to moderate northeasterly prevailing winds and average daily temperatures varying from 23^0C in January to about 28^0C in July. Humidity ranges from 66% to 87% with a significant diurnal variation resulting in high morning humidity dropping off significantly in the afternoon.

The long term (1951-1980) mean annual parish rainfall for Trelawny is just over 1600 mm. The 30-year monthly mean rainfall ranges between 69 mm (minimum) to 222 mm (maximum). The drier period is December to March where the long term average rarely exceeds 130 mm. Rainfall data from the Meteorological Office over the period 1951 - 1980 indicates mean monthly rainfall for Falmouth in the order of 85 mm with a high of 163 mm in November and 105 mm in May. There are two distinct periods of higher than average rainfall from October to January and during May.

Northers that form over the North American continent produce slow moving cold fonts that approach the island from the north and bring with them rainfall that can persist for days.

During the period June to November each year extreme weather conditions can be influenced by tropical systems that develop in the North Atlantic and Caribbean Basins. These systems are typically tropical storms and hurricanes that move westwards through the Caribbean region generating intense rainfall of long duration. In addition to the rainfall, tropical storms or hurricanes are usually accompanied by high velocity winds.

Models produced by the Inter-Governmental Panel on Climate Change, project that more intense tropical systems are likely to affect the Caribbean Basin over the next 50 years or less. The Climate Studies Unit at the University of the West Indies also project that Jamaica will experience less rainfall over the next century but that short duration events will be more intense; that is more extreme weather events are likely to affect Jamaica. The full extent of the implications of climate change for the project site would be better appreciated by interpretation of the downscaling projections made at the parish level.

5.1.2 Air Quality

The site is heavily forested with the exception of the housing development to the south and the access roads. As such it is expected that the air quality would be of fairly high standard. All the monitoring data recorded respirable particulate matter (PM10) significantly below the national outdoor standard (Table 5.1.2). Site 3 which was located in the existing housing scheme showed the highest particulate matter which is likely due to its proximity to the North Coast Highway. The monitoring site most northerly and located in heavy forest (except for the surveyors track) had the lowest value indicating the filtering capacity of the thick vegetation. The site is also surrounded by vegetation which adds to the filtering potential of air pollutants. The vegetation ecosystem service of filtering pollution therefore is fundamental to the integrity of quality air parameters.

Table 5.1.2: Respirable air quality data for Coral Springs 2-3 February 2012

Sample ID	Location	Monitoring Results /µg/m³		NEPA 24 Hr Guideline µg/m³
		07.02.12	16.05.12	
Site #1	~ 100 m up on Spring Hill (eastern hill slope) in the eastern end near the north eastern boundary; area cleared by surveying team.	13.2	43.9	150
Site # 2	Top of south eastern slope ~ 10 m from southeastern border; tall open dry limestone forests	25.0	41.8	
Site #3	At the rear of second residential property in western section of original subdivision. The site conditions were unchanged on the second visit.	51.4	35.9	
Site # 4	In the western central section of the property ~ 100 m east of the western boundary. The site conditions were unchanged on the second visit.	22.2	42.1	

5.1.3 Topography

The site is located within the north-eastern subdivision of the larger Martha Brae Watershed Basin. The property is largely unremarkable, being a part of the larger karst hills on the fringes of the Cockpit limestone. Jamaican topographic maps available show that the elevation ranges from 76 m at its highest point along the eastern boundary (Spring Hill) to 9 m at its lowest in the region of the sinkhole. The landscape is heavily fault-controlled with two major escarpments (>30°), one north and one east of the sinkhole (Figure 5.1.3). A further steep slope is located in the southeastern section of the property.

The slopes along with the remainder of the site were assessed in a Geotechnical investigation (NHL Engineering, 2012).

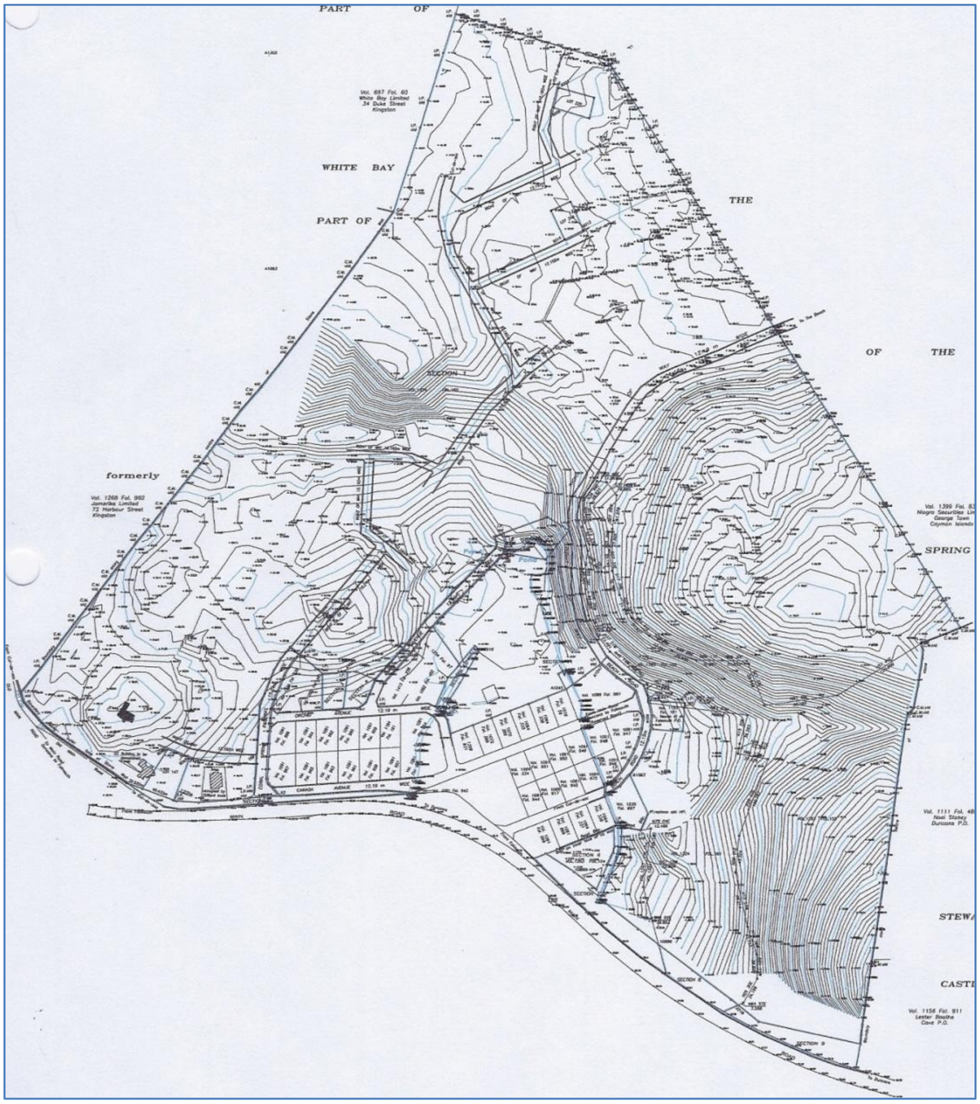


Figure 5.1.3: Topography map of the Coral Springs property in Trelawny.

5.1.4 Soils and Geology

Plate 5.1.4: Limestone rock outcrop on the western section of the site

The site is overlain by a thin veneer of soil on the steep slopes and hills with a greater depth of soil accumulating within the sinkholes. The soils are classified as Bonnygate Stony Loam and are described as "rapidly" internal draining soil. The results of the geotechnical investigation reveal that the soils are classified as dense calcareous gravels and sands in a clay/silt sized matrix (powder).

Intrusive soil borings performed in February 2012 advanced six of seven intended boreholes to depths of up to 15 m (50 ft) (Figure 5.1.4a). The report prepared by NHL Engineering Ltd (March 13, 2012) shows weathered soils (silty clays and gravels) in the vicinity of the existing pond up to 20 m depth in BH#3 and up to 5 m (15 ft) in BH#4. The remaining boreholes encountered heavily fractured limestone from surface requiring coring either at surface or within 1.5 m (5 ft) of surface. Borelogs are illustrated in Appendix V.

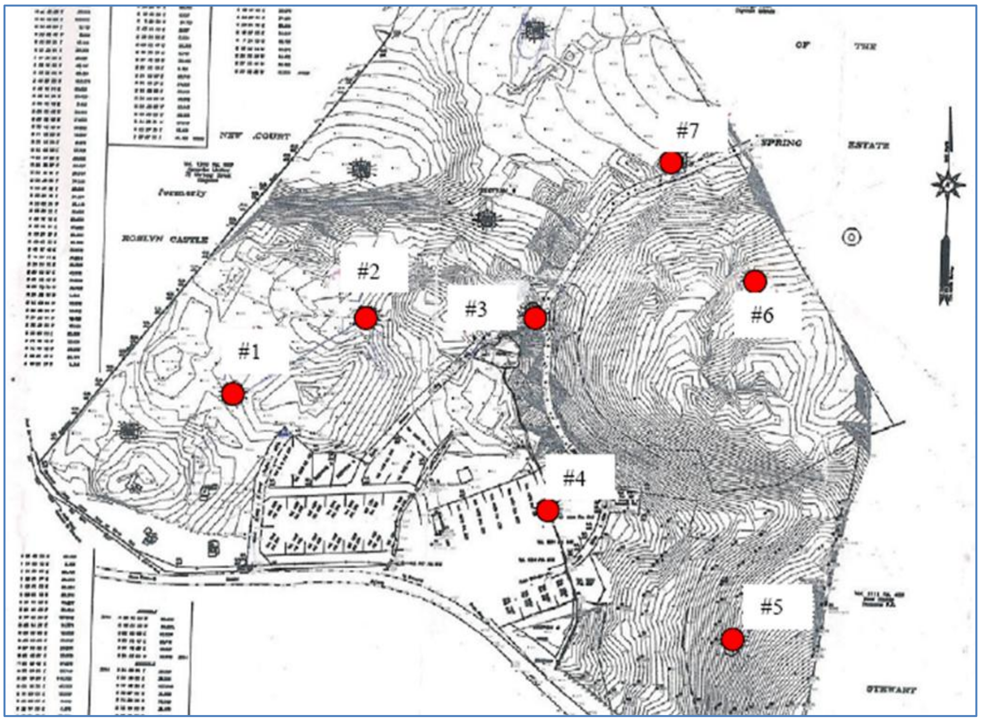


Figure 5.1.4a: Borehole locations on the Coral Springs property (Source: NHL Engineering, 2012)

Published geological information (Geological Sheet 08, 1:50,000 Imperial Series) indicates that the majority of the site is underlain by the Miocene aged Montpelier Limestone Formation (Mm). The Montpelier Formation is the youngest member of the larger White Limestone Group and comprises well bedded white chalks (Plate 5.1.4) with abundant flint nodules with some grey silty limestone clay in the lower portions. It is up to 460 m (1500 ft) thick. The Montpelier Limestone has extensive secondary openings (i.e. caves) due to the enlargement of fissures over time by percolating waters. These secondary solution fissures are likely to occupy the upper 5 m of the bedrock and result in a significant increase in porosity in the upper zones of the bedrock. The site geology is shown in Figure 5.1.4b below.

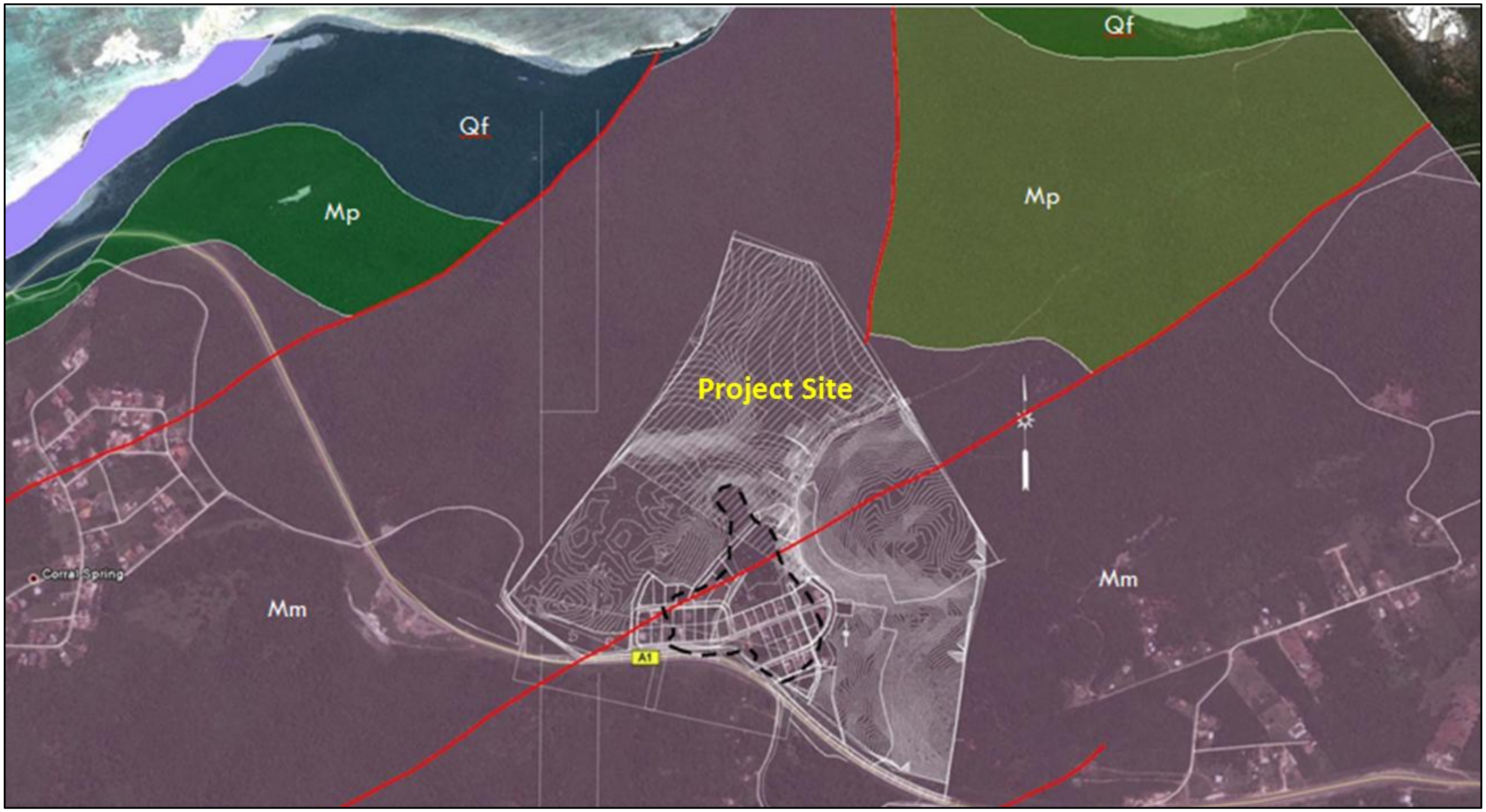


Figure 5.1.4b: Extract of geological map No.8 showing the bedrock geology underlying the site and its immediate surroundings. Mm – Montpelier Limestone Formation; Mp – Older reefs, marls & limestone; Qf – Falmouth Formation. Solid red lines denote geological faults. Black dashed lines denote the sinkhole 50 ft. contour lip from the 1:12,500 topographic sheet 51D. Image adapted from Google earth. Image date July 3, 2009.

Karst Features

The site investigation showed evidence of significant fractures and mature karstification of the limestone with a central well-defined sinkhole/depression on the property. The engineering karst classification is a Type kIII Karst (Figure 5.1.4c). The diagnostic karst landform is determined by "the closed depression formed where the ground surface has eroded around an internal drainage point into the underlying limestone" (Waltham and Fookes, 2008). The type of sinkhole is classified as a dissolution sinkhole formed by the slow dissolutional erosion of the heavily faulted Montpelier Limestone aided by small scale collapse to the water table. The surrounding landscape is dominated by repetitive conical limestone hills surrounded by smaller enclosed depressions, typical of tropical Cockpit Karst.

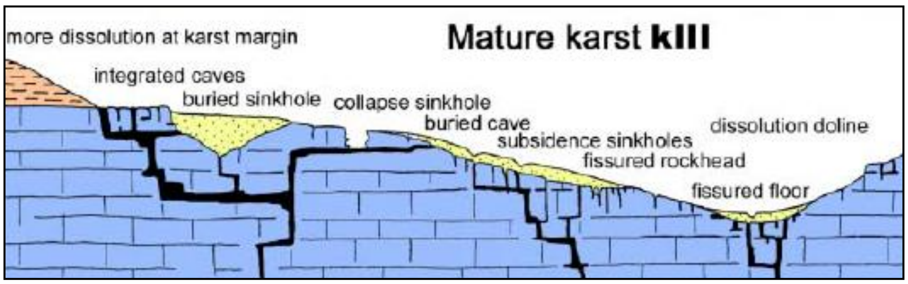


Figure 5.1.4c: Typical morphological features of karst conditions associated with mature karsts (kIII).

Structural Geology and Slopes

Structurally, there are several parallel north east trending regional faults in the Falmouth area, one of which bisects the project site (Figure 5.1.4a). This fault gives rise to the steep slopes along the base of the eastern conical hill and is likely to be the main factor in the formation of the site's dissolution sinkhole - due to percolation of water along the fault plane and other stress-relief fractures which results in an increase in the permeability of the limestone. Limestone bedding typically dips to the south west at about 25° toward the sinkhole.

5.1.5 Surface Hydrology

The site's principal drainage direction is completely controlled by the central sinkhole with all temporal drainage lines discharging to it. Fractures in limestone bedrock also affect drainage in its immediate vicinity. The sinkhole also provides runoff outlet from Dry Valley to the south and portions of the North Coast Highway. In total the sinkhole drains an area of approximately 315 hectares. The North Coast Highway separates the southern catchment (the Dry


Plate 5.1.5: Channel from the spring leading into sinkhole

Valley side) from the sinkhole and acts as a physical barrier to surface flow. The southern flows are channeled via a culvert beneath the highway to the sinkhole. Deep flooding on the south side of the highway is historically known, as discussed, in Section 6.0.

An unnamed spring emerges from the base of the hill south of the highway at about the 50 m elevation and drains to the sinkhole through a concrete conveyance beneath the highway. This spring is perennial, but it is understood that there are several temporal springs that emerge at the base of the hills and drain to the sinkhole during significant rainfall events.

5.1.6 Hydrogeology

The Water Resources Authority (WRA) classifies the geology underlying the site as a Limestone Aquiclude which underlies the entire site. Groundwater levels based on a well sunk at Stewart Castle (1 mile east of site) averages about 6 m ±1.7 m above sea level (asl) based on readings from 1965 to 1967. Historical records indicate that other temporal springs emerge from the base of the hills at Coral Springs. These temporal springs are likely to discharge to the sinkhole as this is the lowest spot within the catchment.

The perennial spring described above provides constant baseflow to the sinkhole. Its flow measured at the concrete U-drain under the roadway during site investigation ranged between 0.005 - 0.007 m^3/s. Figure 5.1.6 shows several images of standing water within the sinkhole.

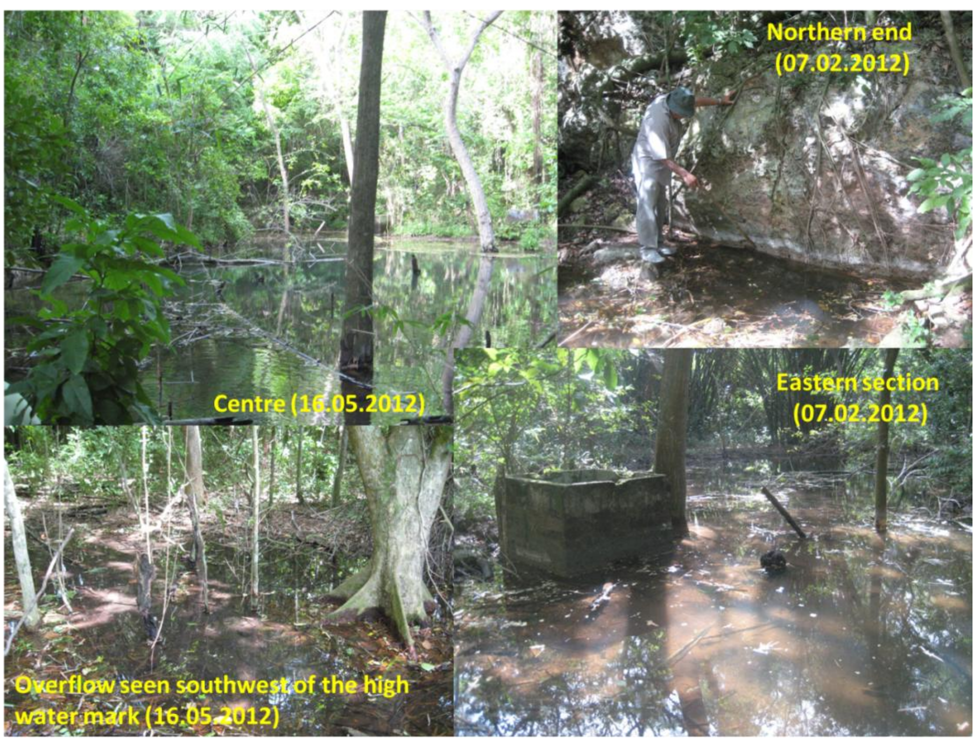


Plate 5.1.6: Images of the sinkhole area. Images dated February and May, 2012.

Surveyor spot heights record the lowest point in the sinkhole at 8.7 m. This places the base elevation of the sinkhole below the average groundwater table and consequently this will result in standing groundwater being permanently present within the sinkhole. The geometry of the sinkhole suggests there are possibly two to three base levels to the sinkhole. The significance of this is not presently clear, but suggests the collapse process to groundwater level developed three distinct "floors" to the sinkhole over time with its ultimate rim being defined by the 15 m (50 ft.) contour. This sinkhole is water-table dominated and geologically controlled and classified as a hybrid structural/baselevel polje. It is a sinkhole where in effect the karst surface has been lowered to the regional water-table and forced by geological controls (faulting). Such sinkholes develop on the outlet side of karst systems with the sea forming the output boundary threshold in this catchment. The denudation to the water-table is likely the reason for the exposure and surface flow of the once subterranean unnamed stream. Seasonal and major storm inundation is characteristic of such outlet sinkholes.

Further evaluation of the karst landscape during the site investigation indicates several fractures and fissures that form the larger network of secondary porosity within the White Limestone that surrounds the sinkhole. Fissure/fracture spacing taken on-site ranges between 0.5 m to 10 m with apertures (opening of the fissures/fractures) between 5 mm to over 10 cm. This suggests that groundwater flow within the limestone is a combination of fracture flow in the upper zones and conduit flow within the deeper zones. Typically in fractured limestone these upper fractures are not well connected to each other but are well connected to the larger and deeper conduits (or tubes) through which groundwater flows.

Based on Kiraly's nomographs for determining hydraulic conductivity using aperture spacing and fracture density for various fracture networks (Kiraly, 2002), the estimated hydraulic conductivity of the upper limestone is between 10^{-4}m/s to 10^{-3}m/s (360 mm/hr to 3600 mm/hr). However, natural conditions are more complex than these modeled figures because of uneven openness, roughness of fractures and infilling of fissures/fractures with roots and soil detritus, etc. Based on information from the ODPEM Regional Officer, (Mr. Haye, pers. comm.), that the sinkhole drains after heavy flooding within 1-2 days, scoping calculations suggest a hydraulic conductivity of between10^{-5} m/s to 10^{-4} m/s (36 mm/hr to 360 mm/hr). Detritus infilled fractures will tend to skew fracture flow performance towards lower hydraulic conductivities.

The sinkhole is the main control on surface drainage and acts as output control on the catchment system for Coral Springs and Dry Valley. The working conceptual model of the site suggests that site runoffs from both Coral Springs and Dry Valley are directed into this sinkhole and transmitted through the groundwater system through a network of interconnected conduits. When stormwater runoff exceeds the capacity of the sinkhole, flooding occurs. The output efficiency of the sinkhole appears to be controlled by the intersected water-table and the flow parameters within the subsurface conduit network. Maintaining the outlet efficiency of this sinkhole will be critical to stormwater management within the catchment.

5.1.7 Hydrological/Flood Assessment of the Sinkhole

To evaluate the potential of the sinkhole to accommodate the predicted runoff from the development, international best-practice requires the determination of the ability of the sinkhole to contain the 100-yr frequency, 24-hour storm. The assumptions included pre-development site conditions and a plugged sinkhole outlet (0 outflow), and no evaporation (i.e. all rainfall becomes runoff) without flooding any structures (Richardson, 2011). This defines the 100-yr sinkhole flood elevation for the particular sinkhole. The results of the evaluation of the Coral Spring sinkhole is presented in Tables 5.1.7a and b below:

Table 5.1.7a: Coral Springs catchment runoff evaluation (FCS Consultants, 2011)

Watershed Variable	Pre-Dev: Coral Springs & Dry Valley (ML)	Post-Dev: Coral Springs only (ML)	Post-Dev: Coral Springs & Dry Valley (ML)
Total Watershed Runoff 100yr	164	152	221

The calculated incremental storage volume for the sinkhole presented in Table 5.1.7b is determined by using the volume formula for the frustum of a cone. The areas at different elevations (taken from the recent topographical surveys) are the areas at the top and bottom of the cone frustum and the storage calculated is the incremental volume storage between each elevation. The elevations are determined from the 9 m contour up to the "rim", or lip, of the sinkhole as determined from the published 1:12,500 topographic sheet 51D. From the topographic sheet the sinkhole lip is clearly demarked as occupying the 15 m (50 ft) contour. The site investigation gave no evidence to suggest that that determination should be adjusted. It is clear that encroachment into the sinkhole floodplain has occurred previously and is likely to be a contributing factor for the flooding of houses during significant rainfall events.

Table 5.1.7b: Incremental storage of sinkhole based on existing contours

Elevation (m)	Area Inside Closed Contour (m^2)	Incremental Storage Volume (ML)	Cumulative Storage Volume (ML)
9	278	n/a	n/a
10	518	0.4	0.4
11	2370	1.3	1.7
12	7699	4.8	6.5
13	15688	11.5	18.0
14	21855	18.7	36.6
15 (rim of sinkhole)	36905	29.0	65.7
16	58072	47	112.8

The 100 year floodplain elevation is determined by the cumulative volume that is equal to, or exceeds, the total watershed runoff of 138 ML (Richardson, 2012). Even at the 16 m contour, outside the marked sinkhole lip, the undeveloped 100yr runoff is not contained within the sinkhole without overflow. Post-development the watershed runoff for Coral Springs only and both Coral Springs and Dry Valley are very nearly double and triple the cumulative storage of the 16 m contour. This demonstrates clearly that the

100yr pre- and post-development watershed runoff would not be contained within the sinkhole without overflow or modification.

To achieve a sustainable stormwater management plan volume cuts within the sinkhole footprint will be undertaken by GDL to increase sinkhole storage volume and reduce flood risk. The drainage design report (Appendix III) presents more details on the proposed modifications. The incremental storage volumes, assuming zero outflows, were calculated as presented below:

Table 5.1.7c: Incremental storage of sinkhole based on GDL volume cuts to increase sinkhole storage volume

Elevation (m)	Area Inside Closed Contour (m^2)	Incremental Storage Volume (ML)	Cumulative Storage Volume (ML)
11	6614	n/a	n/a
13	16191	22.1	22.1
14	31546	23.4	45.5
15 (rim of sinkhole)	39893	35.6	81.2
16	61045	50.1	131.2
17	92300	76.1	207.4

Table 5.1.7c shows that the post-development runoff from developing Coral Springs only will be just slightly larger than the expanded 17 m contour under plugged conditions. The plugged condition is the most conservative case. However, there is evidence, for historical drawdown for the Coral Springs sinkhole. Based on this historical drawdown time and estimated hydraulic conductivity of the limestone, FCS Consultants predict that sinkhole floodplain will not extend beyond the 16 m contour under the post-development scenario of Coral Springs (Richardson, 2012).

5.1.8 Water Quality Assessment

The spring from Dry Valley to the south of the property was monitored for ambient water quality parameters based on NRCA Standards at two points – one from the Dry Valley side and ~ 20 m before it enters the sinkhole at Coral Springs – both in the dry season (February) and the wet season (May). The sinkhole was also monitored at two points – the northern and the southern ends. The results of the water quality assessments conducted at the site are presented in Table 5.1.8 below. High total suspended solids values of the spring on Dry Valley and before it enters the sinkhole are the result of the shallow nature of the stream.

Based on the results obtained the data suggests that there is some impact of the existing Coral Springs subdivision/housing estate on key quality parameters. Most of note is the biochemical oxygen demand which is very low on the Dry Valley side but then increases significantly after passing the existing houses on Coral Springs. The values for BOD are lower in the sinkhole indicating that there is a possible dilution effect here.

Faecal coilform a sub-group of total coliform found in the intestines and faeces of warm-blooded animals are normally used as indicator organisms for harmful pathogens. Faecal coliforms are unusually high on the Dry Valley side particularly as there is no evidence of recent human settlement in the area.

The nutrient (nitrate, phosphate and sulphate) levels at all sampling stations are within the NRCA standards and at low levels.

Metals such as iron and lead were unusually high in the spring at Dry Valley, and also at the point just before the spring enters the sinkhole. Although the presence of excess heavy metals in surface water systems can be the result of both natural and anthropogenic factors it is likely that there is a source of pollution in proximity to the waterway leading into the sinkhole. The houses in the existing Coral Springs Estate are not connected to a central sewage treatment system but use septic pits for disposal of waste waters. This is a potential source of pollution and contributing factor for the increases in certain water quality parameters in the spring after it passes the housing area.

Table 5.1.8: Water quality of the drain leading to the sinkhole and the sinkhole (February and May 2012).

Parameters	Sample Location								NRCA Ambient Water Standard
	Drain on Dry Valley side (before Coral Springs Houses)		Drain ~ 10 m before entering sinkhole		Sinkhole South		Sinkhole North		
	07.02.12	16.05.12	07.02.12	16.05.12	07.02.12	16.05.12	07.02.12	16.05.12	
pH	7.83	7.83	7.95	7.72	7.91	7.80	7.80	7.77	7.00 – 8.40
Conductivity (mS/cm)	0.28	0.537	0.28	0.434	0.46	0.462	0.23	0.456	0.150-0.600
Biochemical Oxygen Demand (mg/L)	1.6	2.9	23.2	6.3	2.1	2.7	2.9	2.5	0.8 – 1.7
Total Suspended Solids (mg/L)	15.2	19.7	5.4	14.4	<2.5	<2.5	3.6	<2.5	-
Nitrate (mg/L)	0.9	3.1	0.4	-	0.9	2.2	0.4	1.8	0.10 – 7.5
Phosphate (mg/L)	0.02	0.07	0.05	0.04	0.10	0.03	0.11	0.07	0.01 – 0.8
Sulphate (mg/L)	4	4	4	6	4	7	4	6	3.0 – 10.0
Faecal Coliform (MPN/100ml)	1100	280	460	1600	240	540	240	430	-
Total Coliform (MPN/100ml)	≥2400	>1600	≥2400	>1600	460	>1600	≥2400	>1600	-
Lead (µg/L)	<20	<20	<20	87	<20	<20	<20	<20	-
Iron (µg/L)	212	37	91	407	41	82	85	64	-
Copper (µg/L)	<10	<10	<10	<10	<10	<10	<10	<10	-
Zinc (µg/L)	<10	<10	<10	15	<10	<10	<10	<10	
Dissolved Oxygen (mg/L)	7.91	-	7.91	4.83	7.17	4.95	7.71	-	-

Parameters	Sample Location								NRCA Ambient Water Standard
	Drain on Dry Valley side (before Coral Springs Houses)		Drain ~ 10 m before entering sinkhole		Sinkhole South		Sinkhole North		
	07.02.12	16.05.12	07.02.12	16.05.12	07.02.12	16.05.12	07.02.12	16.05.12	
Oil and Grease (mg/L)	<1	2	1	1	<1	<1	<1	4	-

5.2 Natural Hazards

5.2.1 Storms and Hurricanes

Tropical depressions, storms and hurricanes (Figure 5.2.1a) typically occur during the June to October period which is typically branded as the Hurricane Season in the Northern Hemisphere. Jamaica is susceptible to hurricanes and other storm events as indicated by the historic hurricane tracks (Figure 5.2.1b). 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 5.2.1c) at this time. However the storms may occur at any time during the season and have also been known to form outside of the stated season.

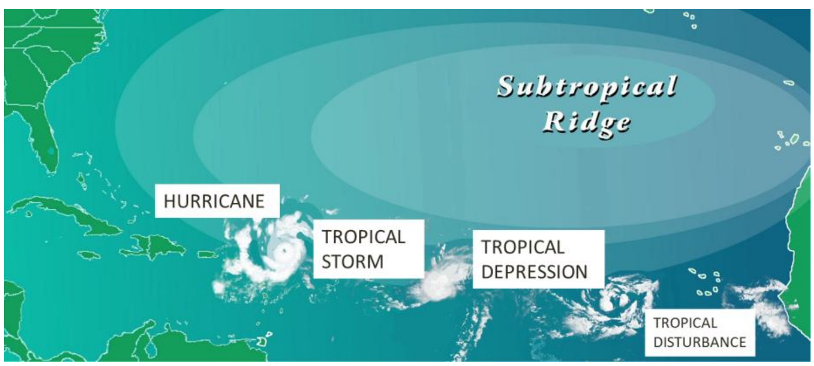


Figure 5.2.1a: Development stages of a tropical cyclone/hurricane

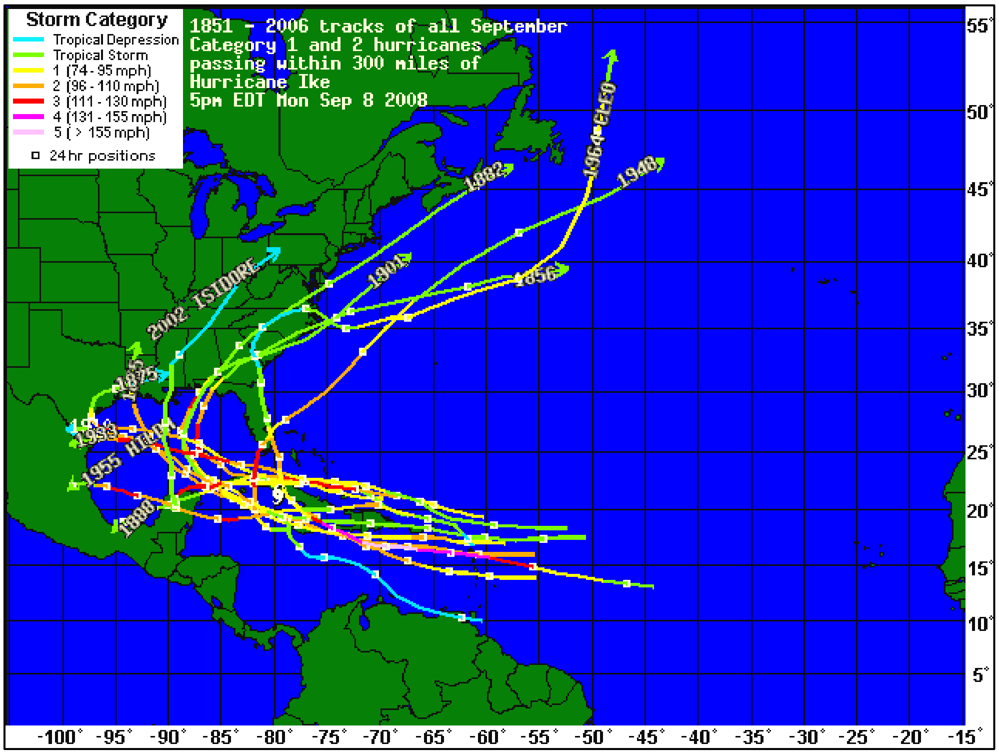


Figure 5.2.1b: Historic hurricane tracks across Jamaica – 1880-2006

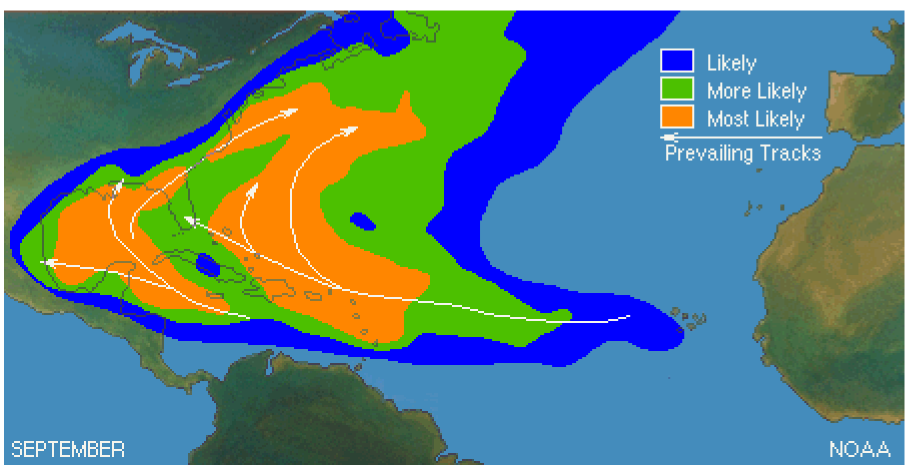


Figure 5.2.1c: Typical Atlantic Basin hurricane tracks in September

Coral Springs like most other communities in Jamaica has some measure of vulnerability to the effects of a tropical storm and hurricane. The currently settled area is already flood prone and will hence be impacted by heavy rains associated with these systems particularly due to the steep slope of Spring Hill (eastern hill) which will contribute much run-off into areas downslope.

5.2.2 Seismic Hazard

The seismic hazard map of Jamaica (Figure 5.2.2) shows that the project site lies in an area that can expect a Modified Mercalli Intensity (MMI) 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].

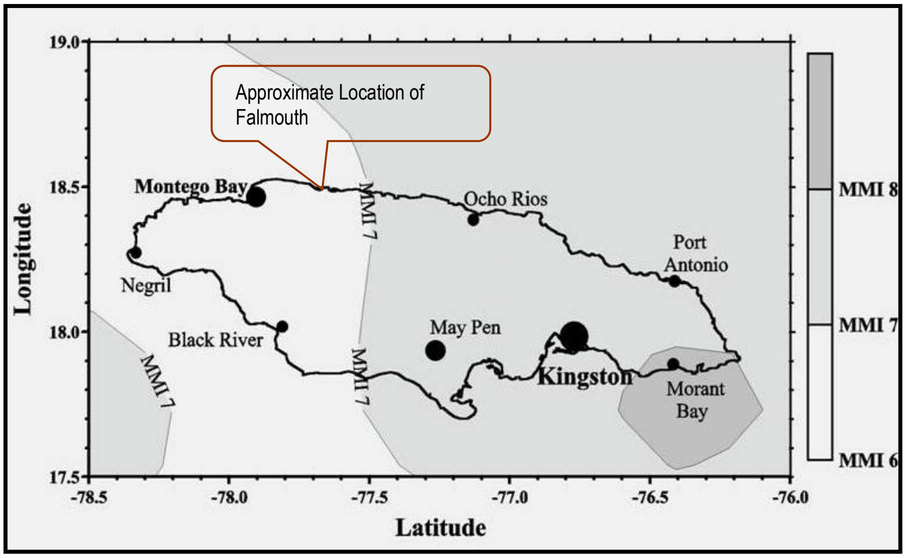


Figure 5.2.2: Expected Maximum Mercalli Intensity across Jamaica with a 1 in 50 yr return frequency (Source: Shephard, *et al.*, 1997)

The designation of MMI 6 usually indicates the likelihood of a moderate earthquake typically felt by all. Other indicators include: people walk unsteadily; many frightened; windows crack; dishes, glassware, books etc., fall off shelves; some poorly built masonry buildings cracked; and trees and bushes shake visibly. Well-built structures will usually face minimal damage.

5.2.3 Pollution Incidents

The WRA database has no record of any pollution incidents on the site or within a 5 mile radius.

5.3 Ecology

5.3.1 Vegetation Surveys

Vegetation identified at the Coral Springs site defines four major habitat types (Figure 5.3.1) as follows:

1. Domestic Cultivated Vegetation
2. Thick/Closed Dry Limestone Forest
3. Open Dry Limestone Forest

4. Riverine Forest

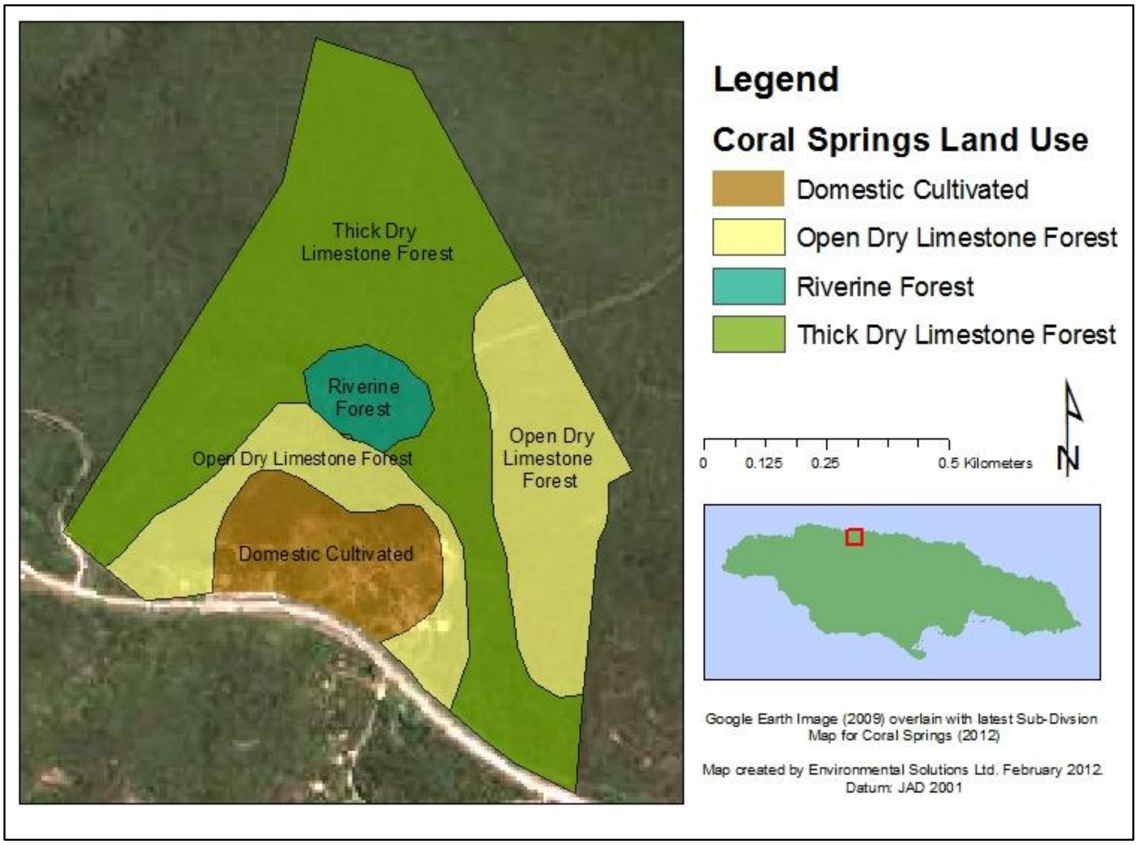


Figure 5.3.1: Habitat map for the Coral Springs property.

5.3.2 Domestic Cultivated Species

These are found in the garden space of the existing houses and developments, with a small overflow into the surrounding environs. The species here are typical to garden species including decorative species such as Ixoria (*Ixora coccinea*), Bougainvillea (Bougainvillea glabra), Indian Coral Tree (*Erythrina variegata*), *Antogonon leptopus*, as well as pumpkin (*Cucurbita sp.*), papaya (*Carica papaya*), cerasse (*Momordica charantia*), mango (*Mangifera indica*), orange (*Citrus sinensis*), lime (*Citrus aurantifolia*), and ackee (*Blighia sapida*) trees. A list of species can be viewed in Appendix VII.

Plate 5.3.2: Domestic cultivated species were primarily found in the garden space and the surrounding environs of any current housing developments, and consisted of typical garden species.

5.3.3 Thick/Closed Dry Limestone Forest

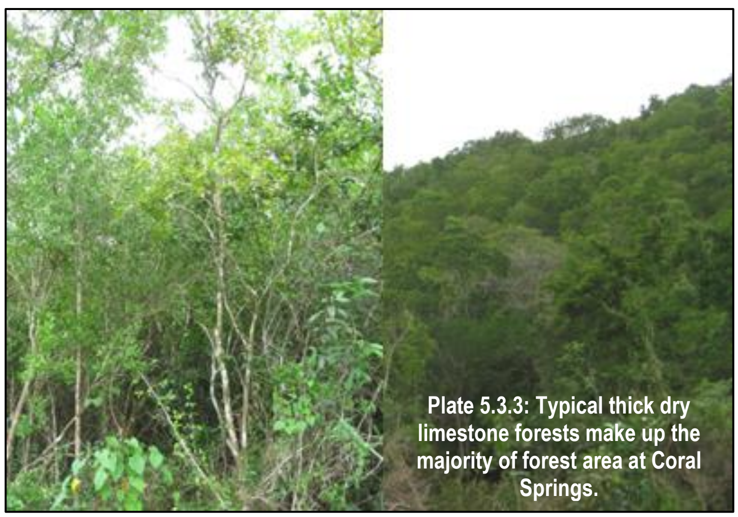


Plate 5.3.3: Typical thick dry limestone forests make up the majority of forest area at Coral Springs.

This habitat type is found mostly on the eastern edge of the property, along the ridge above the centrally located sinkhole, and along the western and northern edges. It exhibits typical dry limestone characteristics composed of a mixture of herbs, shrubs, vines and displaying a thick canopy of trees. The area is dominated by Red Birch (*Bursera simaruba)*, with high abundance of Burnwood (*Metopium brownie*), Bullhoof (*Bauhinia divaricate*), Guango (*Samanea saman*) and Logwood (*Haemotoxylum campechianum*).

The dense presence of shrub and herb species occupying the lower half of the forest was composed of at least 40 (identified) species, with an abundance of *Abutilon trisulcatum*, Pigeon Coop (*Spilanthes urens*), and Moses in the Cradle (*Rhoeo spathacea*). A number of other herb and shrub species was frequently seen throughout the field visit.

5.3.4 Open Dry Limestone Forest

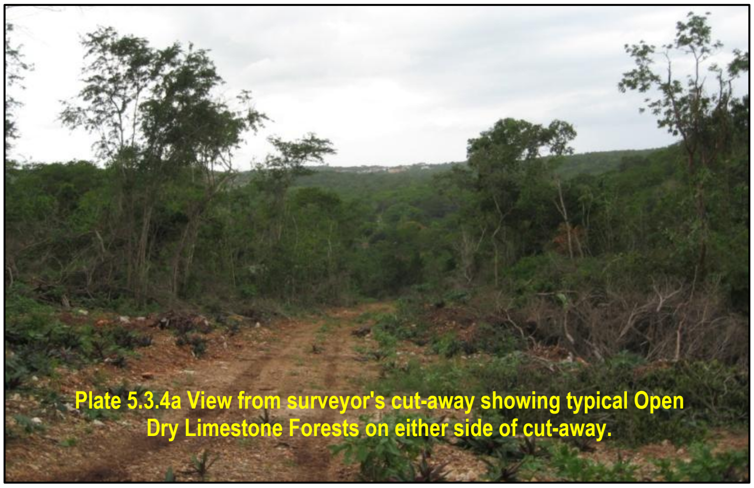


Plate 5.3.4a View from surveyor's cut-away showing typical Open Dry Limestone Forests on either side of cut-away.

This vegetation type was found mostly in the eastern edges of the property at higher elevations, and in the central zone of the property surrounding the current developments. It exhibits typical dry limestone characteristics composed of a mixture of shrubs, vines and displaying a thick canopy of trees. The area showed a less dense arrangement of trees than the Thick/Closed Dry Limestone Forests, and a lower scattered shrub presence. Similar to the Thick/Closed Dry Limestone Forests the area is dominated by Red Birch (*Bursera simaruba)*, with high abundances of Burnwood (*Metopium brownie*), Bullhoof (*Bauhinia divaricate*), Guango (*Samanea saman*) and Logwood (*Haemotoxylum campechianum*). This habitat is reminiscent of the native vegetation of the nearby Florence Hall Estate. A total of 71 species was identified in the dry limestone forests. See Appendix VII for list of species.

Figure 5.3.4b: View from surveyor's cut-away showing typical Open Dry Limestone Forest on Spring Hill.

Active coal burning and signs of coal burning was seen in the eastern hills as well as in the western Thick Dry Limestone Forests (May 15, 2012). Several active spent shells were observed in the flat areas west of Spring Hill (February 7, 2012).

Plate 5.3.4c: Coal burning on the Coral Springs Property (Left: February 7, 2012; Right: May 15, 2012).

5.3.5 Riverine Forest

The area defined as Riverine Forest was found surrounding the sinkhole in the centre of the property and was composed of typical riverine forest species. A distinct change in vegetation is noted upon traversing this area. Of note were the large stands of Bamboo (*Bambuseae* sp) surrounding the sinkhole, numerous Almond (*Prunus dulcis*), Sweet Sop (*Annona squamosa*), and Breadfruit trees (*Artocarpus altilis*), as well as the presence of numerous ferns, and thick mats of vines.

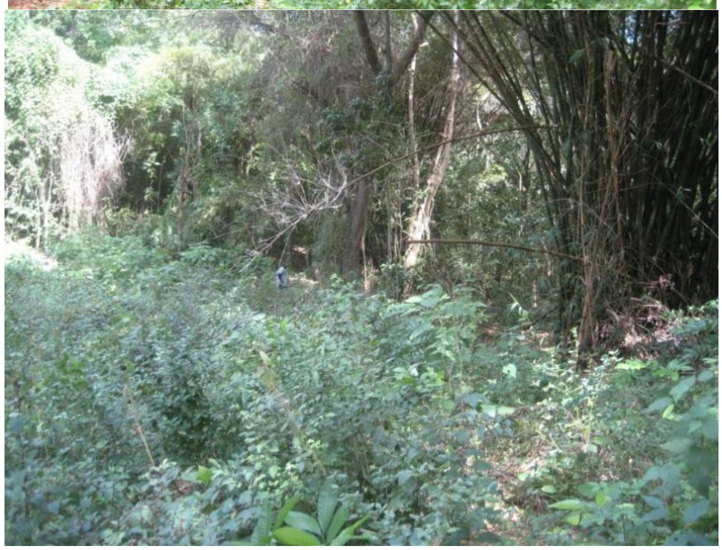


Plate 5.3.5: Vegetation surrounding the sinkhole was typical riverine forest.

5.3.6 Bird Species Survey

Bird Count

A total of 38 bird species (endemics, natives and migrants) was observed and recorded from both fixed point counts and transect counts conducted. Also of note was the fact that 264 individual birds were observed throughout the censure. Of the 38 species observed, 13 were endemic species, three were endemic sub-species and another 12 were resident species (See Appendix VII for species list). As the counts were conducted during the winter season, a total of eight (winter) migrant species was observed (See Appendix VII for list of migrant species).

Bird Distribution

Most observed species were observed throughout the property and proposed development site. Endemic species such as Jamaican Tody, White Chinned Thrush, and Jamaican Lizard Cuckoo were observed in Thick/Closed Dry Limestone Forests, and are characteristic of these forest dependent species. Areas where preliminary clearance had occurred in the recent past have species such as Northern Mockingbird, Loggerhead Kingbird and Sad Flycatcher. These areas mostly within the Tall Open Dry Limestone Forests are more suitable, provided easier access to fruits, with ground and flying insects to feed upon.

Migratory species observed were typical of the dry limestone forest observed at the site. Typical species found in this habitat type include American Redstart and Black Throated Blue Warbler. These species tolerate habitat disturbance fairly well. Other observed species such as Black and White Warbler and Northern Parula were observed in the forest areas with little disturbance. An interesting observation was the Osprey, a large non-breeding migrant, not very commonly seen in Jamaica during this season.

5.3.7 Other Faunal Observations

During both survey days observations of other faunal species were conducted. The surveys indicated the following fauna are present within the site:

1. Fourteen butterfly species of which two species are endemic (See Appendix VII)
2. “Croaking lizard” (*Celestus* sp.)
3. “Rat bats” (*Chiroptera* sp.)
4. Termites
5. Common lizard (*Anolis lineatopus)*
6. 1 species of wasp
7. Lampyrid Fireflies
8. Indian Mongoose (*Herpestes* sp)
9. Jamaican Slider Turtle (*Trachemys terrapin*)

During the site visits, several shotgun casings were observed on the property indicating fairly recent and heavy bird shooting activities.

The presence of charcoal burning which was seen on the site and on bordering properties is usually indicative of other forest activities.

5.4 Archaeological and Cultural Study

5.4.1 Site History

The Coral Spring-Mountain Spring Protected Area (1998) is located to the west of the site bounded by the Jamerika and White Bay properties (both of which form the western neighbouring properties to the project site).

Historically the site was part of the Spring Estate indicating that it was primarily a sugar producing plantation although cattle rearing was another primary plantation activity in this part of the Jamaica coast.

The 1804 Robertson map of Trelawny indicates that there were a couple of houses on what became Spring Estate after 1804, both of them outside the development area. The 1888 Harrison map shows an estate works in the south west corner of the estate and the development area. The central sinkhole/pond and a square structure (see Section 5.4.2 below) could both be features that were connected to the watering of cattle.

5.4.2 Oral History Investigation

The closest oral history sources was the work of the land surveyor Mr. Andre Thomas who as a result of his site surveys has traversed a great deal of the property. No sign of Taino existence, i.e. pottery or shells, was observed on the ground from the several surveyors tracks that were traversed. However, the surveyor identified three structures that might be historic i.e. more than 50 years old although there is no definite way of confirming this. These are as follows:

1. A cut stone wall that lines the inside perimeter of the sink hole/pond and two structures that are said to bring storm water into the pond (Plate 5.4.2a).

Plate 5.4.2a: Left - Pack stone wall around the north western section of pond; Right - Possible stormwater structure leading into the sinkhole/pond.

2. Pack stone walls on the eastern and western sides of the property. These have been breached in a number of places (Plates 5.4.2b).

Plate 5.4.2b: Eastern (left) and western (right) pack stone boundary walls

3. A concrete square-wall structure that has troughs on two sides, possibly a cattle watering facility (Figure 5.4.2c).

Figure 5.4.2c: Concrete square wall structure

5.4.3 Field Survey and Site Profiling Results

Taino populations generally left very discernible footprints on the landscape with three main elements:

- ✓ Settlements were located behind a reef system that protected the beaches and the beach villages, and provided for the conservation and development of stable aquatic resources that were easily harvested.
- ✓ Sites on the mainly flat coastal plains between the beach and the coastal hills, close to a fresh water source.
- ✓ Sites in the principally low lying coastal hills behind the beach.

The property does not extend to the beach or further south into the hills as it originally did however as part of the Spring Estate. There is a reef system outside the beach north of the site. The terrain and floral densities and condition – primary forest on the higher elevations and secondary forest on the lower – suggest a site that would not be mainly conducive to Taino habitation with the exception of the beach, the area of the pond and the hills to the south of the development area. Unfortunately when the consultant visited the pond site the area was heavily bushed and difficult to penetrate. However the development plan indicates that the area around the pond/sinkhole will be left as a green area thereby protecting any Taino site that may possibly be contained therein.

5.5 Socioeconomic Environment

5.5.1 The Socioeconomic Context

The Special Area of Falmouth, within which the proposed Coral Springs development is situated, has 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. Unfortunately the 2011 census data are not yet available to confirm very likely important demographic changes over the 2001 to 2011 period. For example it is likely that the net loss of population from Trelawny to other parishes seen over the 1982 to 2001 period, will be reversed and if so, it will very likely be as a result of migration of persons into the coastal belt of the parish and more specifically, the Falmouth Special Area. The promulgation of this project is a response to the demand for housing in the parish.

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

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 assessment reveals that the neighbouring residential areas to Coral Springs, Carey Park, Coopers Pen, Stewart Castle, Refuge and to a lesser extend Duncans, are all dormitory communities to larger urban townships Falmouth, Ocho Rios and Montego Bay for example 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 infrastructure is improving but still stressed due to increasing population and variable financial resources. Health and Public Safety Services appear better able to cope with demands placed on them than for example in Montego Bay. A relatively new Fire-brigade station is in place in Falmouth. It is however under resourced in terms coping with anticipated return period emergencies. 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 authorities as managing the crime situation. Communities in the immediate project zone of impact do not identify crime as a major problem.

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

5.5.2 Demographics

Though superseded by the 2011 Census, the 2001 Census remains the only official published data that disaggregates demographic data below the parish level. The relatively slow parish population growth is reflected in STATIN census data in Table 5.5.2a.

Table 5.5.2a: Parish of Trelawny Population Data 1970-2010

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
2010	75,996	0.45

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 is developing as well as the major improvement in the housing stock in the Falmouth (e.g. Florence Hall and Stonebrook housing estates) to Martha Brae area (Holland Housing Estate).

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 three Electoral Divisions containing the entire coastal strip including Hague and Martha Brae as 1,600. This can no longer be useful planning data given that several housing developments, for example Florence Hall and Stonebrook each now make up these populations.

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 are reflected in the following Table (5.5.2b), based on the rapid appraisal survey.

Table 5.5.2b Main Reported Sources of Employment in the five Communities of Interest

Ranked	Current Community Perceptions on Employment
First	Construction
Second	Tourism
Third	Tourism
Total Interviewed	**173**

The figures express the perceptions of respondents to the main sources of employment for members of their communities. Overall for the five communities surveyed, construction was the sector that offered the greatest employment.

5.5.3 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 Coral Springs 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 5.5.3), 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 their community.

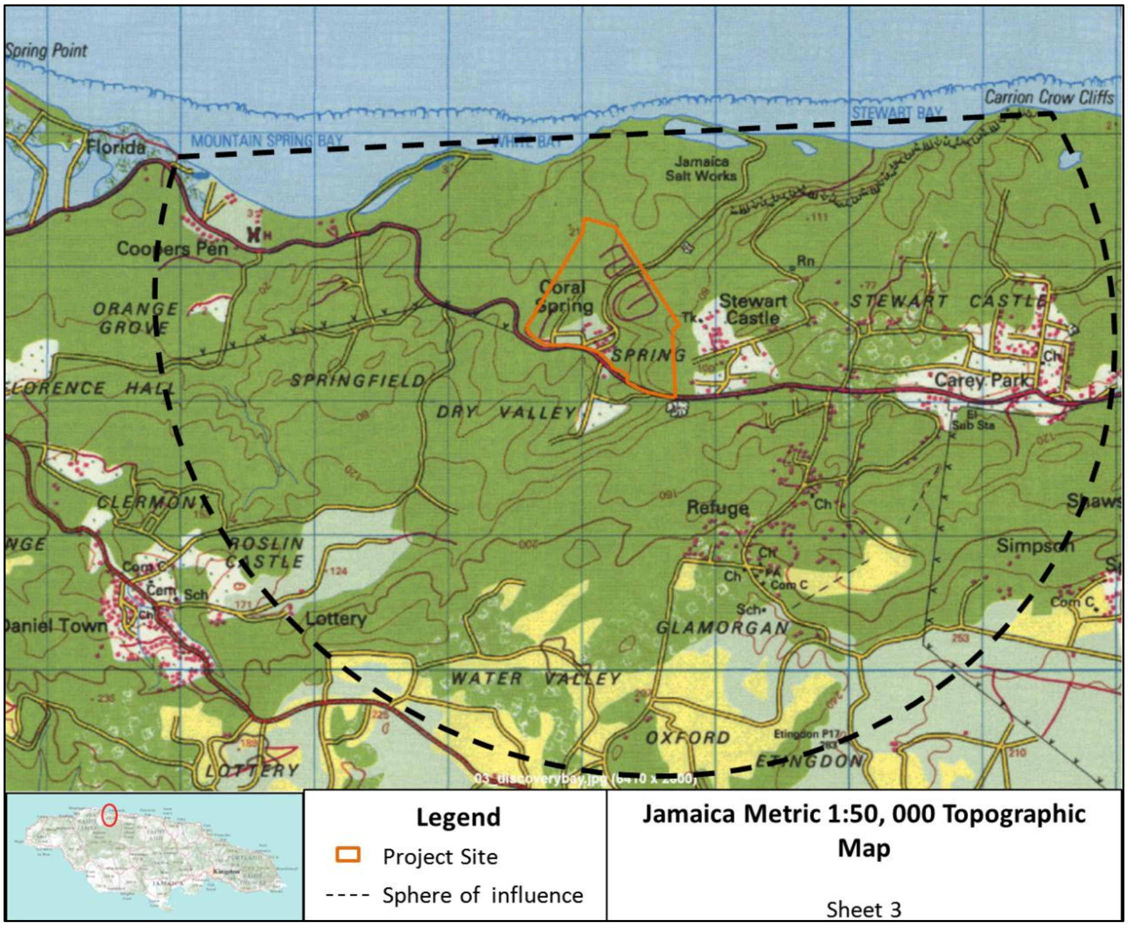


Figure 5.5.3: Project sphere of influence.

The Communities around the Project

The communities of most interest to the project are:

- Coopers Pen
- Coral Springs
- Retreat Heights
- Stewart Castle
- Carey Park
- Duncans

Coopers Pen

Coopers Pen is a seaside village located adjacent to the 350 room Starfish Trelawny Hotel and about 2 miles west of the Project site.

The population could number about 300 including the neighboring unplanned settlement. Coopers Pen is a relatively infrastructure poor, lower income coastal community, with a high proportion of youth and female headed households. This demographic profile is generally representative of the coastal communities found in the Parish. The main land use is residential. Land use density within the community is dominated by 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 substandard residential housing. Coopers Pen itself comprises an older, sea-fronting section which includes a fishing beach and a newer unplanned community on land, edging the new north coast highway. Livelihoods inside the community come mainly from a mix of poorly constructed corner shops, entertainment venues and eateries.

From observation the viability and vitality of the township has been severely compromised since the main road through it was replaced by the Northern Coastal Highway. 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 NEPA approved fishing beach is an integral part of this community.

Coral Springs

This property, on which the project is to be built, was likely linked to several properties with roots in Jamaica's 18th Century plantation history, Roslin Castle and Stewart Castle to the east being two of these. The name Coral Springs indicates the advantage this property would have possessed since water resources were a constant constraint to viable sugar production. In modern times, a perennial spring issued from a cutting beside the older main road just east of the current residences and was a popular stopping point for travelers.

A substantial subdivision of the property was proposed and approved in the 1970's. Roads, some of which are still visible today, were cut and lots sold. However as stated in the introductory chapter, the housing scheme failed and the existing subdivision comprising both built up and vacant lots in the scheme are vestiges of this pioneering development. Currently the structures that exist in the current residential section of Coral Springs are described in Table 5.5.3a below.

Table 5.5.3a: Existing Built Structures at Coral Springs

Type of Structures	Total
Residences	20
Equipment Room	1
Under Construction or construction stopped	5
Total	**26**

Residences are well appointed and of sound construction with those on Beach Road being noticeable for their landscaping (Plate 5.5.3a). There are no actively used recreational facilities within the community, although an area with a tennis court is marked out and an empty swimming pool exists.

Plate 5.5.3a: Left – Typical houses in Coral Springs today; Right – Typical two bedroom house which is signature style of Gore Developments Ltd.

This small community characterizes itself as comprising mainly returning residents and retirees. Some of the houses were vacant at the time of the consultations and their owners reported as being overseas. This is reported as the usual practice among some residents during any given year. The relationship between the community and the project centers mainly around three issues:

1. The concerns and frustrations of those who no longer have a valid claim to lots in the scheme, but who lost investments as a result of the originally failed development. Gore Developments Ltd holds valid title for all the lots that comprise the project, some of which were once paid down on by this group of persons. The matter of lost investments and outstanding claims against the original

developer is essentially a public relations one rather than a legal one, and Gore Developments Ltd has held discussions with some of those affected as a courtesy. Three lots on the property have been designated rights-of-way for three individuals as per the property title. These individuals have access to the beach road.

2. The second issue relates to the existing bona fide lot owners, and GDL's proposal to honour an original contractual right-of-way for such owners who were originally promised access to the coast line. To date GDL reports making good progress on both fronts. One untitled occupant of a large two story house at the entrance to the project, on an original subdivision lot he identifies as 145 is maintaining a claim to that lot and the bordering lot 146, both of which are now part of GDLs holdings. The claim is based on significant payments being initially made to the original developer on two lots (379 & 380) and later exchanged at the request of that developer for the two currently possessed. Having no title to the lots but claiming residence on the lot since 1995, he is considering advancing the argument of Prescriptive Right. Discussions with GDL are taking place and the developer feels confident that a mutually acceptable resolution to an obviously unfortunate circumstance can be leveraged.
3. The third and final issue relates to the attitude of the community members to the development. The Consultants spoke to a sufficient number of available owners to feel confident that their views closely reflected the majority. While accepting the desirability of development there is the certainty that the development will destroy irreversibly the peace and tranquility community members have long enjoyed and prize greatly. This claim, coming as it does from a community of retirees, is underscored by the picturesque physical setting of this small community, located in a bowl surrounded by well forested hills. All community members interviewed refer to the tranquility they enjoy, an important aspect of which is the birdlife which frequent their gardens and whose habitat will be destroyed by the development. One community member claims that as a direct result of the proposed development he has now placed his house on the market.

Coral Springs presents the classic and perhaps inevitable conflict that arises with the insertion of a high density housing scheme, designed at the lower end of the middle income housing market, into a hitherto very low density residential area, comprising individually designed homes built by returning residents and retirees.

The Developers are in possession of subdivision planning, and building approval so the issues of zoning and density do not arise as recourse to the community. Further, the Trelawny Parish Development Order (to be gazetted) supports residential development in this part of the parish. In this context, tensions over perceived rights to the continued enjoyment of a quality of life seen as threatened can best be resolved through amicable engagement between the community and the developer.

Retreat Heights

Retreat Heights is a large upscale residential community which lies opposite to Coral Springs, but with its main entrance located closer to the Breezes Trelawny Hotel. Developed as a build on own lot subdivision

circa 1995, this community has grown steadily since inception to now comprise over 100 high income homes. It offers important confirmation of the demand for a variety of housing solutions needed in the Greater Falmouth Area but particularly along this development corridor. In this respect it is similar to older communities such as Discovery Heights in Discovery Bay and Silver Sands in Duncans, which is itself trending towards residential landuse.

One of the features of Coral Springs is that it is relatively isolated from neighbouring developments. Retreat Heights, the nearest residential development, cannot be seen directly from the existing Coral Springs community, nor its presence detected by traffic flows or noise. Post development however, it is likely that higher hillside units in both developments will be in a line of sight. Attempts at interviewing residents in Retreat Heights for their opinions on the proposed development were mainly met with a preference to defer such questions to a community meeting with a few indicating that they do not see any possible impact of Coral Springs development on their community. Some 17 persons were approached unsuccessfully for interviews using the community survey tool (Appendix VIII).

Stewart Castle, Carey Park and Refuge

Practically little differentiates these villages in their relationship with the project. They may be characterized as moderately distant neighbours, drawing on some of the same pool of social services that the project will utilize, but otherwise having no other discernible impact on the latter. The three communities themselves have a common heritage and interest in that continuum that links Stewart Castle Sugar Plantation in the 18th century through the work of William Knibb, emancipation and the free village system, to the advent of tourism and the present day developments in that industry, as represented by the Falmouth Cruise Ship Port and the Northern Coastal Highway.

Table 5.4.3b indicates the importance of construction and tourism to the livelihoods of these communities. Falmouth is regarded as the most important heritage center in Jamaica. The ruins of Stewart Castle are the most important relics in this particular area of the parish. The iconic British Baptist and abolitionist William Knibb's work is highly respected and in several specific instances reflected in these communities. Therefore much hope is placed by these communities on tourism development and the development benefits expected to flow to them as a result.

The communities have a commonality in that they are unplanned residential areas, middle and lower income in economic terms, and each evidencing signs of growth in housing stock, which ranges from poor construction to fairly substantial architecturally designed houses. They all report adequate water service by the NWC, little or no flooding, very high unemployment with the interesting exception of Carey Park where the perception of unemployment was evenly split between being high and low. This response is probably related to a significant proportion of the community being in a single development and mainly working outside of the area, with others in non-planned communities, finding local employment a challenge.

Duncans

Based on data provided by the Social Development Commission there are about 3,500 persons living in the nine major districts that make up Duncans. Some 61% of households are headed by males and about 60% of household heads were employed.

The major economic activities of the community are tourism and farming with 37% of households engaged in these activities. Main occupations include craft and related trades workers, service workers, and hustling skills.

The community is served by a type one health care facility. It is also served by four educational institutions comprising an all age school and three basic schools. There are several active Community Based Organizations including a citizens association and several church groups.

Water supply is regarded as reliable and is sourced mainly from the Rio Bueno water supply scheme.

5.5.4 Social Services

In this section, issues pertinent to the Project, but shared in common with the communities are presented.

Waste Management

Sanitary conveniences are mainly a combination of pit latrines and flush toilets in all existing communities. In general the juxtaposition of landward populations highly dependent of these type of sanitary conveniences, and the observed and reported generally degraded algae attacked fringing reefs along the coast, suggests the impact of nutrient loading of the coastal waters.

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. Another was built to serve the Greenfield Stadium. Florence Hall Housing Village is served by a biological treatment plants and the Breezes Trelawny Hotel also has its own treatment facility. The remainder of the town of Falmouth and neighbouring communities use soak-away systems, and is viewed as a serious environmental problem to Public Health officials interviewed given the low water table of Falmouth and environs.

Garbage disposal and solid waste management in Trelawny is the responsibility of the Western Parks and Markets. A very limited fleet of two trucks serves the entire parish and waste has to be transported to Retirement 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.

Public Health and Medical Facilities

The Falmouth Health Centre (Type 4) presently serves the health needs of close to half of the communities in Trelawny including the five communities of interest around the project. Its effective catchment area extends as far as to Lilliput in St. James. The centre has therefore outgrown the capacity for which it was built. The Cruise ship terminal in Falmouth also draws on the public health system of Falmouth.

Falmouth has a Type C Hospital which is said to be fairly overwhelmed with no known plans for improvement at this time. The main health concerns in the general Falmouth area were expressed as:

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

Contamination of the groundwater was cited as a major environmental concern in Falmouth and the growing development due to lack of a central sewage system.

Fire and 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 inadequate in the event of there being a significant incident, not to mention an emergency situation of multiple fires or need for emergency service. Considering Falmouth's heritage assets, and the introduction of the tourism package, this situation will need to be rectified in the near future.

The main police station is in Falmouth. The Divisional Headquarters is housed at the Green Field Stadium. The crime situation in Falmouth is not as severe as other parish capitals such as Montego Bay in St. James.

Roads and Traffic

The road network serving the zone of impact allows for the orderly flow of traffic through the communities of interest. The network is centered on the Northern Coastal Highway which impacts Traffic in the project area.

Local Traffic Authority reports that Falmouth to Duncans road is generally not a congested area, except when events are held at the Greenfield Stadium. The speed limit on the highway is 80 Km in the vicinity of the entrance to the Project. However speeds are probably higher. 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.

The Consultants recommend that a traffic management plan be undertaken at the proposed project entrance on the Duncans main road. In relation to the latter it should consider the introduction of a left-on lane for traffic entering the development and left off coming out of the project when proceeding towards Duncans, and a right hand turning lane from the highway into the project and coming out of it onto the highway.

Utilities

<u>Water</u>

With the exception of Coral Springs the communities of interest 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 5.5.4a).

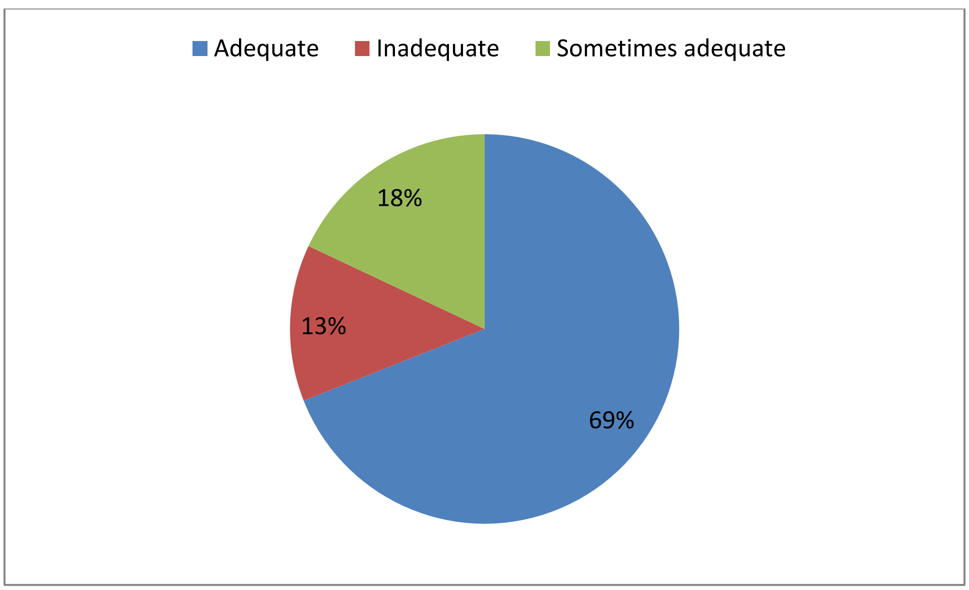


Figure 5.5.4a Adequacy of water supply in communities within the project area

Table 5.5.4b 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 several communities in the near Falmouth area. The main plant is referred to as the New Treatment Plant and is located on the Martha Brea to Perth Town Road. It has the capacity to produce 6 Million Gals per day. 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 Greenfield Stadium and neighbouring housing developments and to the communities of interest, with the exception of Coral Springs which receives its own supply from a spring. Other than the Martha Brae the other main sources of water to the parish are tapped from the Dornoch River and three operating wells in the Queen of Spain Valley. The Rio Bueno contributes marginally to the water resources available to Trelawny.

Land Use

The main land use in the more limited zone studied is agriculture and settlement followed by commercial activity and tourism. Agriculture is mainly market, gardening and pen keeping. This is reflected from the community membership's perception of land use in the project area as reflected in Figure 5.34.4c. Consistent with observation, the main land use identified by the respondents was residential (45%), followed by agricultural (36%) and commercial activity (18%).

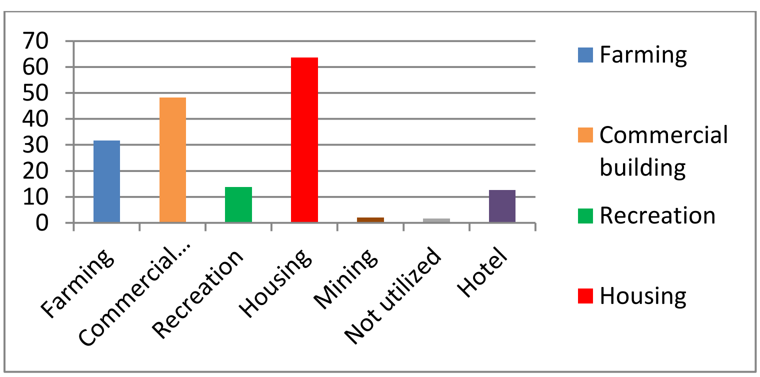


Figure 5.5.4c: Main land use in communities surrounding the project site

On the coastal strip several tourism establishments are in various planning stages such as the 1800 room Oyster Bay Hotel development on Florida Key (currently halted). Oyster Bay Lagoon, home of the famous luminescent dinoflagellate population *Pryodinium bahamene,* also lies along the coastal strip and provides another potential focus point of tourism. Similarly to the west of the project is the 25,000 seat Greenfield Stadium complex which still remains at the center of the Government's interest in promoting sports tourism. Centered near Martha Brae is the important rafting attraction along the Martha Brae River.

Agriculture is most intense in the sugar belt extending through the Queen of Spain's Valley. Fishing takes place in the Falmouth harbor and along the coast. The nearest NEPA licensed fishing beach to the project is at Rock. However two fishing boats were observed on the beach north of Coral Springs. These are reported owned and operated by fishermen from Refuge.

The recently completed Falmouth Cruise Terminal, a project of the Ports Authority of Jamaica includes berthing and other landside facilities to accommodate two mega line size cruise ships in the Genesis class. It is currently in operation with weekly visits by Carnival Cruise Lines. This major tourism development is an important compliment to the landside expansion of the existing tourism hotel infrastructure which currently is centered on the existing and planned developments listed in Table 5.5.4d below. Other important resorts include Silver Sands which comprises 41 villas of various room sizes.

Table 5.5.4d: Current and Planned Hotel Properties in Trelawny

Property	No. of Rooms	Percentage (%) of Total Rooms
Breezes Braco Resorts	186	2.6
Breezes Trelawny	350	4.9
FDR Pebbles	90	1.3
Oyster Bay (halted)	1,800	25.3
Harmony Cove (halted)	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 also a priority); and continued housing infrastructure to ensure orderly accommodation of tourism expansion as it takes place.

In relation to the communities, and based on the rapid appraisal survey, the majority of community members preferred no other land use than the proposed, while a small percentage would have preferred alternatives such as a commercial center, entertainment facilities a shopping mall and fast food outlets.

A new Development Order has been drafted for Trelawny but has not to date been officially gazetted. The Town and Country Planning (Trelawny Parish) Provisional Development Order 1980 is therefore still valid and identifies this area of the parish for both residential and tourism development.

Flooding

Flooding has been reported by residents of Coral Springs mainly along Beach Road. Anecdotal information from the ODPEM indicates that both the north and south side of the highway are inundated during significant storm events (Richardson, 2011). On the south side (Dry Valley) the indicated depth of flooding covers the first floor of a two storey structure in Dry Valley, approximately 1.5 m to 2.5 m (5-8 ft) and remains flooded for weeks to months. On the Coral Springs side it is said that the flooding can reach as far as unto the verandah and into rooms of the homes adjacent the sinkhole and may last 1-2 days (Richardson, 2011).

5.6 Community Opinion on the Project

The rapid rural Appraisal approach used to inform the socioeconomic 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 400 units). The results are presented below (Figure 5.6a).

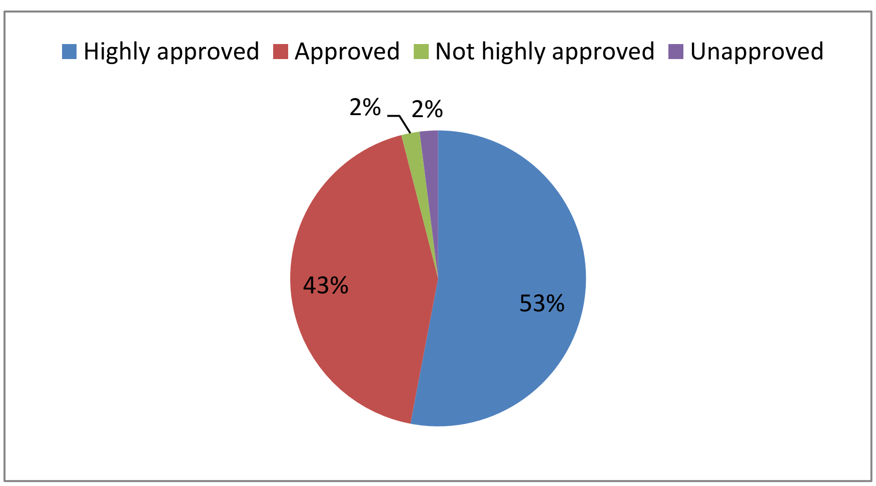


Figure 5.6a: Community approval of the Project

The project received high rating by respondents with 96% of them feeling that the community would highly approve or simply approve the Project. The negative opinions (4%) related to the high numbers of intended units. 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 65% thought it very necessary and 29% simply necessary (Figure 5.6b). The concern of the minority opinion (6%) was centered on the fact that they thought the project should be in Stewart Castle or no reasons were offered.

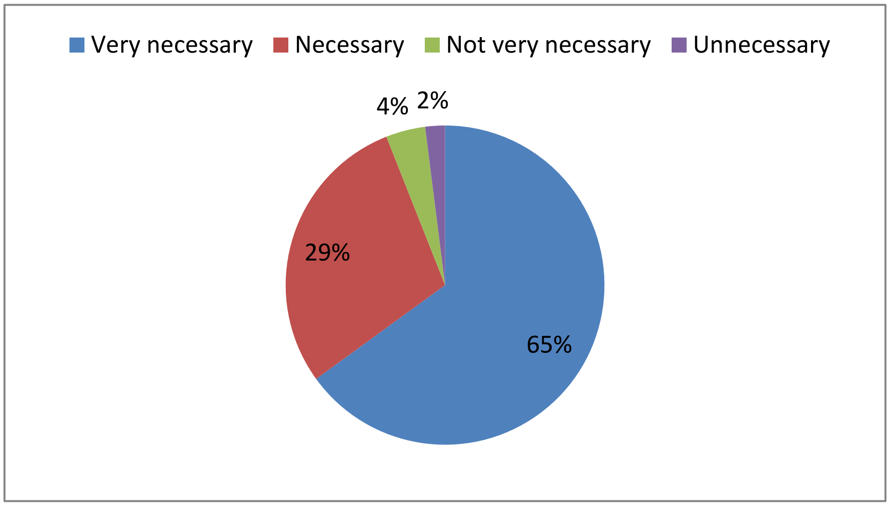


Figure 5.6b: Perception of community views in respect of the Project

The communities were asked to determine their greatest fear with the introduction of the proposed development. Some of the reservations contained in the 100 responses were the introduction of crime - 33%, sewage disposal - 20%, overcrowding - 13%, and fears of air pollution and noise accounting for the majority of the remaining responses.

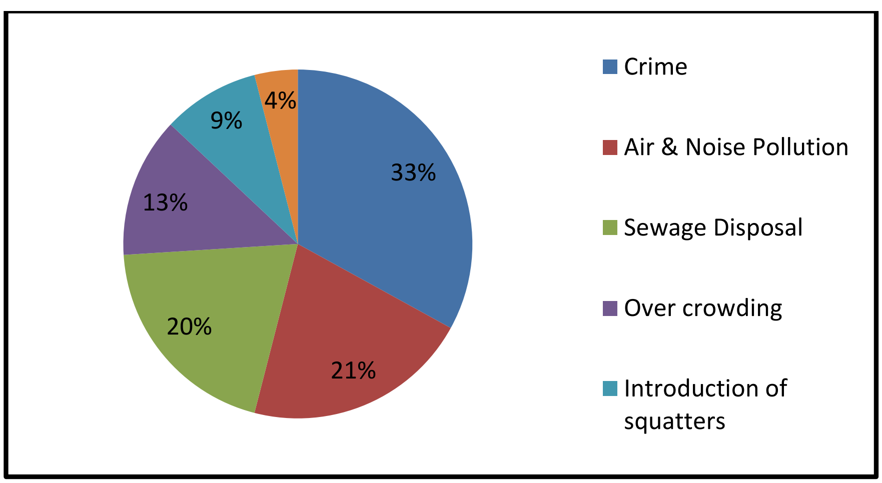


Figure 5.6c: Fears or reservations regarding the Project (from public consultations)

Overall the Project was perceived by the community members as being able to potentially confer major benefits. Chief among these were employment opportunities (72% of responses), better housing ownership possibilities (26% of responses), better educational services (10%), recognition for the communities (4%) and improved community based friendships (6%) (Figure 5.6d).

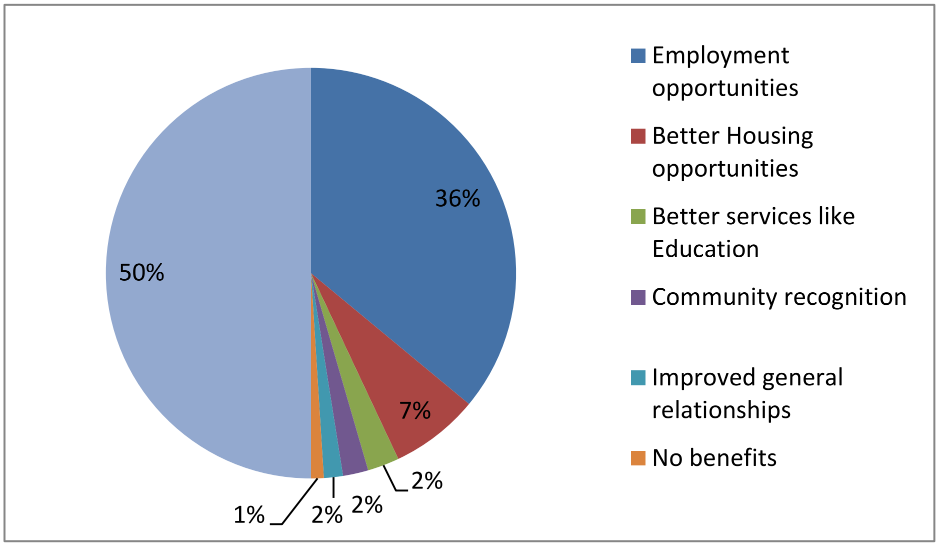


Figure 5.6d: Expected benefits from the Project

Respondents were also asked to identify the environmental fears community members were likely to have for the project and the results are shown in Figure 5.6e below.

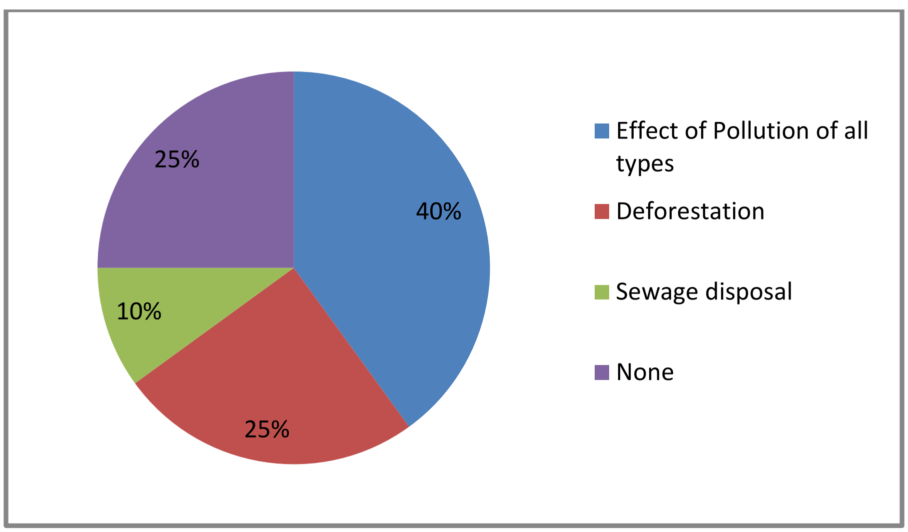


Figure 5.6e: Environmental Fears Associated with the Project

Pollution perceived as mainly dust and noise was a dominant concern (40%). This was followed by deforestation to make way for the development (25%) and sewage disposal (10%) as expressed by community members. Some 25% had no opinions to offer.

Councilor with responsibility for the Coral Gardens division on the Trelawny Parish Council Mr. Garth Tomlinson expressed no significant concerns about the project but was aware of the flooding issues in Coral Springs. The other main concern expressed by the Councilor was that of the proposal for subdividing the hilly sections of the property and the implications for flooding of the existing homes in the lower sections as a result of disturbance of the slopes by lot owners.

Bird shooting enthusiasts, who were asked to pass an opinion on the proposed project, were realistic in their assessment that other stands would need to be identified as they felt that the bird population would seek new habitats.

6.0 IMPACT ASSESSMENT

6.1 Introduction

The Coral Springs development will occupy 169 acres (68 ha) of land, most of which is presently vegetated by dry limestone forest. The development will conform to the basic topography and geology of the site and earthworks will be reduced to a minimum, mainly for grading the flat lands for housing foundations, roadways and other infrastructure.

The main components of the development will be:

I. 401 housing units on the flat lands in the northern, western and south western sections of the site.
II. 141 service lots on the steeper slopes to the east (Spring Hill) and south east.
III. Two steep, densely vegetated escarpments to the east and south east to be left undisturbed.
IV. A centrally located sinkhole, depression area (drainage basin), and open green area to facilitate central site drainage, sewage treatment and recreation.

The design of the development is meant to facilitate (and enhance) the existing drainage pattern of the site and adjacent areas; preservation of the steepest slopes; maximum conservation of the forests and birdlife; and adequate open spaces for recreation and aesthetics. The project impacts have been assessed in the construction phase and the operation of the development as seen in the ensuing sections.

6.2 Construction Phase Impacts

Construction of the project will produce the typical impacts associated with construction activities. These activities are discussed below and correlated with the environmental resources that are expected to be impacted by each.

6.2.1 Air Quality

Site preparation and construction activities (such as blasting, rock crushing, open cuts and earthmoving operations) have the potential to generate fugitive dust which will directly impact areas less than a half a kilometre from the site. This is hence likely to be a nuisance to the existing residents on the Coral Springs property. Due to the nature of the site topography this impact can be minimized by ensuring phased vegetation clearance so that buffers will be available to filter out the dust. Also the practice of dampening down exposed surfaces during dry periods should be implemented as part of the site activities during construction. Construction crews will be impacted by the fugitive dusts and should be provided with the appropriate safety gears.

6.2.2 Geology, Topography and Slopes

The geology of the site will be impacted mainly in terms of the areas to be re-graded and / or leveled for house foundations and roadways. This will reduce the permeability of the surface areas and therefore similarly reduce immediate contribution to the groundwater.

Regarding the topography of the site, very little change will occur except again for the leveling of surface bumps and the re-grading of shallow slopes. However, within the drainage basin further re-grading will take place to lower certain areas and increase the holding and percolation capacities of the pond areas (See Drainage Report, Appendix III). These impacts will be inevitable but minor.

Slopes

Based on the results of the geotechnical investigation the slopes will be suitable for infrastructure and house construction.

The steep escarpments that define both Spring Hill and the southeastern slope should not be disturbed during site clearance and construction activities. It is recommended that the construction manager be present on site to ensure that no removal of vegetation occurs and that the site is developed as per the development plan. Roads and parking areas, shall designed so that land disturbances will not result in excessive erosion. Both the vertical and horizontal alignment of vehicular facilities should be so designed that hazardous circulation conditions will not be created.

The geotechnical investigation has indicated that the use of isolated conventional shallow pad and beam foundation appears suitable across the site. However, in instances where evidence of localized solution cavities have been encountered deeper foundation types should be used. For cuts and fills the soil information suggests that a generalized guideline can be recommended. Fills shall be properly stabilized and cuts supported by retaining walls or other appropriate structures when found necessary depending upon existing slopes and soil types. Anomalous areas e.g. where loose colluviums are encountered during construction should be addressed accordingly.

6.2.3 Hydrology and Drainage

Construction practices such as inadvertent sinkhole infilling, blasting and inadequate erosion control and sediment control may alter the karst terrain and increase the potential for flooding. Blasting can change the geometry of the sinkhole throats and underground cavities, blocking outflow pathways. Lack of erosion and sediment control measures can increase the potential for silt and other debris to accumulate within fissures/fractures and effectively reduce outflow efficiency. Encroachment within the sinkhole rim could also reduce the storage volume available to contain stormwater runoff. If output efficiency is reduced in sinkholes it could be difficult to rectify or regain.

Mitigation Measures

During construction there should be minimal disturbance of the immediate area around the sinkhole. The use of mechanized equipment near the sinkhole should be controlled as the underground system of cavities and streams is dynamic and explosions in the vicinity can alter or block underground drainage passages changing the output efficiency beyond current understanding of the system.

All temporal and perennial spring outlets must remain open and free of obstruction. To maintain the integrity of the drainage system no spring, or spring entombment, should be filled. Any conduits, channels, caves encountered during site development should not be infilled or covered over (Richardson, 2012).

Based on the storage evaluation, the obvious throat of the sinkhole, the history of flooding and the existing encroachment within the sinkhole floodplain, a no-fill zone is recommended to ensure the proper management of the sinkhole and the local stormwater system. For this particular sinkhole the no-fill line shall be the existing 14 m contour (Figure 6.2.3). The area encompassed by this line shall be the no-fill zone for all development activities (Richardson, 2012). No construction, vegetation removal/modification, stockpiling or storage of any kind should be allowed in this zone. Any fill added to the sinkhole floodplain outside this no-fill line must be compensated for by an equal volume cut outside of the no-fill zone.

Figure 6.2.3: The 13 m contour no-fill zone (light blue polygon) for coral spring outlet sinkhole. Proposed post-development contour modifications are shown in red. White contours are the existing site contours. (Source: Richardson, 2012)

6.2.4 Surface and Groundwater Quality

Sinkhole

The main water body on site that would be affected by construction activities is the central pond where the sinkhole exists. This means that any impact on the pond water quality will likely impact ground water quality. The typical ways that waters become polluted on construction sites is usually due to run off from site activities, waste waters from washing of vehicles and improper and inadequate sewage disposal facilities. It is necessary that vehicles be not serviced or maintained in the drainage basin. Additionally waste water from such activities should not be channeled into the sinkhole.

Stockpiles

The impact of the project on water quality during construction is expected to take place during heavy rain events which may erode compacted soil and carry off materials such as sand and soils from stockpiles. These can result in blocked drains and may eventually lead to flooding in the local area. Covering of stockpiles and storage away from drains will reduce migration of fines.

Building of a drainage canal around the stockpile areas can serve to divert the surface run-off from stockpiles.

Fuel and Chemical Storage

Fuels and chemical stores at the construction site have the potential to contaminate surface and ground waters. These areas should have precautionary bunding/construction of dikes; in addition oil-water separators will prevent contaminated water from reaching the drainage channel. As a result of the implementation of these mitigation measures the impact of the construction activities on water quality of the drains in vicinity of the site will be minimal.

Domestic Waste Water

Wastewater produced from construction site sanitary facilities as well as lack of facilities has potential impact on groundwater quality if not properly contained and disposed. 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.

6.2.5 Ecology

Site clearance and construction activities associated with the housing development will entail the inevitable removal of a substantive portion of vegetation from the site - approximately 150 Ha. However, 17.6 Ha of vegetation on the steep escarpments will be left in natural cover as nature reserves.

During construction as a mitigative, measure the pace of vegetation removal should be matched with development implementation so as to ensure that bare, unprotected expanses of ground are avoided.

As the removal and establishment of trees is a lengthy and potentially expensive undertaking it is recommended that wherever possible, clear-cutting should be avoided and the larger trees of the property should be strategically marked/flagged for conservation.

6.2.6 Cultural and Archaeological

1) The two areas that need more attention are the pond and the south west corner of the site.
    - The pond - Any disturbance of this area and the surrounding green area needs to be observed by an archaeologist to ensure the recording of any archaeological/cultural situation.
    - Although there is nothing to be observed on the ground, the fact that maps indicate the existence of structures suggests that these may have become sub-surface. Either a fuller exploration needs to be done prior to the commencement of the project, or during site clearance activities the JNHT should be on site to observe if there are any buried structures of importance.

2) It is the recommendation that those features that are most probably historic i.e. the packed cut stone walls, the cut stone perimeter banking around the pond, and the square structure, be retained, integrated into the final development design of the site and labeled.
3) There is no recommendation for legal protection at this time.

6.2.7 Socio-economic Environment

Employment

The construction phase will draw on the local labour pool for construction work force which although is short term is still a positive benefit to the local communities of the Greater Falmouth area.

Traffic

With the need for materials and equipment, traffic in the Coral Springs area is expected to be impacted negatively when heavy vehicles are entering and leaving the property for deliveries, etc. This is expected to be intermittent and short term but will potentially be a nuisance to the existing residents.

Solid Waste

Construction sites generate considerable waste from the various materials that must be used in each stage of the house and road construction process. Solid waste generated from the site preparation and construction activities will include construction debris, vegetation, and solid waste generated at the construction camp. Some mitigation measures include:

- ◊ Provision should be made for suitable separation and storage of waste in designated and labelled areas throughout the site.
- ◊ Collection of waste by certified contractors and disposal at an approved site, as recommended and approved by the National Solid Waste Management Authority. The one closest to project 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 in containers provided.
- ◊ Consideration should be given to the establishment of an integrated Solid Waste Management Plan.

Noise

Any blasting activities associated with construction will generate noise of varying intensity based on location from the source of noise. Also the noise of operating machinery is likely to present a noise nuisance to the existing Coral Springs residents.

It is expected that standard operating practices for constructions within a residential area will be adhered. Some of these include restricting the time of day that such activities are undertaken such as during work hours when most residents will normally not be home to face disturbance. Weekend works should also not be practiced. Servicing of vehicles and use of noise buffer where appropriate is also recommended.

Worker Health and Safety

Worker health and safety are always typical issues on large scale construction sites where several persons are contracted to undertake heavy duty works in an environment with large scale equipment.

Worker safety should be protected by contractual undertakings to implement safe site practices. Sanitary practices in regard to providing potable water and the disposal of human waste should be enforced to safeguard worker health as part of the construction contract.

Emergency Response

Construction activities involving the combined impact of use of heavy equipment, fuel and chemical storage, moving vehicles is likely to pose a safety risk and as such emergency response actions must be developed for response to various scenarios.

6.3 Operation Impacts

6.3.1 Hydrology, Drainage and Flood Impact

The basic hydrology and drainage of the Coral Springs site will be retained although enhanced. Two sub-catchment areas from the proposed development will flow north towards the sea in natural channels in 600 mm to 900 mm wide open U drains. This post development drainage will be similar to the pre development situation.

Five sub-catchment areas covering almost the entire housing development to the west will flow to the drainage basin (depression or pond area) in a series of 600 mm to 900 mm diameter storm sewers and covered U drains.

Seven other catchment areas to the north-east, east and south east will flow into existing earth channels via several 600 mm drains and empty into the depression area.

Due to the potential increased run off from the housing development to the depression area, this area has been designed so as to expand the storage capacity of the depression and its infiltration potential. This will be accomplished by re-grading a part of the depression area above the standing water elevation (13.3 m), excavating between the 13.5 m contour and the 14.2 m contour, and removing the hard brown clay and filling with compacted gravel and crushed limestone. It will then be re-vegetated for use as a park and recreational area.

This re-grading exercise will ensure that the post development flood elevation will not exceed the pre development flood elevation. Furthermore, this will reduce the flood levels in the existing Coral Springs Housing area by approximately 0.78 m in a 100 year storm.

With the measures taken above and the additional cleaning up of the sinkhole and the entire pond area, it is estimated that drainage of the Coral Springs Site and the catchment area to the south will be significantly improved. However, it should be noted that flooding will continue to occur as it does at present over the improved park and recreational area. A description of the entire drainage improvements is given in Appendix III.

It should be further noted that all subdivision lots and services, including the sewage treatment reed beds have been located above the proposed 100 year flood limit of 16.7 m.

The impact of the post development drainage system as compared with the pre development system will be positive. Hence, not only the proposed Coral Springs development itself, but also the existing housing area to the south will benefit from the improvements. These positive impacts will be permanent and irreversible once the infrastructure has been built and the depression area is properly maintained to allow for maximum percolation of the drainage water to underground.

6.3.2 Water Quality

Sewage Treatment and Water Quality

The wastewater treatment system designed for the Coral Spring development is basically the same as that operating at Florence Hall, although with minor differences. The basic system comprises:

I. Septic tanks for anaerobic breakdown of the organics.
II. Constructed wetlands (reed beds) for further breakdown of the organics and uptake of nitrates and phosphates. Coliform bacteria are significantly reduced in the reed beds.
III. Disinfection (chlorination) chambers for effective elimination of the fecal coliform bacteria.

In the case of the Coral Spring development, each house lot will be provided with its own septic tank to cater for a household of average 4.5 persons. Where occupancy significantly exceeds this average, it may be necessary for the lot owner to put in a second tank. The lot owner will also be responsible for the periodic emptying and disposal of the septic tank solids by a certified contractor.

From the individual septic tanks, the wastewater will flow by the sewage collection system to one of four constructed wetlands (reed beds) located generally around and above the drainage depression area. From the wetlands, the effluent will flow to three chlorination chambers. The northern and eastern lots wetland effluent will be chlorinated together.

Final disposal of the effluent will be via the sinkhole in the drainage depression area. Based on the quality of the effluent designed for (according to NEPA standards) and based also on two years' experience with a similar system at Florence Hall, it is anticipated that the final effluent will be of equal or better quality than the surface drainage water. Hence, no contamination or water quality impairment of either the ponded water or groundwater should occur.

The overall impact of the designed sewage treatment system should therefore be positive and permanent.

6.3.3 Ecological Impacts

Change in Vegetation Cover

Most of the vegetation to be removed will be from the thick dry limestone forest on the flatter lands, but the open limestone forest will also suffer significant loss on the steepest areas reserved for service lots. The riverine forest will be mostly left intact but considerable cleaning up and clearing of fallen trees will be necessary. All these changes will affect the bird and other faunal species, but the overall composition of the fauna will not be greatly altered, except on the flatter area where the majority of houses will be built.

Due to the nature of the development, the impacts on the ecosystem as a whole will be irreversible in the short and long term. Tree species composition within the residential lots will also most likely vary considerably from natural forest species and may be expected to be comprised of non-native fruit trees and ornamentals. The four (4) endemic species of plants identified – God Okra (*Hylocereus triangularis*), Bromeliad (*Hohenbergia* sp), Orchid (*Broughtonia sanguinea*), and Broom Thatch (*Thrinax parviflora*) - will be preserved in the forested areas on the escarpments, but will likely be lost in the housing areas.

Because the proposed development is located within a larger forested area which is divided by the Highway adjoining the Coral Spring property, the wider expanse of limestone forest in the immediate area will remain a favourable habitat for all of the species encountered at the Coral Spring site. Hence the local and migratory species that are found at Coral Spring will continue to populate the general area.

Natural vegetation loss 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 forest may not be able to range freely, ultimately depleting resources within their biological islands.

With the loss of native forest species in the housing area, new species will be introduced by various home owners for landscaping and other aesthetic purposes as is typical. It is critical that these species be non-invasive and so not compete with the natural vegetation.

Impact of Vegetation Change on Faunal Composition

The natural vegetation provides nesting for several of the bird species identified. With the loss of about 180 acres of natural forest, the nesting capacity for birds will definitely be reduced. This will include both the game (example Bald Pate and White Wing) and non-game species. The loss of the former will be a major negative impact on the many bird shooters who frequent the Coral Spring site. As far as the non-game species are concerned, the majority are insectivores and the loss of so many trees on the site will also result in their reduction.

Significant vegetation removal will reduce the butterfly population and diversity, and other observed insects and the chiroptera observed. The mongoose population should also decrease due to the increase in open areas.

The enlargement and cleaning up on the pond area will lead to an increase in fish population in the pond surrounding the sink hole, and maybe an increased attraction for water birds and the Jamaica Slider Turtle which now exists in small numbers in the pond.

In summary, the removal and other changes in the natural vegetation at Coral Spring will generally have a negative and irreversible impact on the ecology there. However there will also be some positive impacts as described above. The overall impacts should be no greater than those observed in similar housing developments in dry limestone areas, for example Florence Hall.

Mitigation Measures

The following standard practices are recommended for minimizing the ecological impacts at the site:

- A proper balance between natural vegetation removal and preservation must be managed to ensure that biologically isolated "islands" of natural vegetation are not created. Leaving corridors for species provides a solution to this, as well as serving the purpose of providing aesthetic balance.
- 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.

6.3.4 Natural Hazards

Flooding

Surface water flooding, generated from typical trade wind conditions, tropical storm conditions and other weather phenomena is possible based on site location, the central sinkhole critical to local drainage, and surface water network. The 100 year evaluation of the sinkhole was undertaken in this study to determine appropriate no fill zones that would minimize flood levels.

Earthquake

Earthquake is a natural hazard risk to which all of Jamaica is vulnerable to varying degrees. Vulnerability to the effects of earthquakes particularly in the central and south western sections of this site is moderate due to the unconsolidated nature of the underlying strata in addition to high groundwater table, both of which accelerates earthquake forces thus increasing the liquefaction risk.

A geotechnical evaluation of the potential earthquake forces and design elements required to reduce these risks is necessary to guide the engineering aspects of the development. The geotechnical data generated to date indicate that the geological foundations, land slopes and surface soils are appropriate for the type of development and structures that are planned.

6.4 Socioeconomic Impacts

6.4.1 Employment

The project will deliver direct and indirect employment (approximately 250-300 jobs) and incomes growth benefits. Indirect employment will stem from the services required by the new home owners who will settle in Coral Springs and include domestic services such as house keepers, gardeners, construction workers for addition to houses.

6.4.2 Security

The expected increase in the number of persons living in the area as well as those entering for labour will, in the short term, pose some security concerns for the communities of interest, most so for the existing Coral Springs Housing Estate. This has been clearly expressed by residents who have been consulted. These perceived impacts are long term and irreversible but are insignificant.

6.4.3 Housing

Like the nearby Florence Hall and Stonebrook Housing Developments, the Coral Springs Housing Development is expected to contribute to filling the gap in middle income housing demand in the greater Falmouth area. There is a growing tourism trade in Falmouth and hence the increased opportunities for employment in various forms. In the past provision of adequate housing of good quality has restricted the movement of skilled professionals such as those in health care, teaching, among others, into the Greater Falmouth area for employment opportunities. With the growing stock of good quality middle income homes more development opportunities are likely to be introduced into Falmouth.

6.4.4 Waste Management

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

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

Mitigation Measures

- ◊ A warning sign should be erected in the vicinity of the pond/sinkhole.
- ◊ Garbage collection should be adequately facilitated by regular collection.

6.4.5 Impact on Neighbouring Communities

Socio Economic project impacts on the neighbouring communities comprise both positive and negative impacts. Beneficiaries will comprise households; public sector and private sector business interests not the least being staff housing availability for current and planned large developments. This benefit is likely to extend beyond the immediate project area to include the external community. Persons working in the Falmouth area commute daily from as far as St. Ann's Bay and Montego Bay.

An immediate benefit will be the job creation opportunities to skilled workers during the construction phase and in the post construction phase when additional home improvements are typically made. Local suppliers of hardware and electrical goods and appliances also benefit from large housing developments. Local haulage and public transportation services will be important beneficiaries, as too, other sub-sectors such as the household services trades.

It can be reasonably inferred that Falmouth will be the main trade beneficiary locally, and the other communities will also share the benefits.

Table 6.4.5: Impact matrix for Coral Springs Housing Estate

Main Issues	Possible Impacts	Possible Impacts			
		Direction	Duration	Magnitude	Type
Possible Impacts Due to Construction Phase of the Development					
Employment	Generation of employment for housing construction activities	Positive	Short term	Significant	Reversible
Disruption of surface and ground water: 1. Changes in hydrologic regime	Impairment of: ✓ drainage	Negative	Short-medium term	Major	Irreversible
2. Pollution from leaching of spoils deposits	Impairment of: ✓ aquatic ecology ✓ pond water quality	Negative	Short-medium term Short-medium term	Major Major	Reversible Reversible
Removal of forest cover	Loss of plant species Reduction in bird populations Reduction of most faunal species	Negative Negative Negative	Long term Medium-long term Long term	Significant Significant Significant	Irreversible Irreversible Irreversible
Escape of air pollutants and dust	Damage to health and nuisance	Negative	Short term	Minor	Reversible
Noise and vibrations from blasting and other activities	Damage to health and nuisance	Negative	Short term	Minor	Reversible
Waste disposal: Solid Liquid	Pollution of receiving water in the pond	Negative	Short term	Minor	Reversible
Environmental aesthetics degradation	Loss of environmental aesthetics	Negative	Short-medium term	Major	Irreversible

Main Issues	Possible Impacts	Possible Impacts			
		Direction	Duration	Magnitude	Type
Possible Impacts Due to Operation of the Development					
Drainage and surface run-off	Improvement in natural drainage – Dry Valley and Coral Springs sites Increase in percolation to groundwater Reduction of flooding in existing housing estate Aesthetic improvement of sinkhole/pond area	Positive Positive Positive Positive	Long term Long term Long term Long term	Significant Major Major Major	Irreversible Irreversible Irreversible Irreversible
Water Resources Management: (i). Groundwater	Concentration of groundwater percolation in pond area	Neutral	Long term	Major	Irreversible
(ii). Sewage Treatment	Placement of septic tanks in residential lots with management responsibilities by householders Tertiary treatment of effluent by constructed wetlands followed by chlorination	Neutral Positive	Long term Long term	Major Major	Irreversible Irreversible
Ecology	Loss of forests Bird population will lose major habitat and feeding species Fragmentation of habitats	Negative Negative Negative	Long term Long term Long term	Significant Significant Significant	Irreversible Irreversible Irreversible
Housing	Project will add to housing stock in a development corridor	Positive	Long term	Major	irreversible
Existing residents	Loss of sense of peace and quiet/serenity	Negative	Long term	Major	irreversible
Commercial areas	Ease of access to gas station and other facilities that will come into area	Positive	Long term	Major	irreversible
Transportation and Traffic	Improved access road increase in traffic, ingress and egress issues	Positive Negative	Long term Long term	Minor Minor	Irreversible Irreversible

Main Issues	Possible Impacts	Possible Impacts			
		Direction	Duration	Magnitude	Type
Solid Waste Management	Improper disposal with aesthetic impairment, increase in vectors and nuisance species	Negative	Long term	Minor	Reversible
Utilities Water supply Electricity supply		Neutral	Long term	Major	Irreversible
Bird Shooting	Loss of an active bird shooting stand	Negative	Long term	Minor	Irreversible
Education	Provision of space for basic school	Positive	Long term	Significant	Irreversible

6.4.6 Carrying Capacity

Water Supply

The National Water Commission (NWC) is the regulatory body with responsibility for the allocation and treatment of potable waters in Jamaica. Water consumption estimated for the Project is approximately 595 m^3/day based on 250 gallons per household for the 400 units. Discussions held with representatives of the National Water Commission (NWC) in Martha Brae have confirmed that an adequate supply of water exists to meet the Project's requirements as it has done for other developments such as Florence Hall which reportedly did not have a significant impact on the availability of potable water. It is the way that water use and allocation are managed that will be integral to the supply and demand for new projects in the Falmouth area.

Waste water treatment facilities will be provided for the development as there is no central system in Falmouth. The treatment facility is designed for an average of 4.5 persons per household and also incorporates use from the commercial zone.

Solid Waste Facilities

The current capacity of the responsible solid waste body in western Jamaica (Western Parks and Markets) is already overwhelmed by the ongoing growth in population in the parish. With each Jamaican producing approximately 1.5 kg of waste per day (Energy from Waste Policy 2010-2030) major solid waste disposal facilities such as the Riverton Dump is projected to reach its full capacity by 2014. An addition of some 500 houses and hence 3375 kg of daily waste will not significantly impact this situation. It is clear that the need for long term waste management solutions in Jamaica is eminent. The Government of Jamaica's Energy from Waste Policy (2010-2030) makes provisions for the economic utilization of wastes for energy production and that would then provide more space for disposal.

Health Care Facilities

With the additional increase in the population at Florence Hall Estate and Stonebrook the public health care system in Falmouth is said to already be overwhelmed. Furthermore the new cruise ship pier has also put even more pressure on the public health system as Public Health Officers must undertake inspections of the shipping facility at least twice per week when the ships berth. Some days they are required to monitor activities at the ship for its duration in port.

An increase in the population of at least 2000 due to development at Coral Springs will further add to the stress of the facilities. However, the facilities had long outgrown the demand placed on them before the introduction of Florence Hall and Stonebrook housing developments due to the large expanse of the geographical area served.

Although no plans have been made for expansion of the Public Health Facility to date it is clear that upgrading and expansion is now necessary to facilitate the projected development of the next tourism mecca in Jamaica.

Emergency Services

Services such as firefighting are deemed as inadequate in Falmouth. One advantage that the development possesses is that there will be adequate fire hydrants throughout the development which should prove useful when such eventualities occur.

7.0 CUMULATIVE IMPACTS

Cumulative impacts result when the effects of an action are added to or interact with other effects in a particular place and within a particular time. It is the combination of these effects, and any resulting environmental degradation, that is the focus of the cumulative impact analysis. While impacts can be differentiated by direct, indirect, and cumulative, the concept of cumulative impacts takes into account all disturbances since cumulative impacts result in the compounding of the effects of all actions over time. Thus the cumulative impacts of an action can be viewed as the total effects on a resource, ecosystem, or human community of that action and all other activities affecting that resource. Cumulative impacts are also assessed in terms of the incremental effect that acts cumulatively with the effects of other actions, either past, existing or future.

The existing populations at Coral Springs along with the new housing developments in the area from Greater Falmouth to Martha Brae are considered in the cumulative impact assessment of this project.

Noise and Vibration Effects

Cumulative noise impacts are assessed in terms of traffic-related noise and a general increase in urbanization in the Coral Springs area. The commercial area will also add to this urbanization of the area particularly the proposed gas station which will generate much traffic due to the long distance of both east and west of other existing gas stations. It is expected that the existing Coral Springs residents will no longer enjoy the levels of peace and tranquility currently that they have experienced for years. The cumulative impact can hence be both positive and negative.

Air Quality and Dust Effects

Implementation of the proposed project would result in short-term impacts to air quality associated with construction and long-term impacts associated with increased vehicle traffic. These will be most felt by the existing residents in the Coral Springs Housing Estate. Implementation of appropriate mitigation measures will reduce potential short-term impacts related to construction, however these will not completely mitigate for them.

Traffic and Transport Effects

The development will include only one entrance from the highway. This is likely to result in a cumulative impact of traffic over time as increasingly more residents move into the area. Development of all the several housing projects in the Greater Falmouth area also calls for improvements in the public transport system which will experience an overall increase in demand.

Drainage and Hydrology

The studies conducted to date indicate that the central sinkhole/pond is critical to drainage of the Coral Springs property as well as for the Dry Valley site to the south of Coral Springs. The proposed development is projected to result in an improvement to the overall drainage conditions in the Coral Springs property. However, any future developments at Dry Valley could result in a cumulative impact on drainage of the sinkhole/pond.

Fire and Police

The proposed project is expected to increase demand on police protection and fire and emergency services. The local government will need to examine and address the need for additional police services and recommend methods to maintain acceptable service levels.

Education

The proposed project, projects under construction in the Falmouth area, as well as foreseeable future projects, will contribute to the cumulative need for additional school facilities. This is particularly related to secondary level education which is already limited in the Falmouth to Martha Brae area. Most new developments have made provisions for basic school level education. Provision of additional primary and secondary educational facilities should be taken under consideration in the long term development plan of this area as it is projected to develop even further.

Vegetation and Wildlife

Development of this project, combined with other developments in the woodlands surrounding Falmouth, will contribute to the loss of forests through land clearing and an increase in human presence in the area. Continued development in the area surrounding Coral Springs would extend bare areas once characterized by natural habitats and utilized by some endemic plant and wildlife species into housing and resort developments.

Although the development plan for the project allows for the retention of some woodland on the Coral Springs Estate, the construction of houses means loss, sensory alienation and fragmentation of habitat and direct mortality due to increased traffic.

Visual Impact and Aesthetics

The proposed project will contribute to the change in visual character of the Coral Springs area. While the project site presently represents natural forests in a mostly undeveloped site the proposed project of over 400 houses would incrementally contribute to the developed, suburban nature of the Coral Springs area. These visual changes will be most evident to the existing residents of Coral Springs. In conjunction with other existing, developing or planned developments, the project's contribution to the loss of a forested area would represent a cumulative impact.

8.0 ASSESSMENT OF ALTERNATIVES

No Build Alternative

The no-build alternative would mean that the property is not further developed to provide the additional housing solutions required in the Greater Falmouth area. The proposed improvements in the drainage for the Coral Springs area that would reduce the flood impact to the lowlands surrounding the sinkhole/pond will not be achieved if the development is not constructed. Present flooding would continue to occur and also possibly become exacerbated as the impacts of climate change and variability continue to produce intense meteorological events.

Retention of Forested Slopes

As an alternative, the developer may consider leaving the slopes in their natural state with no consideration for subdivision of these sections of the site. The Forestry Division's Private Forestry Programme provides property tax exemptions for land owners who allow their forested properties to remain undeveloped. This would prevent any issues with poor slope development and resultant slope failure brought on by the new land owners who will often breach land clearance and development protocols agreed in sales contracts, etc.

Sewage Treatment Options

The developer may also consider allowing existing Coral Springs residents to have the option of connecting to the central sewage system. This could likely minimize the contamination that appears to emanate from the existing housing estate.

9.0 OUTLINE MONITORING PLAN

Environmental monitoring of construction activities relates to environmental legislation and regulations, permits and authorizations, erosion and sediment control, deleterious substance control, air, noise and water quality assessments, habitat management, site and habitat restoration, environmental management plans. Effective environmental reporting and diligent professional practice are of essence to the monitoring programme that is implemented at any major construction.

As is typical under the NEPA system, if a permit is granted for the proposed development, a Monitoring Programme will be requested for submission to NEPA for their approval before site preparation and construction activities begin at the project site. The aim of the Monitoring Programme is to ensure the following:

- compliance with relevant legislation
- implementation of the mitigation measures provided in the EIA submitted to the Client and regulatory agencies
- conformance with any General or Specific Conditions as outlined in the permit
- long-term minimization of negative environmental impacts

9.1 Components of the Monitoring Programme

The following sections present the basic requirements of a typical environmental monitoring programme.

9.1.1 Initial Project Team Consultations

Prior to commencement of the project, a meeting should be convened between GDL, NEPA and ESL to review the monitoring programme in detail and to agree on its purpose, mode of implementation, and the procedures for monitoring and reporting. This meeting should also include a review of the construction schedule and methodologies.

9.1.2 Monitoring Frequency

For the duration of the construction works it is likely that the project site will be inspected once per month for the first six months of the construction phase, then on a quarterly basis for the rest of the project. This has been the typical experience with NEPA permits of this nature. If deemed necessary, this monitoring frequency may be adjusted at any stage by NEPA after consultation with Gore Developments and their environmental representatives.

Monitoring of the operations phase will be done on a bi-monthly basis for the first six months.

9.1.3 Construction Phase Monitoring Tasks

The project areas to be monitored will be determined and specified.

Materials Sourcing and Transport

Objectives:

1. To ensure project does not induce indirect environmental impacts due to illegal quarry operations.
2. To ensure that transport of earth materials does not cause undue spillage or dusting.

Tasks:

- Through Contractor, examine quarry licenses to verify that earth materials are supplied from approved quarries.
- Confirm that material in trucks as they traverse the property is covered with tarpaulin and that tailgates are closed during transport.

Construction Works

Objectives:

1. To maintain sites in tidy manner with adequate sewage and garbage facilities.
2. To ensure that the general construction site works do not exceed air quality standards for respirable particulates or create other environmental problems.

Tasks:

- Inspect construction sites to verify provision and use of garbage receptacles and VIP or chemical toilets for worker use.
- Inspect equipment maintenance yard and ensure that marl base is laid to absorb spilled oil and lubricants.
- Inspect site to ensure that fine construction materials are stored and covered/contained without risk of being washed into drains.
- Inspect site and verify that dust is adequately controlled by wetting.
- Measure noise levels and respirable particulates.

Solid Waste Management

Objective:

To ensure that solid waste generated at sites during the construction phases are disposed of in an environmentally acceptable manner.

Tasks:

- Verify use of identified disposal site by contractor.
- Inspect sites to ensure that construction wastes/garbage are not being scattered over the site or deposited in the pond/sinkhole.
- Inspect site to ensure provision of adequate numbers of garbage receptacles.

Water Quality

Indicator parameters for nutrients, organics and bacteria are usually monitored within water bodies at the project site to control the discharge of sediments and pollutants from construction activities.

Objective:

To determine whether quality of surface waters is being adversely affected by construction activities (at sampling stations selected to reflect water quality at project sites)

Tasks:

Measure water quality at specified sites on a monthly basis, prior to and throughout the duration of the construction phases. The parameters to be measured will be as stipulated in the permit granted by NEPA.

Ambient Air Quality

Various categories of construction activities will generally produce windblown dust as the site is cleared and exposed surfaces are created on the site. High dust levels can lead to complaints from neighbours. Air monitoring equipment that measure particulate matter are generally set up to monitor the 24 hour dust levels at the site so the developer will be cognizant that the site may require greater levels of mitigations such as more frequent wetting of marled surfaces.

Noise

Noise monitoring at construction sites is usually done to determine if the construction activities exceed recommended standards beyond the boundaries of the site. In other words environmental monitoring for noise can advise if the activities are nearing nuisance levels and / or whether complaints are valid. The relevant mitigation measures such as screening and servicing of equipment will normally be implemented by the developer at large construction sites such as the proposed project.

Vegetation

The regulators will normally require that large trees be flagged in an effort to retain as much as possible of the native vegetation. Phased clearance of vegetation is usually required by the regulators and should also be monitored throughout construction.

REFERENCES

A.C. Waltham and P.G. Fookes. 2003. Engineering classification of karst ground conditions, QJEGH, vol. 36. pp101-118

Bibby C.J.; Jones, M.J. and S.J. Marsden. 1998. *Expedition Field Techniques: Bird Surveys*. Expedition Advisory Centre, Royal Geographical Society, London.

Douglas, L.R. 2001. *The impact of disturbance on resident and migrant birds occupying the tropical dry forest life zone of Jamaica's South Coast*. M.Phil Thesis University of the West Indies.

FCS Consultants. 2012a. Coral Springs Drainage Design Engineering Report.

FCS Consultants. 2012b. Coral Springs Sewage Treatment Design Engineering Report.

FCS Consultants. 2012c. Coral Springs Sewage Treatment Plant Operation and Maintenance Manual.

FCS Consultants. 2012d. Engineering Report: Water Supply Report.

Garraway, E. & A. Bailey 2005. *Butterflies of Jamaica*. Macmillan Publishers Limited.

Kiraly, L. 2002. Karstification and Groundwater flow in Grabrosvek, F. (Ed.), Evolution of Karst: from Prekarst to Cessation, Postojna-Ljubljana: Institut za raziskkovanje krasa, ZRC SAZU, pp155-190.

NHL Engineering. 2012. Coral Springs Soil Investigation Report.

Raffaele, H., *et al*. 1998. *A Guide to the Birds of the West Indies*. Princeton University Press. New Jersey.

Richardson, B. 2012. Coral Springs Sinkhole Evaluation.

Wunderle Jr, J.M. 1994. *Census methods for Caribbean land birds*. Gen. Tech. Rep. SO-98. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station

Hill, D.A. 2005 *Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring*. Cambridge University Press.