ENVIRONMENTAL AND SOCIAL ASSESSMENT FOR PROPOSED HOUSING DEVELOPMENT- CORAL SPRING VILLAGE 2 TRELAWNY

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Draft Final Report

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Executive Summary

Gore Developments Ltd (GDL) proposes to extend the existing Coral Springs 1 housing development in Trelawny. This expansion aims to address the growing demand for housing on the north coast of Jamaica, while adhering to sustainable development practices. The project's site and situation necessitate careful consideration of potential impacts on local flora and fauna, hydrology and water quality.

The aforementioned concerns, *inter alia*, underscore the importance of comprehensive environmental assessment and mitigation planning. It is significant to note the need to meet national/ regional housing needs as well as the setting of the development within the North coast resort development corridor and its proximity to other existing and proposed developments.

Project Description

The site is located about 7 km due east of the town of Falmouth and 7.5 km due west of Duncans, Trelawny. It is bordered by the Coral Spring-Mountain Spring Protected Area (CSMSPA) to the west and the existing Coral Spring community to the south. The proposed development site spans approximately 0.7 km^2 with a perimeter of about 3.22 kilometers and is located in close proximity to the North Coast Highway and Ocean Coral Spring Hotel.

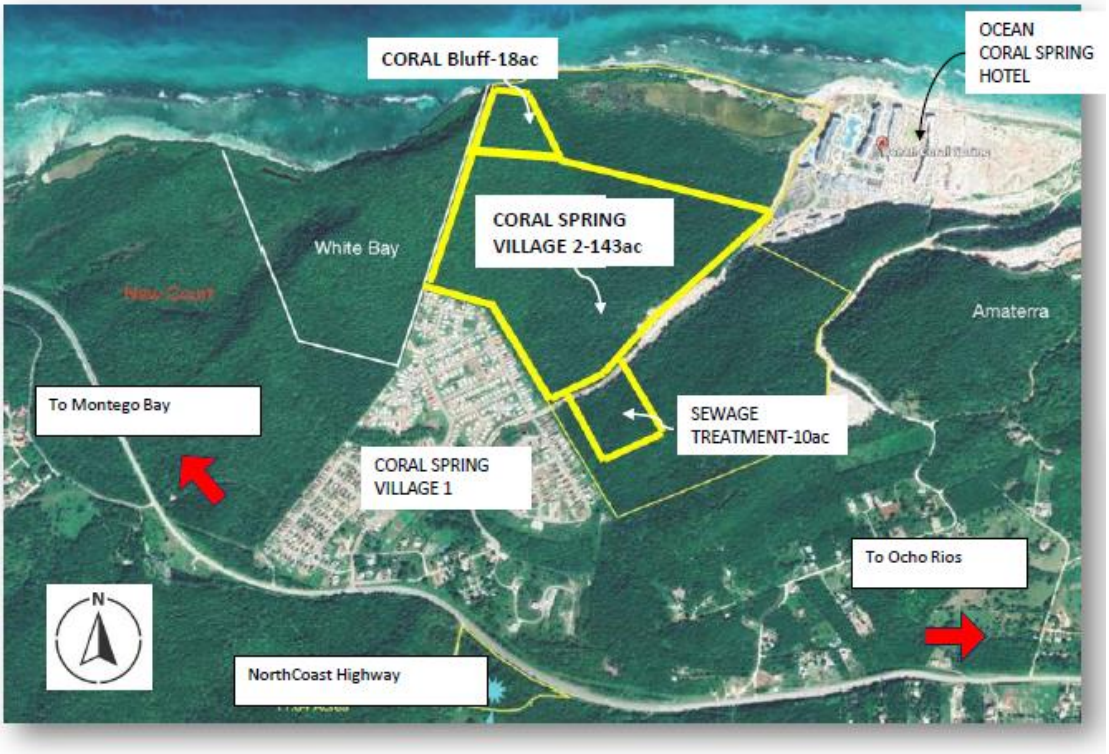


Figure 1: Location of Proposed Development Site

Project Components

Coral Spring Village 2 comprises two main sectors of houses, delineated by the central boulevard leading to the Coral Bluff duplex development. The southern sector encompasses 397 lots situated on undulating terrain, which is conducive to construction, and naturally divided by terrain features and nature reserves where the existing tree cover will be preserved. The road layout in this sector is designed to accommodate the terraced nature of the land, optimizing views of the ocean for many of the homes. On the other hand, the northern sector consists of 203 lots situated on flat land within its own neighborhood. A spacious detention area is incorporated to provide open space, while a landscaped neighborhood park utilizing native floral species will enhance the area's aesthetics.

Project schedule and Timelines

Land Clearing and Filling (12 months)

This initial phase, estimated to take 12 months, involves preparing the site for construction. Activities include the removal of vegetation, rocks, and any existing structures. The land will be leveled and graded to ensure a stable foundation for subsequent construction activities. This stage is crucial for addressing any geotechnical issues, such as sinkholes or cavities, which could impact the stability and safety of the development.

Set Up Property Office, Storage Areas, and Batching Plant (5 months)

Following land clearing, temporary facilities will be established to support the construction process. This phase is expected to take 5 months. The property office, storage areas, and batching plant will be located in the southern section of the property on sloped lands (~10 acres). The strategic location minimizes transportation time and ensures a steady supply of concrete for foundation and structural works. The batching plant will be essential for concrete production, while the storage areas will house construction materials and equipment. The property office will serve as the hub for project management and coordination.

Foundation Works (12 months)

The foundation phase is estimated to take 12 months. It involves laying the groundwork for the buildings and infrastructure. Activities include excavating trenches, pouring concrete for footings and slabs, and installing necessary reinforcements. Given the site's geological characteristics, such as potential sinkholes and cavities, careful engineering and design will be employed to ensure robust foundations capable of supporting the planned structures. This phase is critical for ensuring the structural integrity of the development.

Proposed Location for STP (Sewage Treatment Plant)

The Sewage Treatment Plant will also be situated in the southern section of the property, in proximity to the proposed property office, storage areas, and batching plant. This centralization facilitates efficient management and monitoring of construction activities and environmental controls.

Throughout these phases, continuous monitoring and quality control will be implemented to ensure compliance with environmental and safety standards. This includes managing runoff and erosion during land clearing, ensuring proper handling and storage of materials, and maintaining construction equipment to prevent leaks and spills. These measures are essential for minimizing the environmental impact of the construction activities and ensuring the long-term sustainability of the development.

Regulatory Framework

Permitting Requirements

Successful implementation of the project requires adherence to various regulatory frameworks and obtaining several permits. Below is an outline of the key permitting requirements essential for the project, ensuring compliance with national regulations and promoting sustainable development.

1. Subdivision and Environmental Permits
2. Diesel Storage and Batching Plant Permits
3. Sewage Treatment Plant (STP) Permit

The Physical Environment

The property features undulating terrain with rolling hills sloping toward the sea. Elevations range from 71 meters in the southern part to approximately 5 meters at the northern boundary. Digital Elevation Model (DEM) used to delineate catchments and drainage lines shows drainage channels flowing northward from the southeastern hills, corresponding to mapped sinkholes. The area lacks perennial rivers due to impermeable surface geology (coastal aquiclude) and karst limestone composition. Steep slopes are primarily on the eastern side, transitioning to gentler terrain with rounded hilltops and an undulating landscape. Surface runoff is expected to flow northward toward the mangroves and sinkholes.

The project area features karstic terrain with mature karst, small cavities, voids, fractures, and pinnacle karst. Karst features include dissolution cavities, sharp points, and pits, particularly in the central and eastern sections. Cavities can be managed with proper engineering solutions like grouting, raft foundations, geogrid, or piles. Two caves, Stewart's Cave and Johnson's Cave, are located within 500 meters southeast of the site. A small collapsed cavern observed in the north-central part requires further investigation during site clearance.

The northern sections of Trelawny parish predominantly feature bauxitic soils associated with White Limestone. The project site is characterized by Bonnygate stony loam soil, known for its brown or reddish hue, rapid drainage, low moisture retention, and slightly alkaline pH. Geotechnical investigations noted shallow or absent soils with exposed bedrock, typical of raised reef platforms. According to the Trelawny Local Sustainable Development Plan, areas with this soil type are recommended for residential development. The soil composition mainly consists of stony loam and clay with low permeability, categorized under Hydrological Soil Group B.

The site experienced tectonic uplift during the Miocene period, forming raised reef terraces and headlands. The site is affected by three prominent northeast-southwest trending faults, forming a steep fault-bounded escarpment. These faults displace older reef deposits but are not seismically active. The project area has a lower seismic risk compared to other parts of Jamaica. Historical earthquake data and the seismic hazard map indicate a Modified Mercalli Intensity (MMI) of 6 with a 10% chance of exceedance in any 50-year period.

Hydrology and Drainage

The site lies within the Limestone and Coastal Aquiclude hydrostratigraphic units, characterized by karst limestone formations, resulting in limited surface drainage and a predominance of underground drainage systems. The property has a sloping terrain with an elevation difference of 35 meters from south to north, with the western boundary on the Roslin Castle ridge and drainage flow

primarily towards the north where several depressions or cavities exist. Runoff from the eastern ridge (Stewart Castle) flows onto the access road and into the salina.

Hydrogeological studies and site visits confirmed the presence of karst limestone and revealed groundwater levels averaging about 6 meters ±1.7 meters above sea level.

Data from the Water Resources Authority (WRA) indicates five wells within the Duncans sub-watershed management unit with varying depths and static water levels, and the presence of two caves (Stewart Castle and Johnson caves) indicating subsurface discharge of groundwater.

Several sinkholes on the northern margin of the property suggest potential ponding from development drainage, requiring post-development attention. 63 catchments were delineated from the Digital Elevation Model (DEM), with 20 within the residential subdivision and 3 impacting the property. Under pre-development conditions, peak discharges of 8.142 cumecs (50-year period) and 9.038 cumecs (100-year period) were observed, with Catchment I indicating the highest peak flow. Post-development conditions showed an increase to 16 cumecs (50-year period) and 18 cumecs (100-year period) at the final outlet point (Junction A), indicating a 50% increase in flow.

Climate and Rainfall

Variations in temperature and rainfall across Jamaica are primarily driven by the island's Tropical Marine climate. Over a 30-year period, the temperature recorded for the area aligns with the temperature patterns typically observed across the island. The coolest period spans from December to March, with temperatures reaching their peak during the summer months. An anomaly is observed with a temperature decrease in August, contrasting with the usual trend of peak temperatures in July and September, which emerge as the hottest months with average temperatures peaking at just under 28°C.

May stands out as the wettest month, experiencing higher levels of rainfall compared to any other month in the late wet season. Apart from May and the period between September and November, all other months of the year receive less than 100mm of rainfall on average. Over a 30-year period, monthly mean rainfall varies between 69 mm (minimum) and 222 mm (maximum). Drier months: December to March, with average rainfall rarely exceeding 130 mm. Wet periods: October to January and May.

Water Quality

Based on the results obtained from the samples collected during the assessment, all samples could be classified as saline or highly saline water samples (see Table 4 6). Sampling points WQ1 - WQ3 exhibited salinities greater than 38 ppt and can be defined as hypersaline waters, while sampling points WQ4 – WQ8 had salinities between 37.52 and 37.61 ppt and can be classified as saline or marine water samples. The table below summarizes the results.

Description	Results
Marine Water Samples (WQ4 - WQ8)	Marine Water Samples (WQ4 - WQ8) exhibited alkalinity values characteristic of marine water samples (between 100 – 130 mg CaCO3/L). Alkalinity values ranged from 118.5 – 126.1 mg CaCO3/L. Samples had high clarity, low oxygen demand, low nutrient concentrations, and were typically free from enterococci, E. coli, and faecal coliform. Likewise, there was evidence of low levels of total coliform in the water.

Description	Results
Hypersaline Samples	Hypersaline samples showed higher alkalinity values (250.2 – 253.4 mg CaCO3/L) due to the higher concentration of ions. All samples exhibited levels of total coliform. WQ1 and WQ2 had low levels of faecal coliform and E. coli, with enterococci detected at WQ1. Lower water clarity and higher oxygen demand compared to marine water samples, possibly due to water stagnation.
Marine Water Quality (WQ4 – WQ8)	All marine water samples collected were compliant with the Draft NRCA Ambient Water Quality Guideline – Marine, 2009 for biochemical oxygen demand, suggesting that the areas sampled were relatively unpolluted from substances that could cause oxygen depletion in the marine environment.
Dissolved Oxygen (DO)	Ideal ambient water quality standards for DO concentration in Marine Environments should be greater than 5 mg O2/L. All sites, except WQ8 and WQ5, had DO concentrations lower than this value at the time of sampling. Although lower than the specified value, all samples had DO concentrations above 4 mg O2/L, indicating that organisms would not be adversely affected.
Fats, Oil, and Grease	Fats, Oil, and Grease was not detected at any location.
Turbidity and Total Suspended Solids	These were low values indicating relative clarity of the water samples. Turbidity ranged from 0.47 – 0.72 NTU. Total suspended solids ranged from 1.7 – 6.9 mg/L.
Nutrients	Nutrient enrichment, particularly nitrates and phosphates, poses a threat to coastal ecosystems by increasing the risk of eutrophication. Phosphates were undetected for most samples. Nitrates, though non-compliant with the Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009, remained low throughout all samples collected.
Microbial Parameters	Either undetected or within the specifications of the Draft Jamaica National Ambient Water Quality Standard - Marine Water, 2009.

Air Quality

All assessment sites (AQ1 to AQ4) were compliant with the PM10 Ambient Air Quality Standards for Jamaica (150 µg/m3). PM10 concentrations ranged from 13.8 µg/m3 (lowest at AQ4) to 20.6 µg/m3 (highest at AQ1). Sources of particulate matter included both natural sources (like wind-blown dust) and anthropogenic sources (such as construction activities, vehicular emissions, and uncovered dirt heaps). The predominant wind directions from NE suggest potential impacts on communities southwest of the proposed development, especially during construction phases.

Noise Levels

Average noise levels ranged from 54.8 dBA (lowest at AQ4) to 58.2 dBA (highest at AQ1). Ambient Noise Standard for residential areas is 55 dBA. Sites AQ1 and AQ2 were in pre-established communities south of the project, while AQ3 and AQ4 were in undeveloped areas near the project boundaries. Natural sources like wind were significant contributors to noise levels, with stronger

winds correlating to higher noise levels. Human activities such as chatter, music, and vehicular traffic also contributed to elevated noise levels, particularly at AQ1 and AQ3.

Biological Environment

Flora

- The site predominantly consists of dry limestone forest, with transitional areas intersecting beach and wetland ecosystems.
- Total Species: 108 species observed, belonging to 47 families and 99 genera.
- Endemism: 6 out of 84 native species are endemic, representing approximately 5.5% of the flora.
- Habit Distribution: Trees make up 35%, followed by herbs (31%), shrubs (23%), and vines (10%).
- Dominant Plant Families: Fabaceae (e.g., Logwood, Lead Tree) and Malvaceae (e.g., Raichie Tea bush, Seaside Mahoe) are predominant.
- IUCN Red List: 46% of species are categorized as Least Concern, 10% as Near Threatened, and 44% were not listed.
- Endangered Species: *Guaiacum officinale* is listed as endangered; *Tabernaemontana laurifolia* and *Portlandia grandiflora* are near threatened; *Celtis trinervia* is data deficient.
- Habitat Fragmentation: Clearings for roads and possible bird shooting activities have fragmented habitats.
- Evidence of tree cutting, branch stripping, and exotic species encroachment in cleared areas.
- The site faces challenges from habitat loss, fragmentation, and invasive species introduction due to human activities such as road/path development and potential hunting.

Fauna

- The fauna of the proposed development site at Coral Springs, Jamaica, includes a variety of wildlife species, ranging from colorful avian species to butterflies and reptiles.
- Each observed species plays a distinct role in maintaining the ecological balance of the adjacent ecosystem, highlighting its ecological richness and biodiversity.
- Specific lists of observed fauna include birds (referenced in Appendix 8.4 – Bird Species List) and butterflies (referenced in Appendix 8.4 – Butterfly Species List), categorized by their DAFOR ranking (Dominance, Abundance, Frequency, Occurrence, and Rarity).
- The presence of diverse fauna underscores the ecological significance of the area, necessitating conservation efforts to protect habitats and maintain biodiversity.
- The faunal assessment highlights the importance of integrating biodiversity conservation into development plans to sustain the area's ecological integrity and wildlife diversity.

Mangrove Forest Characteristics

- The mangrove forest at Coral Spring exhibits diverse species such as Black Mangrove, White Mangrove, and Buttonwood, each varying in tree density, height, diameter, and seedling density across different quadrats (Table 4.12).
- Significant differences in ecological conditions and habitat preferences are observed among the mangrove quadrats, highlighting the varied structure and composition of the ecosystem.

- Specific quadrats show dominance by different species, with varying heights and densities contributing to the overall mangrove biodiversity and ecological function.

Non-Mangrove/Coastal-Affiliated Species

- Non-mangrove coastal-affiliated species contribute significantly to biodiversity, providing habitats and resources for various organisms.
- DAFOR Ranking: Species like *Acacia sp*. and *Batis sp*. are abundant, indicating strong presence, while others like Seaside Mahoe and Seaside Daisy are occasional or rare, reflecting their varying occurrence in the coastal habitat.

Coral Reefs

- Severe coral bleaching is noted among various scleractinian species like *Siderastrea siderea*, *Orbicella annularis*, and *Pseudodiplora spp.*, as well as non-scleractinian species (e.g. *Millepora sp*.).
- AGRRA surveys provided an overview of existing coral species as well as their health status (i.e., species affected by bleaching events).

Seagrass

- Turtle grass (*Thalassia testudinum*) dominates the seagrass beds, with *Syringodium sp*. present in smaller patches.
- Observation of urchins, sea cucumbers, starfish, and diverse algal species like *Dictyota sp*. and *Sargassum sp*., all contribute to the benthic community richness.
- The substrate mainly consists of sand, coral rubble, and crustose coralline algae (CCA), supporting the diverse seagrass and benthic ecosystems.

Fish/Pelagic Species

- Low diversity and numbers of fish observed, predominantly non-commercial species like damselfish and angelfish, along with benthic species such as stingrays.
- Fish species are categorized based on their abundance and frequency within the survey area.

Socio-Economic Environment

Land Use Patterns

The Town and Country Planning (Trelawny Parish) Provisional Development Order, 2013, confirmed in 2015, guides developments, aiming to support local economy while protecting the environment. The proposed site is within the Greater Falmouth development area, identified for the need for additional housing to support population and commercial growth. The northeastern boundary is Adjacent to the Ocean Coral Spring resort (513 rooms). The southern boundary borders prior Coral Spring Village housing development. The western boundary adjoins the Coral Spring – Mountain Spring protected woodland. The area's growth in the last 15 years is driven by tourism infrastructure investments, including several hotel developments and residential communities.

Population and Household Demographics

The 2011 Census recorded 765 persons in the SIA, with significant changes since the Coral Spring Housing Development (2016), adding 517 housing units. Gender Distribution is 46.5% males and 53.5% females.38% males are household heads versus 32.5% females. There are high employment levels, with 80% of respondents employed. Main income sources include public sector (35%), tourism sector (21%), and retail/commercial activities (14%) and 19% are retirees, with pensions as their main income source.

Description of Existing Infrastructure

74.4% of households in the SIA are connected to the National Water Commission main and use indoor piped water as their primary drinking source. 92% are satisfied with their water supply. Dissatisfaction is due to low water pressure and sediments. 57% do not experience water lock-offs, and only 3% report weekly lock-offs. As a result, 64% do not store water in tanks or containers.

Coral Springs Village has its own sewage plant. Periodic checks by the local Ministry of Health are conducted, but it is unclear how frequently the plant is managed by the National Water Commission.

Western Parks and Markets service the area periodically. Collection is scheduled weekly, and the local government needs to make the necessary arrangements to facilitate the garbage collection needs for the new development. 66% have regular public collection, 23% irregular collection, and less than 5% burn or dump waste when collection is irregular.

52% use personal vehicles, 42% rely on public transport (including route taxis), and 5% are pedestrians. No designated bus stops or taxi stands exist despite a steady flow of route taxis.

44% of respondents report no public internet access, while 36% have it. No community hotspots were noted during site visits**.** All households have telephone service, with 98% having smartphones. 26% also have landlines.

The access road adjacent to the North Coast Highway is well-maintained. Internal community roads are in good condition with appropriate drainage. The junction at Coral Springs Road and North Coast Highway is a crash hotspot, with no traffic signals and frequent accidents.

Community Services and Facilities

Coral Spring Village (1) has a community center and recreational facility. Residents access services in Falmouth, including: Healthcare: Falmouth Clinic (Type IV) and Falmouth General Hospital (Type C); Security: Falmouth Police Station; Fire Services: Falmouth Fire Station; Schools: Duncans Infant and All Age, Hague Primary and Infant, William Knibb Memorial High, Falmouth All Age.

Perception of the Proposed Development

Most respondents favor the project concept. Disapproval stems from concerns about overdevelopment, dust, and noise pollution. 63% believe the community will approve the project. 50% think it is necessary or very necessary due to housing needs, infrastructure improvement, economic development, and property value enhancement. 91% are not concerned about the project's impact on the Coral Spring - Mountain Spring Protected Area. Concerns include wildlife impact, water sources, dust, and noise pollution.

Current Environmental Concerns

89% have no flooding experience. 9% of the surveyed population in the wider project area experience flooding during heavy rain, with 33% considering it severe. 64% believe their community is vulnerable

to earthquakes, flash floods, or droughts. 92% have no concerns regarding development of the area. The remaining 8% worry about water supply impact, traffic congestion, noise, soil erosion, and habitat impacts.

Culture and Heritage

- Indigenous and Colonial Heritage: The Mountain Spring-Coral Spring general area has cultural history, having been inhabited by various ethnic groups over the centuries. Notably, an indigenous Taíno site is located in the vicinity, with another site nearby.
- Colonial Evolution: The area was originally within the parish of St. James until Trelawny was established in 1771. Historical maps from 1684 to 1991 reveal the area's development, including the presence of ponds and activity areas.
- The Bochart and Knollis map (1684) depict an area called Flemingo with a large pond named Jarmu and a stream called Little River.
- Herman Moll's map (1728) shows cotton works near Jarmin Pond.
- By 1763, the area saw expanded settlements and the establishment of Mountain Spring Bay.
- Based on the examination of the project site, no evidence has been found of historical importance.

Cultural Assets

Artifacts dating from the late 17th century to the early 20th century have been previously discovered along the shore and near ruins but not on the project site. These include:

- Pieces of light and dark olive-green glass, fragments of wine bottles, slipware, pearlware, creamware, stoneware, and porcelain sherds.
- A nearly complete white clay smoking pipe.
- An assemblage of *Aliger gigas* (queen conch shells), a whole olive-green wine bottle, and fragments of olive-green wine bottles.
- European Influence: The artifacts recovered are of European origin, suggesting residential and commercial activities in the area during the historical period.
- Historic Port Facilities: The coastal area likely served as port facilities with a wharf for shipping produce and receiving imports. A historic road along the coast, now partly eroded, indicates the significance of this area as a transportation and trade hub.
- 19th Century Activities: In the 19th century, the area formed part of the Spring estate, involving sugar cane cultivation, wood harvesting, and cattle rearing.

Impact Identification, Analysis and Mitigation

The physical impacts of various activities associated with the project are outlined below, focusing on geotechnical risks, natural hazards, and operational phase concerns.

Geological and Geotechnical

Construction

1. Geotechnical risks include the presence of depressions, cavities, and voids, which pose threats to road infrastructure, equipment, and the safety of construction workers during construction activities.

2. Natural hazards such as flooding from excessive rainfall and storm events could lead to stormwater runoff, debris flow, and sediment deposition downstream, affecting marine and freshwater environments.
3. Construction, site clearance, and improper disposal of solid waste may also generate sediment that may be washed down into the coastal wetland and the marine environment.

Operation

1. Geological changes over time result in geotechnical risks, which can be aggravated during seismic activities. This risk can result in damage to housing, infrastructures and injury to people. The design of the housing development is crucial in reducing this risk and the potential impacts.
2. Cavities which currently exist on site based on geology can cause damage to building and other infrastructure from geotechnical risks within the area or those that appear over time either during construction or operation.
3. Sedimentation from loose material and transported material used could negatively impact the water quality along the coast if not monitored and controlled. This sedimentation could negatively impact the ecology of coastal and marine environments.
4. Sedimentation and loose material may also negatively impact the functionality of drains and could influence flooding in the immediate and surrounding areas.

<u>Mitigation Measures</u>

Mitigation measures are proposed to address these impacts, including site assessments by qualified professionals, proper construction practices, compliance with environmental regulations, and implementation of erosion and sediment control measures. It is crucial to ensure that activities are conducted in a manner that minimizes adverse effects on the environment and surrounding communities.

Construction

The following mitigation measures are recommended for implementation to minimize the potentially negative impacts in the construction phase of the development.

1. For an engineering geologist, geotechnical engineer or geologist to assess the site during site clearance and foundation excavation and determine the best approach, and have appropriate measures in place for the safety and security of all people and assets.
2. There should be minimal disturbance of the immediate area around the sinkhole if discovered during site clearance. The use of mechanized equipment near the sinkhole should be controlled as the underground system of cavities and streams is dynamic.
3. Plan and design Management Plans for the control of rockfalls and cliff excavation and include information on signage, communication with workers and protective barriers.
4. Construction practices, such as blasting is not recommended as it can change the geometry of the sinkhole throats and underground cavities, blocking outflow pathways and influence rockfalls.
5. Compliance with Environmental Permit conditions.
6. Sediment traps in any drains entering the sea/ implement other sediment control measures.
7. Do not store construction material/debris in natural drainage pathways.
8. Practice good housekeeping to avoid spreading litter and waste from human/construction activities.
9. Ensure there is an emergency response plan in place during construction.

Operation

The following mitigation measures are recommended for implementation to minimize the potentially negative impacts in the operational phase of the development.

1. Ensure all buildings and supporting infrastructure are designed according to proper building and seismic codes.
2. It is recommended that a geotechnical engineer/ engineering geologist be available to advise on best practices based on observations after site clearance.
3. Voids within the footprint of the development that are over 2 meters will be individually evaluated and an on-site decision taken for no buildings or infrastructure to be erected in that location.
4. Comply with permit requirement conditions granted by NEPA.
5. Concessionaires should abide by Erosion and Sediment Control Plans, Stormwater Management Plan, and Emergency Spill Response Plan, particularly near sensitive habitats such as mangrove areas adjacent to the road.
6. Inspect nearshore road sections and bridges intermittently for effects of coastal or riverine erosions.
7. Minimize bare areas and replant with vegetation, using native vegetation to the extent practicable to minimize sediment runoff from soils.

<u>Biological Impacts</u>

The proposed development will have an impact on the site's biodiversity, extending to adjacent areas. Bordering the Coral Spring-Mountain Spring Protected Area (CSMSPA), the site shares ecological processes and genetic exchange between species across boundaries. Potential impacts from the development include:

- Habitat Fragmentation and Loss: Clearance for roadways and paths has already fragmented the dry forest, and further development will remove most remaining forested areas on site. This may reduce carbon sequestration, coastline protection, water filtration, and/or habitat provisioning.
- Ecosystem Disruption: The intrinsic value of biodiversity will be lost, potentially exposing the CSMSPA to new impacts. Temporary impacts include dust and noise during development, while post-development impacts include altered hydrology, runoff, artificial lighting, and increased pollution.
- Anthropogenic Activities: Road and housing construction may affect the area's hydrology, and runoff and artificial lighting will impact surrounding fauna. Preliminary observations include solid waste dumping, mangrove cutting, evidence of firearm use (bird shooting), horse tours impacting vegetation, and high salinities in salina ponds.

Mitigation Measures

- Preserve existing biodiversity-rich areas within the development site.
- Undertake habitat restoration initiatives, focusing on native vegetation replanting.
- Carefully remove and transplant tank bromeliads, especially if they host endemic taxa.
- Implement nature-based solutions where possible such as a vertical (wall) garden on the concrete boundary wall between the development site and the CSMSPA to mitigate negative impacts.

- Implement strict zoning regulations and land-use planning to protect critical habitats and ecological corridors.
- Retain larger trees and incorporate them into the landscape design where possible, that does not interfere with the footprint of the infrastructure.
- Use wildlife-friendly lighting designs (e.g., monochromatic amber LEDs) to reduce impacts on nocturnal fauna.
- Install shields or directional lighting to minimize light pollution and its effects on surrounding ecosystems.
- Employ best-construction practices to minimize disturbance to surrounding ecosystems.
- Use erosion control measures to prevent sedimentation in water bodies and nearby habitats.
- Implement noise and dust control measures during construction to minimize disturbance to wildlife and nearby residents.
- Schedule construction activities to minimize noise impacts on sensitive species during breeding seasons.
- Carry out dust suppression exercises to reduce impacts on surrounding vegetation and maintain a green buffer.
- Develop and implement a comprehensive stormwater management plan to mitigate runoff impacts on surrounding ecosystems.
- Engage with residents and stakeholders to raise awareness about biodiversity conservation.
- Establish community programs for responsible waste management and habitat protection.
- Implement regular monitoring programs to assess the effectiveness of mitigation measures and adjust as needed.
- Develop an adaptive management plan to address unforeseen impacts and ensure ongoing biodiversity conservation.

Human/Social/Cultural

The following section outlines the main issues identified, associated with key activities during the preconstruction, construction and operational phases of the housing development project. It highlights the potential impacts of these activities, specifying their direction, duration, magnitude, and permanence. Additionally, recommended mitigation measures are provided to address each impact, ensuring that the development proceeds with minimal adverse effects on various aspects, including traffic safety, cultural heritage, biodiversity, stormwater management, air quality, noise levels, solid waste management, earthquake risks, potential squatting, hurricane preparedness, security, and parking issues.

Issues

- Traffic Safety- Increased vehicle movement causing potential traffic hazards, disruptions during peak hours leading to congestion.
- Cultural Heritage- Risk of damaging or disturbing historical sites or artifacts.
- Stormwater Management- Increased runoff leading to potential flooding and erosion, contamination of water bodies from construction materials.
- Air Quality- Dust and emissions from construction equipment affecting local air quality.
- Noise Levels- Elevated noise from machinery disturbing nearby residents.
- Solid Waste Management- Accumulation of construction waste leading to disposal challenges.
- Earthquake Risks- Structural vulnerabilities during seismic activities.

- Potential Squatting- Unoccupied spaces being used for unauthorized settlements.
- Security- Increased risk of theft and vandalism on the construction site.
- Parking Issues- Limited parking spaces causing inconvenience to workers and residents.

Mitigation Measures

- Traffic Safety- Implement traffic management plans, including designated routes and schedules to minimize congestion; Use signage and barriers to enhance safety around construction zones.
- Cultural Heritage- Conduct thorough site assessments and work with JNHT to protect historical sites; Implement monitoring and protection measures during construction.
- Stormwater Management- Install proper drainage systems to handle runoff and prevent flooding; Use sediment control measures to prevent contamination of water bodies.
- Air Quality- Use dust suppression techniques such as water spraying; Ensure construction equipment is well-maintained to minimize emissions.
- Noise Levels- Limit construction activities to daytime hours; Use noise barriers and quieter machinery where possible.
- Solid Waste Management- Develop a waste management plan for proper disposal and recycling of construction materials; regularly remove waste from the site to prevent accumulation.
- Earthquake Risks- Design structures to comply with seismic building codes; conduct regular safety drills and inspections.
- Potential Squatting- Secure the site with fencing and surveillance; Engage with local authorities to monitor and prevent unauthorized settlements.
- Security- Hire security personnel and install surveillance cameras; Maintain proper lighting and secure storage for materials and equipment.
- Parking Issues- Designate specific parking areas for workers and visitors; Implement a shuttle service to transport workers from off-site parking areas.

Cumulative Impacts and Mitigation Measures

The proposed housing development project in Coral Spring faces significant cumulative impacts that could affect surrounding ecosystems and infrastructure. Key concerns include potential flooding, water table contamination, sediment runoff, and increased traffic, exacerbated by changes in hydrology and wastewater management practices. Of particular concern is the project's impact on water resources, including the nearby hotel’s reliance on local wells and the complexities of managing spring flows and potential sinkholes.

To address these challenges, robust mitigating measures have been proposed. These include further hydrological investigations, enhanced runoff management through detention ponds and overflow systems, ecological protection strategies to safeguard coastal habitats and species migration routes, and pollution control measures to mitigate air and noise pollution. Additionally, construction considerations will ensure structural stability by avoiding building on unstable cavities and implementing proper foundation practices. These measures are essential for sustainable development, ensuring compliance with environmental regulations, and safeguarding the long-term ecological integrity of the Coral Spring area.

Continued monitoring and adaptive management will be crucial to addressing evolving challenges and maintaining environmental sustainability throughout the project lifecycle.

Analysis of Alternatives

No Action

In the No Action alternative, the core dry limestone forest remains undisturbed, preserving endemic species and ecosystem services such as habitat provision, carbon sequestration, and natural storm protection. However, this approach does not address the critical need for housing in the area, which is currently zoned for resort development.

The Development as Proposed

The proposed development aims to provide affordable housing for approximately 700 residents while incorporating sustainability measures. These include ample green space, native vegetation use, and fencing incorporating vertical gardening for environmental integration, along with a buffer zone where possible, to protect adjacent protected areas. This approach balances housing needs with environmental sensitivity.

The Development as Proposed with Modifications

Potential modifications include larger lot sizes with fewer housing units to increase green space and preserve biodiversity. This adjustment would however not be feasible for the developer.

Development in Phases

The phased development plan begins with essential infrastructure like the Sewage Treatment Plant and progresses systematically to minimize environmental impact, manage resources efficiently, and integrate new residents gradually into the community.

Reduce Size of the Development

Reducing housing density by decreasing the number of units could have some benefits such as enhancing the available green space, privacy, and environmental sustainability. However, this may impact affordability and housing availability for the community.

Retention of Forested Slopes

Retaining forested slopes and implementing water management features like detention ponds and berms preserves natural beauty and ecological integrity, supporting sustainable development practices.

Locate the Development in Another Location

Relocating the development is not feasible due to land ownership constraints. Therefore, the proposed site remains the most viable option for meeting housing needs while managing environmental impacts.

Conclusion

The proposed Coral Spring Village 2 development project represents a significant opportunity to address housing needs while balancing environmental conservation and community benefits. Through extensive stakeholder consultations and comprehensive impact assessments, several key findings have emerged. The project's potential impacts on biodiversity, hydrology, cultural heritage, and community infrastructure highlight the importance of strategic planning and implementation of appropriate mitigation measures. Concerns such as biodiversity loss, water resource management, and community integration have been carefully evaluated. The phased development approach, coupled with stringent environmental safeguards and community engagement initiatives, aims to mitigate adverse effects and enhance project sustainability.

Recommendations

The following recommendations are crucial for achieving the project's goals of providing sustainable housing solutions while protecting and enhancing the natural and cultural heritage of the Coral Spring area. By following these guidelines, stakeholders can ensure that the development contributes positively to the community while safeguarding the environment for future generations:

- Implement robust mitigation measures to address biodiversity disruption, stormwater runoff, and air and noise pollution. This includes enhancing habitat preservation, implementing advanced stormwater management systems, and adhering strictly to environmental regulations throughout all phases of construction and operation.
- Collaborate closely with the Jamaica National Heritage Trust to monitor and protect archaeological sites and artifacts. Conduct ongoing assessments to ensure any discoveries are properly cataloged and preserved.
- Continue to engage with local stakeholders, including residents, hotels, NGOs and governmental agencies, to foster transparency and garner support. Establish community programs for waste management, environmental education, and sustainable practices.
- Develop and adhere to comprehensive traffic management plans to minimize congestion and ensure safety during construction and post-development phases. Enhance security measures to mitigate potential risks associated with increased population density.
- Proceed with a phased approach to construction to manage resources efficiently, reduce environmental impact, and integrate new residents gradually into the community. Monitor each phase closely to adapt to changing conditions and community needs.
- Implement regular monitoring programs to assess the effectiveness of mitigation measures and adapt strategies as necessary. This adaptive management approach will ensure ongoing compliance with environmental standards and the project's long-term sustainability.

1 Introduction

1.1 Project Background

Gore Developments Ltd (GDL) proposes to extend the existing Coral Spring Village housing development in Trelawny. The proposed expansion, known as Coral Spring Village 2, will comprise approximately 600 detached housing units and will be situated adjacent to the existing Coral Spring 1 development (see Figure 1-1). This expansion aims to address the growing demand for housing on the north coast of Jamaica, while adhering to sustainable development practices. The project's proximity to the Mountain Spring Protected Area necessitates careful consideration of potential impacts on local flora and fauna. Concerns regarding ecology, hydrology, drainage, water quality, and coastal threats underscore the importance of comprehensive environmental assessment and mitigation planning. It is significant to note the need to meet national / regional housing needs as well as the setting of the development within the north coast resort development corridor and its proximity to other existing and proposed developments.

Figure 1-1:(a) Preliminary subdivision plan with conservation overlay

Environmental Solutions Ltd. (ESL), contracted by GDL, is tasked with conducting an Environmental Impact Assessment (EIA) for the proposed development. The objective is to provide a comprehensive description of the proposed project and evaluate its physical, ecological, social, and archaeological aspects. The EIA will identify potential impacts and propose mitigation measures to minimize or prevent negative impacts, and further recommend measures to ensure positive impacts. Additionally, the EIA will adhere to the guidelines outlined in the Terms of Reference provided by the National Environment and Planning Agency (NEPA).

1.2 Project Location

The site is located about 7 km due east of the town of Falmouth and 7.5 km due west of Duncans, Trelawny. It is bordered by the Coral Spring-Mountain Spring Protected Area (CSMSPA) to its left, Coral Spring Village Housing development to its southwest, undeveloped coastal forests to the southeast and east, the Ocean Coral Spring Hotels to the northeast as well as coastal wetlands and

the Caribbean Sea to the north (see Figure 1-2). The proposed development site spans approximately 0.7 km^2 with a perimeter of 3.22 kilometers.

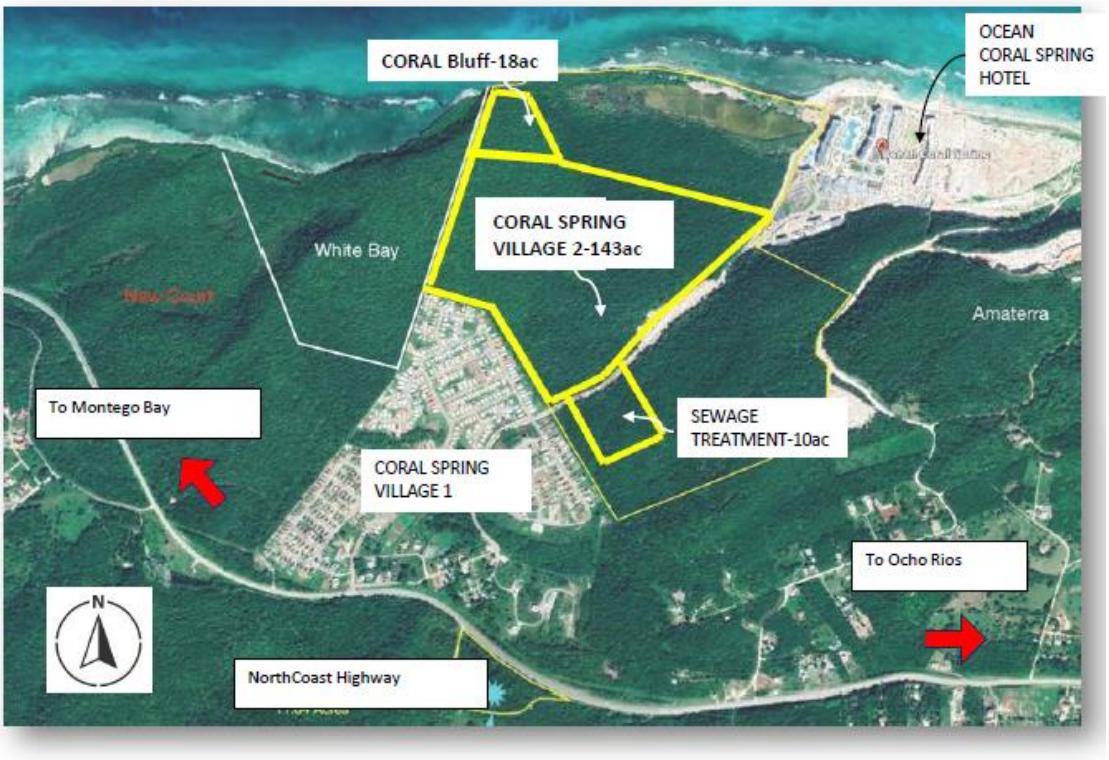


Figure 1-2: Location of Proposed Coral Spring 2 with regard to site and situation

According to Asprey and Robins (1953), Jamaica's coastline is predominantly composed of limestone rock or low-fringing coral shelves. Kapos (1986) also identified the study area as a disturbed dry limestone forest, along with most other dry limestone forests along the north coast. The CSMSPA was officially designated as a protected area by the National Environment and Planning Agency on September 18th, 1998, under the Natural Resources Conservation Act. It forms part of the largest remaining contiguous dry limestone forest along the north coast, covering an area of approximately 170 hectares. Figure 1-3 illustrates the boundaries and zoning designations of the CSMSPA, including the conservation zone, multiple use zone, habitat and heritage protection zone, buffer zone, and protected area boundary.

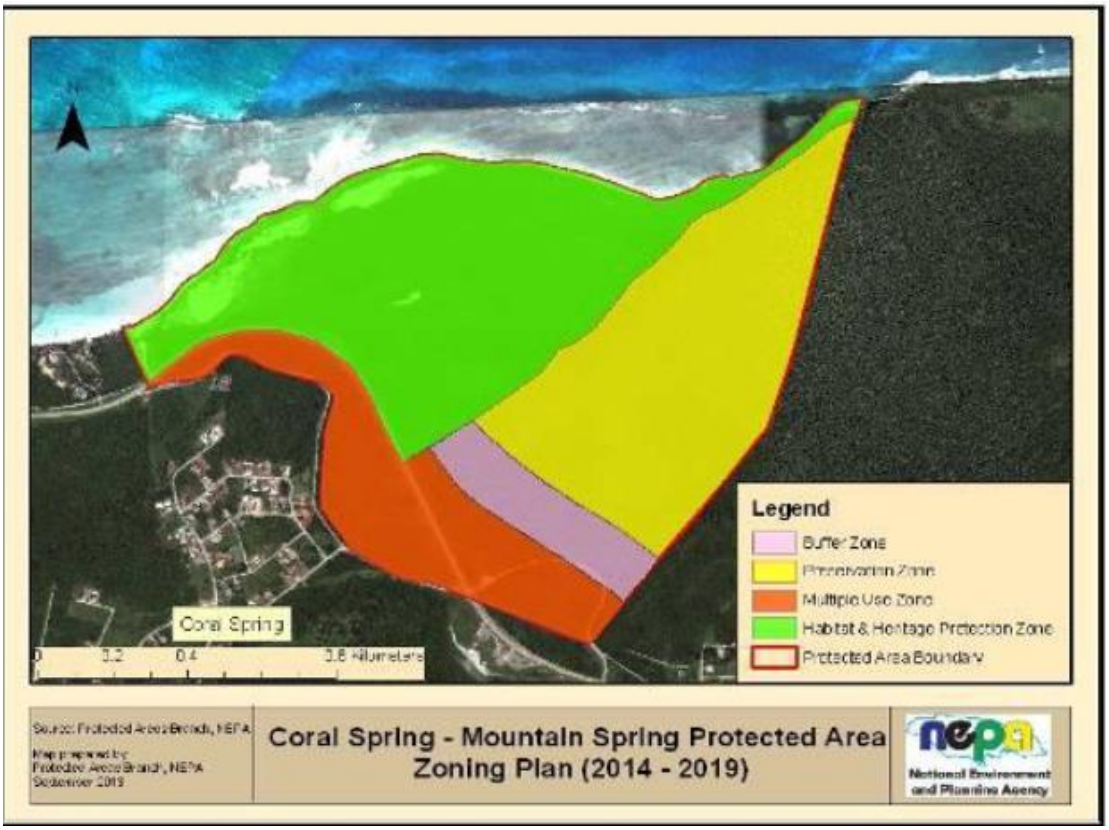


Figure 1-3: Mountain Spring Protected Area

1.3 General Approach and Methodology

A 'Charette-styled' approach was adopted, assembling a multidisciplinary team of experienced scientists and environmental professionals to conduct the necessary resource assessment, baseline data generation and analysis, impact determination, and recommendation of mitigation measures. Details of the members comprising the EIA Professional Team are provided in (Appendix 1). Regular team meetings were held to facilitate discussion among the team as well as with the client and among project proponents.

Baseline data for the study area was derived through a comprehensive methodology involving:

1. Fieldwork and sampling
2. Analysis of maps, plans, and aerial photos
3. Review of engineer's reports and drawings
4. Examination of background project documents and EIA reports for other proposed projects completed in the area
5. Structured interviews and social surveys
6. Utilization of internet resources
7. Agency requests and document searches

Additionally, government resources such as the Water Resources Authority (WRA), National Water Commission (NWC), and the Office of Disaster Preparedness and Emergency Management (ODPEM)

were consulted. Website searches of the National Environment and Planning Agency (NEPA), Meteorological Service of Jamaica, and NWC were also conducted to obtain further relevant information.

Details of specific methodologies employed to assess the physical, ecological and socioeconomic environment as well as to undertake the impact evaluation are presented below.

1.3.1 Physical

1.3.1.1 Geomorphology and Geology

Information was collected from geology maps and reports published by the Mines and Geology Division; soil maps and reports provided by the Agricultural Land Management Division of the Ministry of Agriculture and Fisheries; previous Environmental Impact Assessment reports of the surrounding area; published literature; as well as recent soil and ground investigations. Other supporting information was collected from the Trelawny Local Sustainable Development Plan, and Provisional Development Orders for the parish of Trelawny.

A Ground Penetrating Radar (GPR) survey was also conducted to assess the subsurface conditions and identify potential underground anomalies that could impact the construction project. The GPR survey aimed to detect buried utilities, voids, and other features such as old foundations or archaeological artifacts, by using high-frequency radar pulses. The results of the GPR survey were used to inform the planning and design phases, ensuring that any potential issues were identified and addressed before construction commenced.

Limitations:

Limitations within this study with respect to soils, geomorphology and geology include:

1. Availability and accessibility to information.
2. Accessibility and visibility of ground conditions on the site due to the thick vegetation present.

1.3.1.2 Hydrology and Drainage

The hydrological analysis for the site was conducted by reviewing previous studies conducted in 2016 and the Sink Hole Evaluation Report from 2012. Additionally, runoff estimation for 50 and 100-year return periods was performed based on rainfall data. The rainfall-runoff analysis utilized the Rational Method, which is a widely accepted approach outlined in the "Guidelines for Preparing Hydrologic and Hydraulic Design Reports for Drainage Systems of Proposed Developments" (2015), issued by the Ministry of Transport, Works, and Housing through the National Works Agency (NWA), Ministry of Local Government and Community Development. This method is commonly used for areas with plot sizes smaller than 100 hectares, which aligns with the project site's dimensions (162 acres or 65.5 hectares). The project site falls within the Northeast Subdivision (Duncans) sub-watershed management unit of the Martha Brae watershed management area and the Martha Brae Hydrological basin (refer to Figure 1-4).

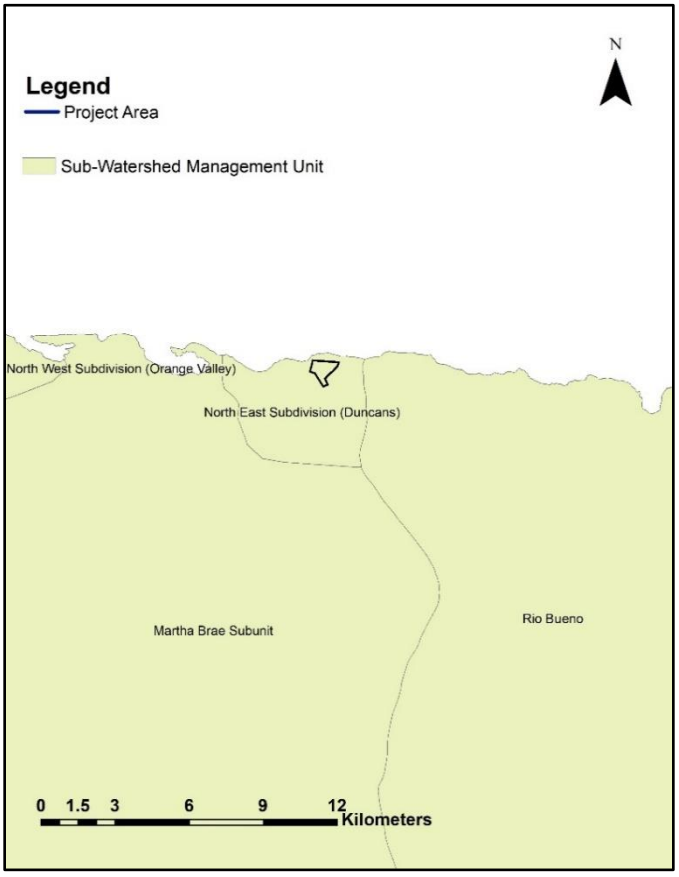


Figure 1-4: Map showing the Sub-Watershed Management Units of Jamaica and the project site.

1.3.1.3 Climate

This Section was completed with a review of reports and maps from the Climate Studies Group UWI-Mona, Meteorological Services of Jamaica, Water Resources Authority, the Trelawny Municipal Corporation, and newspaper reports. Information was used to populate the potential impacts of the project within the project area during the construction and operation phases. Potential impacts were restricted to the impact on the physical environment, buildings, and infrastructure. Impacts identified were used to populate potential mitigative measures to be employed according to best practice. Impacts and mitigative measures are presented in tabular format.

1.3.1.4 Water Quality

Eight (8) water quality samples were collected from the marine environs and ponds (previously used as salt evaporation ponds) north of the proposed project area. A summary of the water quality assessment is presented in Table 1-1 below.

Table 1-1: Summary of the Investigations for Water Quality within the Coral Springs, Trelawny Area (2024)

Attributes	Parameters	Data Points	Sampling Period	Assessment Timeframe
Water Quality (Freshwater)	Physical, Chemical and Microbiological	Eight (8) Sampling Stations	April 4, 2024 (Dry Season)	N/A
			September 24, 2024 (Wet Season)	

Parameters assessed include those outlined below: -

pH (pH units)
Dissolved Oxygen (mgO_2/L)
TDS (mg/L)
Salinity (ppt)
Conductivity (mS/cm)
Chlorophyll
Biochemical Oxygen Demand (mgO_2/L)
Fats, Oil and Grease (mg/L)
Orthophosphates ($mgPO_4^{3-}$/L)
Nitrates (mg NO_3^-/L)
Total Alkalinity (mg $CaCO_3$/L)
Total Coliform (MPN/100mL)
Faecal Coliform (MPN/100mL)
E. coli (MPN/100mL)
Enterococci (MPN/100mL)
Total Suspended Solids (mg/L)
Turbidity (NTU)

Parameters in bold text indicate those parameters that were measured *in situ* using a YSI ProQuatro Model Multiparameter system (MPS), while other parameters were later analysed in the laboratory. Other field observations were made with respect to smell, colour, and temperature at each site.

The major objectives of the water quality assessment were to:

- Establish the pre-existing water quality conditions in the area
- Assess land use practices and their impacts on the environment prior to the construction and operation of the proposed development
- Make recommendations, where possible, for the monitoring and management of water resources based on the proposed activities.

Sample locations are shown in Figure 1-5 below, while the findings and description of each water quality location sampled are presented in section 4.1.7..

Figure 1-5: Water Quality Assessment Points

Quality Assurance

All samples collected were kept below 6°C and transported to the ISO/IEC 17025 accredited Quality and Environmental Health Laboratory at Environmental Solutions Limited for analysis bearing in mind the analysis hold time for each test parameter. All in-field equipment were calibrated at the site location prior to use in the field. Water quality results were compared to Jamaica's National Resource and Conservation Authority's (NRCA) Draft Jamaica National Ambient Water Quality Standard – Marine (2009).

1.3.1.5 Air Quality and Noise

The objective of the air quality assessment and noise survey was to capture information about the existing conditions of this area. The locations for the air quality assessment and noise level sampling stations were selected to represent the use of the land in the project sphere and sites likely to be impacted by changes in air quality, for example, areas with high human populations were considered as these sites are some of the most sensitive receptors.

The air quality assessment was conducted over a 24-hour period between April 3-4, 2024 in the dry season and September 23-24 during the wet season, while three-minute-long noise surveys were conducted on two separate days during the period April 2 – 4, 2024 and September 22 - 24. The concentration of respirable particulates (PM_{10}) for air quality and noise levels in dBA were assessed. A summary of the field investigations is outlined in Table 1-2 below while the air quality assessment and noise survey locations are presented in section 4.1.7.

Table 1-2: Summary of the Investigations for Air and Noise Quality within the Coral Springs, Trelawny Area (2024)

Attributes	Parameters	Data Points	Sampling Period	Assessment Timeframe
Air Quality (Ambient)	Respirable Particulates (PM_{10})	Four (4) Sampling Stations	April 3-4 (Dry Season)	24-Hours
			September 23 – 24 (Wet Season)	
Noise Levels (Ambient)	Noise Levels in dBA	Four (4) Sampling Stations	April 2-4 (Dry Season)	3 Minute Assessments done over a 2-day Period
			September 22 – 24 (Wet Season)	

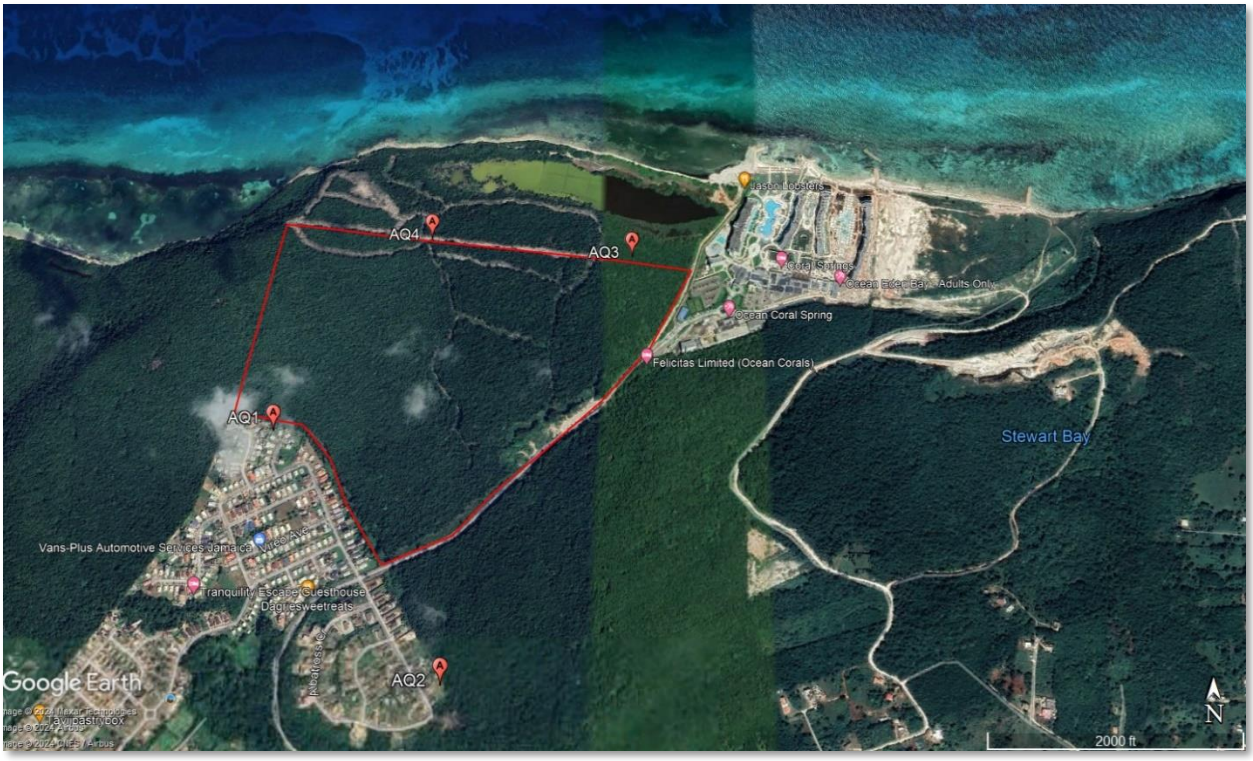


Figure 1-6: Air Quality Assessment and Noise Survey Locations

Particulate matter was measured using calibrated air pumps (with flow rates at 5L/min), attached to pre-weighed filters. The pumps were calibrated prior to use in the field. The pumps were placed at the approximate respiratory height of the individual/s for a 24-hour period. After the 24-hour sampling period, the pumps were collected, and the filters returned to the laboratory where they were stabilised and weighed to determine a Time Weighted Average (TWA) value for the particulates.

The results at the end of the sampling period were compared to the NRCA Ambient Air Quality Standard and the US EPA Ambient Air Quality Standard.

Noise readings were compared to the Jamaica National Noise Standards at the end of the survey period.

Quality Assurance

For the air quality assessment and noise survey, all equipment were calibrated prior to use and where applicable, field blanks were used for quality control purposes. Monitoring devices were placed from any known sources to prevent bias in the data collected.

Detailed observations were made at all sampling stations and were georeferenced for traceability and future monitoring requirements.

1.3.2 Ecological

1.3.2.1 Terrestrial Ecology - Flora

An initial walk-through was conducted to determine the best method of assessing the vegetation of the site. The walk through was also used to document the general species composition and record data related to species abundance based on the DAFOR scale. During sampling new species were documented and photographed as they were encountered until no new species were observed. Plants that were not immediately identified during the walk-through/ data collection were verified subsequently based on samples or photographs that were captured.

1.3.2.2 Terrestrial Ecology – Fauna

Ten (10) sampling points were strategically selected within the 2km project area sphere of influence to ensure comprehensive coverage of the various habitats present (see Figure 16). These points were chosen based on habitat diversity, accessibility, and the potential presence of faunal species, including those that are endangered or protected. The faunal surveys were conducted over a 2-day period, with additional night surveys carried out over two nights to account for nocturnal species. This dual-timing approach allowed for a thorough assessment of both diurnal and nocturnal fauna, providing a more complete picture of the terrestrial ecology.

At each sampling point, a range of data collection methods were employed:

Visual Encounter Surveys (VES): Researchers conducted systematic walks within a defined area at each sampling point, recording all fauna encountered. This method is effective for detecting larger and more conspicuous species.

Acoustic Surveys: Audio recording equipment was used to capture the calls of birds, amphibians, and other vocal species. This technique is particularly useful for identifying species that are more often heard than seen.

Camera Traps: Motion-activated cameras were deployed to capture images of elusive or nocturnal species. These cameras were positioned along animal trails and at water sources to maximize the likelihood of capturing diverse fauna.

Night surveys involved using headlamps and flashlights to search for nocturnal species, such as amphibians, reptiles, and mammals. Researchers recorded sightings, calls, and other signs of nocturnal activity. These surveys provided crucial data on species that are active after dark and are often missed during daytime surveys.

Species abundance at each sampling point was recorded using the DAFOR scale (Dominant, Abundant, Frequent, Occasional, Rare). This scale helped to quantify the relative abundance of

species within the study area. A species list was generated for the project area. Particular attention was given to identifying and recording any endangered or protected species present within the survey area. These species were documented in detail, including their locations and any observed behaviors or habitat use.

The collected data were analyzed to identify trends in species distribution and abundance. Maps and charts were created to visually represent the findings, highlighting areas of high faunal diversity and the presence of endangered or protected species. The results were then integrated into the overall ecological assessment for the project area.

Figure 1-7: Animal Sampling Points

1.3.2.3 Marine/Coastal Environment

The proposed wetland area for conservation within the sphere of influence of the development was surveyed between March 21-22, 2024. The mangrove forest was accessed using the roadway to the Coral Spring Hotel. The area was sampled by collecting data from 10 (10m x 10m) sample plots/quadrats (see Figure 1-7).

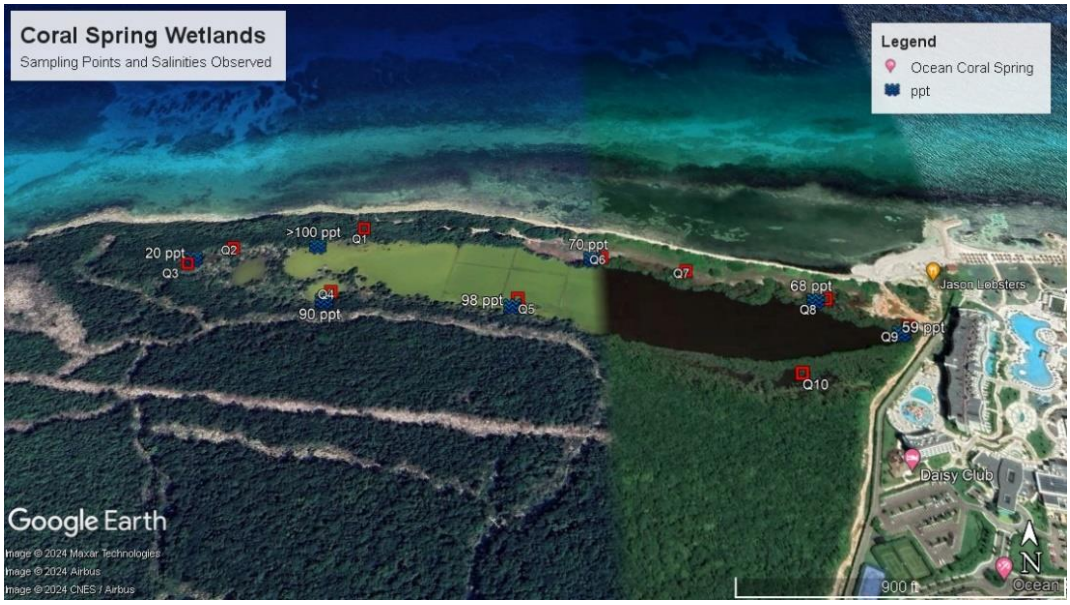


Figure 1-8: Wetland Sample Plots/ Quadrats

The following data was collected within each quadrat (see Table 4-12):

i. Mangrove tree species and number of trees present in the area (10m x 10m)
ii. Mangrove tree heights (m) and diameter at breast height (cm)
iii. Density of mangrove seedlings within 1m2. This was conducted in a randomly selected patch within the sample area
iv. Standing water depth and salinity

1.3.2.4 Coral Reefs

A survey of the reef crest located ~120m* from the shoreline (i.e., zone of influence) was carried out using the Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocol. The survey focused on characterizing the benthic substrate composition, including the presence/absence, and condition (i.e., disease) of coral, alcyonaceans, macroalgae, and other substrate categories.

1.3.2.5 Fish/ Pelagic Species

The fish community was assessed using the AGRRA belt transect method at the reef crest (T9, T10) and Roving Diver Technique (RDT) along the nearshore transects where the fish were less abundant. The RDT survey data provided species lists and frequency of occurrence for species encountered (i.e., Dominant, Abundant, Frequent, Occasional, Rare). A supplemental spot survey was carried out from the beach to the reef crest, seaward of the proposed Coral Spring project area.

1.3.2.6 Seagrass

Seagrass density was quantified using quadrats (0.25 m2 and 1 m2) placed at 5m intervals along the length of transects, alternating on the left and right sides of the tape. These quadrats were used to estimate the density (#/m2) of seagrass species as well as fauna, including sea urchins, starfish, conch, and any other indicator species encountered.

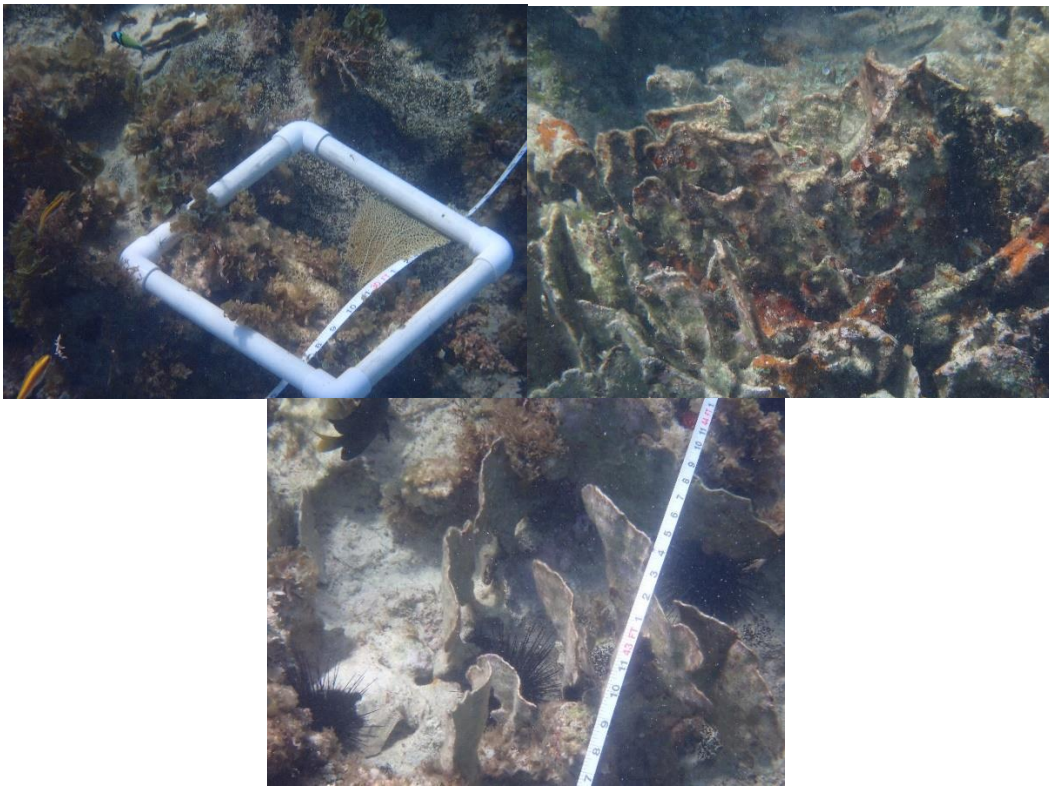


Figure 1-9: Methodology for Seagrass Assessment

1.3.3 Socioeconomic

The Social Impact Area (SIA) for this project consists of a 2-kilometre square area around the proposed development site. The SIA spatially defines the socio-economic characteristics of the surrounding communities and assesses potential effects on the immediate and surrounding communities. The following communities are located within the SIA:

- Coral Spring Village (1)
- Coral Spring Gardens
- Stewart Castle

The study utilized a combination of qualitative and quantitative methods to collect data from residents and other key stakeholders living and operating within the SIA. Primary data was collected via field surveys, key informant interviews, site visits and observations.

1.3.3.1 Research Sample

A quantitative survey was deployed throughout the respective communities. Utilizing a convenience sampling technique, with a sample frame of 5%. This generated a sample of 86 households within communities in the SIA.

1.3.3.2 Method of Data Collection

Data collection for the socio-economic study spanned the period of January 24 to May 3, 2024. The socioeconomic study began with an aerial reconnaissance on January 24, 2024. This was followed by a site visit on March 20, 2024, during which the team walked through the proposed site and adjoining communities, noting historic sites, social amenities, land use and physical characteristics of the communities. This was followed by an intensive data collection exercise from April 24 to 26 2024, which included virtual and face to face interviews with key stakeholders, and the deployment of community surveys, administered by a team of local data collectors.

1.3.3.3 Limitations

The research is guided by the established requirements for conducting socioeconomic assessments. Key stakeholders were identified, and every effort made to engage them in the consultative process. Several attempts were made to interview the Chief Executive Officer of the Trelawny Municipal Corporation or his designate for the study, however, we were unable to secure a consultation.

1.3.4 Culture and Heritage

Data utilized to compile the inventory of cultural assets was sourced from historical documents, including maps and past surveys conducted by the JNHT. It is important to acknowledge that not all areas outlined in the proposed zone were surveyed due to heavy vegetation cover and the rugged terrain.

1.3.5 Impact Assessment and Mitigation Measures

Following the assessments of the existing environment, the team identified various environmental and social aspects and possible impacts associated with the various project components. The construction and operation phases of the proposed activities were also analyzed. These impacts were assessed with respect to their direction, duration, magnitude and type.

- Direction defines whether the impact is positive or negative
- Duration defines whether an impact is a short-term, long term, intermittent or continuous
- Magnitude defines an impact as minor, moderate, major or significant
- Type defines an impact as reversible or irreversible

Impacts were identified based on the factors in Table 1-4.

Table 1-3 Impact Assessment Criteria

IMPACT ASSESSMENT CHARACTERISTIC	
Direction of impact	
Rank	**Definition**
Positive	• Impacts of the project on the environment and vice versa are likely to be good
Negative	• Impacts of the project on the environment and vice versa are likely to be bad
Magnitude of impact	
Rank	**Definition –** one/the combination of

IMPACT ASSESSMENT CHARACTERISTIC	
Low	• Little or negligible action and/or control are useful, but not required in the short term, review in the future is useful • Exceeding of threshold value in case of operating problems (abnormal conditions) and low effect and low probability of occurrence and/or high probability of detection. • Minimal effect • Limited probability of occurrence • "Aspect" controlled under normal conditions • High knowledge of "Aspect"
Moderate	• Action and/or control are required in the near future • Exceeding of threshold values in case of operating problems (abnormal conditions) and above • Average high probability of occurrence and/or low probability of detection. • Financial threat • Effect likely to increase under planned activities • Rising concern of shareholders • Emergency situation would cause a large environmental impact • Complaint likely to be received • "Aspect" not fully controlled under normal conditions
High	• Immediate Action and/or control is mandatory • Aspect" is currently not controlled under normal operations. • Could break legal or policy documents. • In breach of legislation • Sensitive environment (groundwater proximity, conservation area, residential area) • Repeated complaints
Impact Duration	
Short term	Occurring infrequently or during one project phase
Medium term	Occurring frequently during a few project phases
Long term	Occurring frequently during most or all project phases
Types of Impacts	
Reversible	Effects that are reversible and diminish when activities cease or over time.
Irreversible	Effects that are not reversible and do not diminish even if the activity ceases to occur, and do not diminish with time.
Cumulative	Effects of an action are added to or interact with other effects in a particular place and within a particular time
Probability of Impacts	
Low	An impact which is unlikely to occur
Moderate	An impact which may occur
High	An impact which is very likely to occur

Appropriate mitigation measures were then recommended to address all the negative impacts. These results were used to develop management actions to deal with the negative impacts identified. These management plans have been developed as a part of this EIA.

2 Legislation and Regulatory Considerations

A thorough review was conducted of pertinent policies, legislation, and regulations of the Government of Jamaica concerning the proposed development. Additionally, international obligations such as treaties and protocols to which the Government of Jamaica is a signatory were examined in relation to the development. Several critical areas applicable to the proposed development were scrutinized, as listed below:

- The Natural Resources Conservation Authority (NRCA) Act (1991)
- Natural Resources Conservation Regulations 1996, amended 2015
- Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013
- Beach Control Act
- The Jamaica National Heritage Trust Act (1985
- The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction and Development) Order (1996)
- Watersheds Protection Act (1963)
- Water Resources Act (1995)
- Quarries Control Act (1983)
- Wild Life Protection Act (1945)
- Fishing Act (2018)
- The Pesticides (Amendment) Act (1996)
- Clean Air Act (1964)
- Endangered Species (Protection, Conservation and Regulation of Trade) Act (2000)
- Town and Country Planning Act (1958)
- Building Act
- Trelawny Development Order
- Land Development and Utilization Act (1966)
- Public Health Act (1976)
- National Solid Waste Management Authority Act (2001)
- Country Fires Act (1942)

- Land Acquisition Act (1947)
- Registration of Titles Act (1989)
- The Housing Act (1968)
- Draft Noise Standard

Table *2-1* below outlines the relevance of each legislation, regulation and international convention identified above. Sections 2.1 and 2.2 which follow, presents the ambient water quality standards and the effluent standards as set by the NRCA to be applied

Table 2-1: Review of Relevant Legislation, Regulations and International Conventions

Legislation/Regulation/ International Convention	Relevance
The NRCA 1991, Act	The NRCA Act of 1991 serves as the principal legislation governing environmental management in Jamaica. It mandates that all new projects, including the expansion of existing ones falling within prescribed categories, undergo an environmental impact assessment (EIA). According to the regulations, eight copies of the EIA Report must be submitted to the Authority for review. A preliminary review period of ten days is allotted to determine if additional information is necessary. Subsequently, the approval process can take up to ninety days. If the EIA meets the required criteria upon evaluation, a permit is granted. However, if the EIA is not approved, provisions are made for an appeal to the Minister. The relevant sections of the Act pertaining to the proposed project are as follows: ➢ Section 10: Empowers the Authority to request EIAs for the construction of enterprises falling within prescribed categories. ➢ Section 12: Addresses the potential contamination of groundwater by trade effluent and sewage. ➢ Section 15: Addresses the implementation of stop orders and fines associated with water resource pollution. ➢ Section 16: Authorizes the government to intervene to prevent groundwater contamination. ➢ Section 17: Addresses the government's authority to request, in writing, information concerning the performance of facilities, quantity and condition of discharged effluent, and the affected area. The NRCA Act serves as the foundation for the drafting of the Natural Resources Conservation Regulations 1996 (amended 2015) and the Natural Resources Conservation (Wastewater and Sludge) Regulations 2013.
The Beach Control Act, 1956 and the Beach Control (Amendment) Act 2004	The Beach Control Act of 1956, supplemented by the Beach Control (Amendment) Act of 2004, regulates activities within twenty-five meters of the shoreline. It encompasses the control of constructing sheds and huts on beaches and prohibits the use of public beaches for fishing activities. Administered by NEPA, the Act also facilitates the establishment of Marine Protected Areas. The pertinent sections of the Act relevant to the project include: *Section 7:* Notwithstanding any contrary provision in this Act, the Minister, upon the Authority's recommendation, may issue an order declaring: a) A specified part of the foreshore, sea floor, and associated water as a protected area for

Legislation/Regulation/ International Convention	Relevance
	this Act's purposes; b) Specified activities within the defined area as prohibited activities, including: i) Fishing by means specified in the Order; ii) Use of boats other than wind or oar-propelled boats for non-authorized purposes; iii) Disposal of rubbish or waste material; iv) Water-skiing; v) Dredging or disturbance of the sea floor. *Section 9*: No person shall erect, construct, or maintain any dock, wharf, pier, or jetty on the foreshore or sea floor, or any related structure, apparatus, or equipment encroaching on the foreshore or sea floor without a license granted by the Minister. The Act also ensures the maintenance of prescriptive rights for beach use (Regulation 12, 13, and 14). The Beach Control (Licensing) Regulations of 1956 necessitate a permit for any works on a beach, coastline, or foreshore, with applications directed to NEPA. Furthermore, the following regulations also fall under the Beach Control Act of 1956: The Beach Control (Hotel, Commercial, and Public Recreational Beaches) Regulations of 1978 The Beach Control (Safety Measures) Regulations of 1957
The Jamaica National Heritage Trust Act, 1985	The Jamaica National Heritage Trust Act of 1985, administered by the Jamaica National Heritage Trust (formerly the Jamaica National Trust), is designed to safeguard significant areas, including monuments, forts, statues, and architecturally significant buildings throughout Jamaica. This Act becomes relevant if any structures of archaeological or architectural significance are present on the site, impacted by site activities, or discovered during site operations.
The Natural Resources (Prescribed Areas) Order 1996	The Natural Resources (Prescribed Areas) (Prohibition of Categories of Enterprise, Construction, and Development) Order of 1996, along with the Permits & Licensing Regulations, was enacted under section 9 of the Natural Resources Conservation Authority Act of 1991. This Order designates the entire island of Jamaica as a prescribed area and outlines specific categories of enterprise, construction, or development that necessitate a permit. Furthermore, the Act addresses sewage and trade effluent discharges, as well as air emissions.
Policy for the National System of Protected Areas 1997	The Policy for the National System of Protected Areas of 1997 is a White Paper proposing a comprehensive protected areas system for Jamaica. The NRCA/NEPA serves as the lead agency responsible for the protected area system, although various other entities, including government agencies, local management entities, non-governmental organizations, the private sector, and individuals, are identified as important stakeholders. The proposed system includes six types of protected areas: 1. National Nature Reserve/Wilderness Area (Equivalent to IUCN Category I) 2. National Park, Marine Park (Equivalent to IUCN Category II) 3. Natural Landmark/National Monument (Equivalent to IUCN Category III) 4. Habitat/Species Management Area (Equivalent to IUCN Category IV) 5. National Protected Landscape, or Seascape (Equivalent to IUCN Category V) 6. Managed Resource Protected Area (Equivalent to IUCN Category VI)

Legislation/Regulation/ International Convention	Relevance
The Watersheds Protection Act (1963)	The Watersheds Protection Act of 1963 aims to safeguard watersheds and adjacent areas while promoting water resource conservation. Although the entire island is recognized as one watershed, it is divided into smaller units for management purposes. The Act facilitates watershed conservation through the implementation of provisional improvement schemes, which involve soil conservation practices on land.
The Water Resources Act (1995)	The Water Resources Act of 1995 is designed to manage, protect, and regulate the allocation and utilization of Jamaica's water resources. It also addresses water quality control and establishes the functions of a Water Resources Authority. This Act becomes relevant if the development necessitates drilling a well for water abstraction or discharge purposes.
Quarries Control Act (1983) Amended	The Quarries Control Act of 1983, amended, regulates the licensing, operations, and transportation of quarry materials. It established the Quarries Advisory Committee, which advises the Minister on quarry-related policies and license applications. This Act designates quarry zones, governs licensing and operations, and mandates that individuals in possession of quarry material produce relevant documentation upon request. While no quarrying activity is planned for the project, developers must specify the use of materials solely from licensed quarries.
The Wild Life Protection Act, 1945	The Wildlife Protection Act of 1945 involves the establishment of game sanctuaries and reserves, appointment of game wardens, regulation of river fishing, and protection of specified rare or endemic species. It prohibits harming or killing protected species and possessing any part of a protected animal, whether alive or dead, without proper authorization. This Act must be considered for the proposed project, with ecological assessments determining potential impacts on rare or endangered species. It's noteworthy that the proposed development area lies approximately 4.5 km east of the Glistening Waters Game Reserve.
The Pesticides (Amendment) Act (1996)	The Pesticides (Amendment) Act of 1996 introduced changes to the principal Act established in 1975, which created the Pesticides Control Authority. This Act assigns the Authority the responsibility of regulating the importation, manufacturing, packaging, sale, use, and disposal of pesticides. Section 11 mandates the Authority to maintain a register containing relevant information such as registered pesticides, restricted pesticides, licensed pest control operators, and individuals authorized to import or manufacture pesticides. Additionally, Section 16 grants the Authority the authority, with Ministerial approval, to enact regulations pertaining to various aspects, including: ➢ Aerial application of pesticides; ➢ Required supervision for pesticide usage, mandated protective clothing, and other precautionary measures; ➢ Permissible pesticide usage levels; ➢ Periods for pesticide application on specific agricultural crops; ➢ Pesticide and package disposal. The proposed development is likely to necessitate the use of pesticides for landscaping purposes and routine pest control activities within and around common area buildings.
Clean Air Act (1964)	The Clean Air Act of 1964 falls under the jurisdiction of the Central Board of Health, which appoints designated personnel responsible for ensuring compliance. The Act specifies offenses for owners of affected premises, defined as premises with industrial operations likely to discharge smoke,

Legislation/Regulation/ International Convention	Relevance
	fumes, gases, or dust into the air. During construction, the existing Coral Spring Village qualifies as an affected premises.
Natural Resources Conservation Authority (Air Quality) Regulations, 2006	These regulations outline the standards and requirements for managing and controlling air pollution in Jamaica. They establish the legal framework for industries to monitor emissions, obtain permits, and ensure compliance with specified air quality limits, promoting environmental protection and public health.
Natural Resources Conservation Authority (Ambient Air Quality Standards) Regulations 1996	These regulations define the acceptable limits for ambient air pollutants, such as particulate matter, sulfur dioxide, and nitrogen oxides. They serve as benchmarks for assessing air quality across different areas, with the goal of maintaining healthy air standards for the population and environment.
The Endangered Species (Protection, Conservation and Regulation of Trade) Act (1999) (Amended 2015)	The Endangered Species (Protection, Conservation and Regulation of Trade) Act of 1999, amended in 2015, addresses restrictions on trade in endangered species, regulation of trade in specified species, permit suspension and revocation, offenses, penalties, and enforcement. Many endemic reptiles, amphibians, and birds in Jamaica are listed in its Appendices, including sea turtles, yellow snakes, and two species of Amazon parrots.
The Town and Country Planning Act (1987)	The Town and Country Planning Act of 1987 regulates development and land use (excluding agriculture) in specified areas through Development Orders, local planning authorities, development planning processes, and Tree Preservation Orders. The Town Planning Department oversees the review of plans involving development under this Act, which allows for specific conditions to be imposed on approved plans. Planning decisions consider factors such as location, land use, zoning, and impact on amenities and traffic. Under Section 6 of the Act, any person can object to a development order on grounds of impracticality, unnecessariness, or adverse impact on the locality's economic welfare. If the provisions of Section 9A of the Natural Resources Conservation Authority (NRCA) Act apply to the development, approval by the Planning Authority is contingent upon NRCA's issuance of a permit (Section 11 (1A)). Additionally, the Authority may issue a "tree preservation order" under Section 25, aimed at conserving trees and woodlands in the development area by prohibiting cutting, topping, or destruction of trees, and mandating replanting of felled areas
Parish Councils Act 1901 (Amended 2007)	Under the Parish Council Act, local planning authorities have the authority to amend or revoke regulations pertaining to buildings approved by the relevant Minister. They can also establish regulations regarding the installation of sewers on premises.
The Building Act (2018)	The updated Building Act of 2018 represents a significant overhaul of previous legislation governing the building industry in Jamaica. It replaces the both the Kingston and St. Andrew Building Act and the Parish Councils Building Act, consolidating various regulations under one comprehensive framework. The primary objectives of the Building Act are to regulate and facilitate various aspects of building activities to ensure public safety and health. Key provisions of the Building Act include the enforcement of the National Building Code of Jamaica, which sets out standards for construction practices, materials, and design. Additionally, the Act aims to facilitate the adoption of international building standards, ensuring that Jamaica's construction industry remains aligned with global best practices.

Legislation/Regulation/ International Convention	Relevance
	Furthermore, the Building Act seeks to enhance amenities and accessibility in buildings, promote cost-effectiveness, and encourage environmental sustainability in construction practices. It establishes an efficient system for issuing permits, conducting inspections, and resolving disputes related to building projects. The Act also addresses the regulation of training and certification for building practitioners, ensuring that professionals in the industry meet certain standards of competency and expertise. Additionally, it establishes an appeals process to address grievances or disputes that arise during the building permit application or construction phases.
Town and Country Planning (Trelwany Parish) Provisional Development Order, 2013 (Confirmation) Notification, 2015	Under the Town & Country Planning Act, 1957 (as amended), the Town & Country Planning Authority collaborates with Local Planning Authorities to create Development Orders for specific areas in Jamaica. These documents aim to regulate land use, ensuring compatibility and preventing misuse. Initially focused on coastal areas of parishes, Development Orders later expanded to cover entire parishes experiencing significant development. The 2013 Development Order for Trelawny Parish, titled The Town & Country Planning (Trelawny Parish) Development Order, 2013 (Confirmation), covers the entire parish and supports tourism development where potential exists. Functions of Development Orders include specifying relevant areas, providing guidelines for obtaining planning permission, and presenting a land-use strategy for special areas like parish capitals and scenic locations. Development is typically limited to areas with existing or planned major services. The site falls within the Trelawny Development Order (2015) in the 'Greater Falmouth'. Local planning Area and is zoned "Shrub/woodland". The entire site has been rezoned "Resort" in the emerging Development Order 2021.
Land Development and Utilization Act (1966)	Section 3 of the Land Development and Utilization Act (1966) empowers the Land Development and Utilization Commission to designate land as agricultural based on its situation, character, and other relevant factors. However, this designation doesn't apply to land already approved for non-agricultural development under the Town and Country Planning Act. The Commission's responsibilities include ensuring proper development and utilization of agricultural land.
The Fishing Act (2018)	The Fishing Industry Act covers registration, licensing, fisheries protection, and the establishment of fish sanctuaries or Special Fishery Conservation Areas (SFCAs). Although the proposed project isn't within a sanctuary (the closest one being about 15 km east), offenses under this Act are relevant. For instance, it's illegal during closed seasons to disturb or harm fish or to catch undersized lobsters and conch.
The Exclusive Economic Zone Act (1993)	Designed to safeguard resources within the Exclusive Economic Zone (EEZ), as defined by the United Nations Convention on the Law of the Sea, this Act prohibits the exploitation of living and non-living resources and the conduct of research without a license.
The Forest Act 1996	Under the Forest Act, the Forestry Department oversees the management and conservation of forest resources in Jamaica. This Act becomes relevant if any project activities are near a forest reserve.
Towards an Ocean and Coastal Zone Management Policy in Jamaica (2000)	This policy aims to enhance economic sectors' contributions to integrated coastal area management by promoting awareness among sector agencies and resource users.

Legislation/Regulation/ International Convention	Relevance
Towards a Beach Policy for Jamaica (A Policy on the Foreshore and the Floor of the Sea), 2000 (DRAFT)	Acknowledging the value of Jamaica's beaches and the necessity for proper management and protection, this green paper seeks to balance the interests of various beach users, including the public, private sector, and fishermen.
National Policy for the Conservation of Seagrasses, 1996 (DRAFT)	This draft policy regulates the issuance of licenses or permits for development activities like dredging and the disposal of dredged material that could impact seagrass beds.
Coral Reef Protection and Preservation Policy and Regulation, 1997 (DRAFT)	This draft policy and regulation document aims to oversee coastal zone development concerning coral reef destruction or degradation.
DRAFT Policy and Regulation for Mangrove & Coastal Wetlands Protection	The Government of Jamaica has adopted this policy and regulation to advance the management of coastal wetlands. The policy endeavors to: ➢ Provide protection against dredging, filling, and other forms of development ➢ Designate wetlands as protected areas ➢ Safeguard wetlands from pollution, particularly industrial effluent, sewage, and sediment ➢ Subject all planned developments for wetlands to Environmental Impact Assessments (EIAs) ➢ Maintain traditional uses of wetlands
Public Health Act (1976)	The Public Health (Air, Soil, and Water Pollution) Regulations of 1976 aim to control, reduce, remove, or prevent air, soil, and water pollution in all its forms. Under these regulations: 1. No individual or corporation is permitted to emit, deposit, issue, or discharge contaminants into the environment from any source. 2. Those responsible for accidental contamination in the environment must promptly inform the Environmental Control Division of the Ministry of Health and Environmental Control. 3. Entities releasing air contaminants like dust and other particulates must implement measures to mitigate their presence. 4. Discharging industrial waste into water bodies, deteriorating water quality, is prohibited. 5. Owners or occupants of commercial or industrial premises must ensure proper garbage disposal, including incineration, burial, or other approved methods, at least twice every seven days. These regulations apply to the development throughout both its construction and operational phases.
National Solid Waste Management Authority Act (2001)	The Solid Waste Management Authority Act of 2001 incorporates the Litter Act and aims to prevent the improper disposal of solid waste in unauthorized areas, as well as to regulate garbage collection. This Act addresses the appropriate disposal of garbage in unauthorized locations, encompassing public spaces as defined under Section 2 (c) of the Act. This includes public gardens, parks, open spaces, or any area accessible to the general public with or without payment of fees. Disposing of refuse in the vicinity during any phase of the development would constitute an offense under this Act.
Noise Abatement Act 1997	The Noise Abatement Act of 1997 aims to regulate noise emanating from amplified sound and other specified equipment.
Country Fire Act (1942)	The Country Fires Act of 1942, in Section 4, prohibits the burning of trash without prior notification to the nearest police station and the occupiers of

Legislation/Regulation/ International Convention	Relevance
	adjacent lands. Additionally, it mandates the clearance of a minimum fifteen-foot width around the area intended for burning, with all inflammable materials removed. Section 6 empowers the Minister to prohibit burning trash without a permit as necessary. Offences under this Act include setting fires to trash between 6:00 p.m. and 6:00 a.m., leaving unattended open-air fires before extinguishing them completely, setting fires without a permit, negligent fire management leading to property damage, and smoking on plantation grounds where it may cause property damage. During land clearing for the development, the use of fires for vegetation clearance or garbage disposal is prohibited.
Cartagena Convention (Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region) (1983)	The Cartagena Convention, adopted in March 1983, is a legally binding environmental treaty for the Wider Caribbean, aiming to protect, develop, and manage the common waters of the region. Ratified by twenty countries, it serves as a framework agreement, with operational Protocols addressing specific issues and initiating actions. Relevant to this project, the Protocols include those concerning cooperation in combating oil spills, specially protected areas and wildlife, and pollution from land-based sources and activities.
Biodiversity Convention	The Convention on Biological Diversity aims to conserve biological diversity, ensure sustainable use of its components, and promote the fair and equitable sharing of benefits from the utilization of genetic resources. It is the first global agreement addressing all aspects of biological diversity, including genetic resources, species, and ecosystems. Recognizing biodiversity conservation as a shared global concern and integral to development, the Convention outlines several requirements for its signatories: 1. Develop plans for protecting habitats and species. 2. Provide financial assistance and technology to aid developing countries in conservation efforts. 3. Ensure equitable access to biological resources for development purposes. 4. Fairly distribute revenues between source countries and developers. 5. Establish regulations and liability frameworks for risks associated with biotechnology development. Jamaica's Green Paper Number 3/01, titled "Towards a National Strategy and Action Plan on Biological Diversity in Jamaica," underscores Jamaica's ongoing commitment to its obligations as a signatory to the Convention. Compliance with the principles of the Biodiversity Convention will have implications for site clearing activities.
The Montreal Protocol	Jamaica became a party to the Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on March 31, 1993. This Protocol mandates State Parties to gradually phase out the production and consumption of ozone-depleting substances, including Chlorofluorocarbons (CFCs), hydrochlorofluorocarbons, halons, methyl bromide, and other ozone-depleting substances. Jamaica fulfills its obligations under the Protocol through the enactment of regulations and orders and the implementation of a country program. Jamaica's implementation of the Protocol involves restricting the importation of ozone-depleting substances and equipment containing them since the country does not manufacture these substances or refrigeration equipment. The Trade (Prohibition of Importation) (Equipment containing CFCs) Order,

Legislation/Regulation/ International Convention	Relevance
	passed in 1998, bans the importation of equipment containing CFCs and halons, except propellants in metered-dose inhalers.
United Nations Convention on the Law of the Sea (UNCLOS III) 1982	The UNCLOS, also known as the Law of the Sea Convention, delineates the rights and responsibilities of nations regarding the use of the world's oceans. It provides guidelines for marine resource management, environmental protection, and business operations. While the United Nations itself does not have a direct operational role in implementing the Convention, various organizations such as the International Maritime Organization, the International Whaling Commission, and the International Seabed Authority contribute to its implementation.
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter	The London Convention, as it's commonly known, prohibits the dumping of certain hazardous materials into the sea. It mandates a special permit for dumping identified materials and a general permit for other waste or matter. This convention aims to prevent marine pollution by regulating waste disposal practices.
International Convention on Oil Pollution Preparedness, Response and Cooperation 1990	The OPRC Convention is an international maritime agreement that establishes measures for preparing for and responding to marine oil pollution incidents. It sets guidelines for coordinating international efforts to address oil spills and minimize their environmental impact.
Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)	The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) aims to protect endangered plants and animals by regulating their international trade. Given the transboundary nature of wildlife and plants, effective protection requires international cooperation. CITES achieves its objectives by placing species into different appendices based on their conservation status and regulating their international trade accordingly. The convention helps prevent over-exploitation of species due to commercial trade and ensures that any trade that does occur is sustainable and does not threaten the survival of species in the wild.

2.1 Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013

Wastewater encompasses water that has been utilized and contains dissolved or suspended solids, originating from residential, commercial, or industrial sources. According to these regulations, obtaining a license is mandatory for operating a treatment plant for discharging trade effluent or sewage effluent. The regulations further outline specifications for treatment plants, outfalls, monitoring and reporting requirements, as well as standards (see Table 2-4).

Table 2-2: Trade Effluent Standards

PARAMETER	TRADE EFFLUENT LIMIT
Ammonia/ammonium measured as NH_4	1.0 mg/L
Barium	5.0 mg/L
Beryllium	0.5 mg/L
Biological oxygen demand (BOD)	<30 mg/L
Boron	5.0 mg/L
Calcium	No standard
Chemical Oxygen Demand (COD)	<100mg/L or <0.01 kg/1000 kg product
Chloride	300 mg/L
Colour	100 TCU
Cyanide (free)	0.1 mg/L
Cyanide (Total as CN)	0.2 mg/L
Detergent	15 mg/L
Dissolved oxygen (DO)	>4mg/L
Faecal Coliform	<100 MPN/100 ml
Fluoride	3.0 mg/L
Iron	3.0 mg/L
Magnesium	No standard
Manganese	1.0 mg/L
Nitrate as NO_3	10 mg/L
Oil and Grease	10 mg/L or < 0.01 kg/1000 kg product
PH	6.5 - 8.5
Phenols	0.1 mg/L
Phosphate as PO_4	5 mg/L
Sodium	100 mg/L
Sulphate	250 mg/L
Sulphide	0.2 mg/L
Temperature	±2° of ambient
Total Coliform	<500 MPN/100 ml
Total Dissolved Solids (TDS)	1000 mg/L
Total Organic Carbon (TOC)	100 mg/L
Total Suspended Solids (TSS) (maximum monthly average)	50 mg/L
Total Suspended Solids (TSS) maximum daily average	<150mg/L
Trace Metals:	
Zinc	1.5 mg/L
Lead	0.1 mg/L
Cadmium	0.1 mg/L
Arsenic	0.5 mg/L
Chromium	1.0 mg/L
Copper	0.1 mg/L
Mercury	0.02 mg/L
Nickel	1.0 mg/L
Selenium	0.5 mg/L
Silver	0.1 mg/L
Tin	No standard
Total Heavy Metals	2.0 mg/L

2.2 Permitting Requirements

Successful implementation of the project will not only require adherence to various regulatory frameworks, but also obtaining several permits. Below is an outline of the key permitting

requirements essential for the project, ensuring compliance with national regulations while promoting sustainable development:

Subdivision and Environmental Permit

Before commencing construction, obtaining a Subdivision and Environmental Permit is crucial. This permit is required to legally subdivide the land for residential and commercial use and to ensure that the proposed development aligns with environmental regulations. The process involves submitting detailed plans and assessments to the National Environment and Planning Agency (NEPA), including an Environmental Impact Assessment (EIA) that addresses potential environmental impacts and mitigation measures. Key considerations include the protection of natural habitats, management of water resources, and minimization of pollution.

Diesel Storage and Batching Plant Permit

The construction phase will necessitate the establishment of a batching plant and diesel storage facilities to support the onsite production of concrete and the operation of heavy machinery. These facilities will be located in the southern section of the property on sloped lands (~10 acres; see Section 3.2.8). Obtaining permits for these installations involves ensuring compliance with safety and environmental regulations, which include the safe storage and handling of diesel fuel, proper siting of the batching plant to minimize dust and noise pollution, and implementation of spill prevention and emergency response plans. Detailed engineering plans and environmental management strategies must be submitted to the relevant authorities, such as NEPA and the National Works Agency (NWA).

Sewage Treatment Plant (STP) Permit

The development plan includes the construction of a Sewage Treatment Plant (STP) to manage wastewater generated by the new community. The STP will be located in the same southern section of the property, adjacent to the property office, storage areas, and batching plant, to centralize operations and enhance management efficiency. Securing a permit for the STP involves demonstrating how the plant will treat sewage to meet national effluent standards, prevent contamination of groundwater and nearby water bodies, and protect public health. This requires submitting detailed design plans, operational procedures, and environmental safeguards to NEPA and the Water Resources Authority (WRA). Regular monitoring and reporting protocols must also be established to ensure ongoing compliance.

3 Project Description

The goal of Coral Spring 2 is to address the housing needs of an underserved market in Trelawny, aiming to become a sought-after community for families, retirees, and professionals alike. This development, consisting of 640 homes, serves as a natural expansion of Coral Spring Village (1), which was also developed by Gore Developments and completed in 2016, comprising 447 lots.

3.1 Project Features

3.1.1 Community Amenities

Coral Spring Village 2 prioritizes the well-being and leisure of its residents through a range of meticulously planned community amenities including:

Parks and Recreational Open Spaces

- Parks allow residents to organize events and socials that foster togetherness.
- Strengthen community image and sense of place.
- Promote health and wellness.
- Provide recreational experiences.
- Provide a safe environment for children.
- Parks P4 & P5 are naturally a Look Out spot with beautiful views of the Ocean and will feature benches and landscaping.

Community Center

- Park P1 will feature a children's playground and a Community Center for social gatherings and development association meetings

Entrance

- Parks P8 & P9 will function as an entrance green space and be landscaped as an inviting welcoming feature. It will incorporate a bus stop, which allows for safe resting and waiting for public transport in the form of a sheltered drop-off point.
- The northern and southern sectors each will feature a gated entrance.
- A recycle center and collection point will be incorporated at the entrance

Landscaping

- The development boasts tree-lined streets and endemic landscaping in recreational areas.

Nature Reserves

- Open Spaces N1 & N2 remain in their natural state with local vegetation and trees. These open spaces may serve as nature walking and fitness trails for the citizen's recreational enjoyment.

3.2 Project Design and Phases

3.2.1 Project Design

Coral Spring Village 2 is designed with two main sectors of houses: Sector 1 North and Sector 2 South. These sectors are separated by a central meandering road leading to the future townhouses (Lot A01), which will eventually connect to the CORAL BLUFF duplex development (to be part of a future application). The southern sector contains 414 lots with undulating but easily buildable land, naturally separated by terrain and nature reserves. In contrast, the northern sector contains 226 lots situated on flat land, creating its own neighborhood. The road layout is designed to complement the terraced nature of the land, maximizing ocean views for many homes.

A spacious detention area is included in the design to provide open space, and the natural vegetation will be preserved in all open areas where possible. Additionally, a plant nursery will be established to propagate new seedlings and local trees from the site for the newly landscaped areas and parks (see Figure 3-1)

Figure 3-1: (A) Central Boulevard (B) Landscaped Round-a-bout (C) Entrance

Figure 3-2 below highlights the main features of the project design as well as the preliminary subdivision plan:

Lot A01-Multi-Family

Salt Ponds – in ruinate

Northern Sector – 226lots

Mountain Spring Protected Area

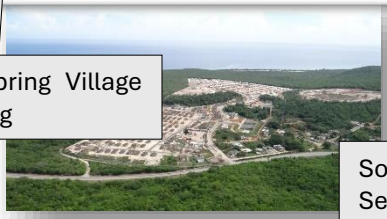
Lift Station

Hotel

Access road to future Lot A01-Multi Family

Double Gated

Coral Spring Village 1-Existing



Southern Sector – 414

Sewage Treatment

N

Figure 3-2: CSV 2 Subdivision Plan (Preliminary)

3.2.2 Traffic-Flow/ Roadways

The design of roadways within this subdivision is guided by local requirements for permitting as well as international standards for similar developments. The subdivision will be accessed at Coral Springs from the Falmouth to Duncans segment of the North Coast Highway (687883.058,702701.202; JAD 2001). As illustrated in Figure 3-2, the development features a central entrance road with a roundabout, providing access for homeowners. From there, the central spine boulevard extends towards the proposed "Coral Bluff" development area. The entrance will be from the private road through Coral Springs to the H10 Hotel at 689008.863,703642.560 (JAD 2001). The roadways are designed to meet a combination of the NWA and the AASHTO road design standards. The subdivision includes eighteen (18) roadways and cul de sacs totaling 7.639 km.

Distinct gated entrances at the northern and southern sectors delineate individual neighborhoods, effectively reducing the number of vehicles and traffic concerns in each area. Each sector features a ring road designed to facilitate easy traffic flow within the development. The central boulevard, spanning 18.2 meters in width, serves as the main thoroughfare leading to the "Coral Bluff" area. All carriageways consist of two (2) 3.65m wide lanes, with a 1.2m sidewalk on one side and a green verge with electrical poles on the other. There are three road reservations provided by the planner for this subdivision. The entry has a 22.2m reservation, for short cul-de-sacs the reservation is 10m; all others have a 12.2m reservation. Within the subdivision the horizontal alignments have radii ranging from 25m to 500m, while the vertical alignments have slopes ranging from 0.3% to 8.3%. There is a mix of carriageway cross sections throughout the development, both crown and monopitch, to facilitate drainage.

The transverse slope will be between 1.5% and 2.5% with the channel against the curb having a triangular section with a slope of 2.5 to 6.25%. Each carriageway will consist of 40mm asphaltic concrete over 200mm of compacted aggregate base course and subgrade with a minimum California Bearing Ratio (CBR) of 10. Base and subbase materials are specified on the drawing provided.

Where additional guidance is required, the following manuals will be used:

1. Road pavement structure will be designed to conform to AASHTO flexible pavement design method or the Asphalt Institute design method.
2. All soil gradation to be specified in the AASHTO Soil Classification system.
3. All soil strength to be specified in accordance with the ASTM 04429-04 Standard Test Method for CBR (California Bearing Ratio) of Soils in Place and 01883-07 Standard Test Method for CBR (California Bearing Ratio) of Laboratory-Compacted Soils
4. All soil compaction to be specified as a percentage of Modified Proctor Compaction ASTM 01557- 07 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort

3.2.3 Proposed Use of Spaces

Table 3-1 to 3-3 below outline the intended allocation of (non-residential) open spaces, as well as the proposed lot and house sizes.

Table 3-1: Overall Development Data for Coral Spring 2

	m2	ha	acre
Overall property area:			
Lot 2 (parent title)	40,571.749	4.057	10.025
Lot 3 (parent title)	607,376.648	60.738	150.086
Lot 4 (parent title)	44,538.282	4.454	11.006
Total:	**692,486.679**	**69.249**	**171.117**
Residential Lot Area:			
Lots 1 - 640 (Single Family)	340,725.002	34.073	84.195
Lot A01 (Multi Family)	67,301.659	6.730	16.631
Total:	**408,026.661**	**40.803**	**100.825**
Non-Residential Lot Areas:			
OPEN SPACES	21,511.585	2.151	5.316
PARKS	32,293.338	3.229	7.980
NATURE RESERVE	50,554.20	5.055	12.492
UTILITIES	53,118.990	5.312	13.126
Total:	**157,478.112**	**15.748**	**38.914**
Roadways, Reservations and Easements:			
	126,981.91	**12.698**	**31.378**

Table 3-2: Residential Lots Proposed (Summary)

	House Type:	Lots:	LOT SIZE in SF: *minimum*	LOT SIZE in m2: *minimum*
Northern Sector	2BR 2BR	226	4,000	372
Southern Sector	2BR 2BR	338	4,500	418
Southern Sector	3BR 2BR	76	5,000	465
Total:		**640**		

Table 3-3: Non- Residential Lots Proposed

		OPEN SPACES m2	OPEN SPACES acre	PARKS m2	PARKS acre	NATURE RESERVE m2	NATURE RESERVE acre	UTILITIES m2	UTILITIES: acre
P1	meeting area and playground			9,221.347	2.279				
P2	Look out Point			2,577.753	0.637				
P3	Look out Point			4,945.245	1.222				
P4	Park			1,116.933	0.276				
P5	Park			669.008	0.165				
P6	Park			1,416.804	0.350				
P7	Park			3,492.520	0.863				
P8	Entrance Green			5,120.696	1.265				
P9	Entrance Green			3,733.032	0.922				
OS1	Open Space	2,846.76	0.703						
OS2	Green Buffer	1,873.95	0.463						
OS3	Green Buffer	1,226.68	0.303						
OS4	Open Space	7,128.02	1.761						
OS5	Open Space	5,592.33	1.382						
OS6	Open Space	2,843.84	0.703						
N1	Nature Reserve					28,426.23	7.024		
N2	Nature Reserve					22,127.97	5.468		
U1	Drainage Detention							12,980.510	3.208
U2	Drainage Detention							25,433.700	6.285
U3	Sewage Lift Station							268.780	0.066
U4	Sewage Treatment Plant (southeast of road)							14,436.000	3.567
SUB TOTAL:		**21,511.585**	**5.316**	**32,293.338**	**7.980**	**50,554.20**	**12.492**	**53,118.990**	**13.126**

The proposed utilization of spaces was influenced by numerous factors, including but not limited to topography, slope, and the presence of cavities. The slope analysis, presented in Table 3-4 below, categorizes the terrain by slope class and shows the area of each slope type on the property (in square meters and percentage).

Table 3-4: Slope Analysis of Proposed Project Area

Slope Analysis:				
Slope Gradient		Terrain Slope Category	Area on property (m2)	Area on property (%)
Slope Class (Degree)	Slope Class (% Slope)			
1 2	1 3.5	Flat	151,674	21.9
3 9	3.5 16	Gently Sloping	464,149	67.0
10 17	17-31	Moderately Sloping	36,723	5.3
17-25	32-48	Moderately Steep	39,941	5.8
26-30	49-58	Steeply Sloping	-	0.0
>30	>58	Very steeply Sloping	-	0.0

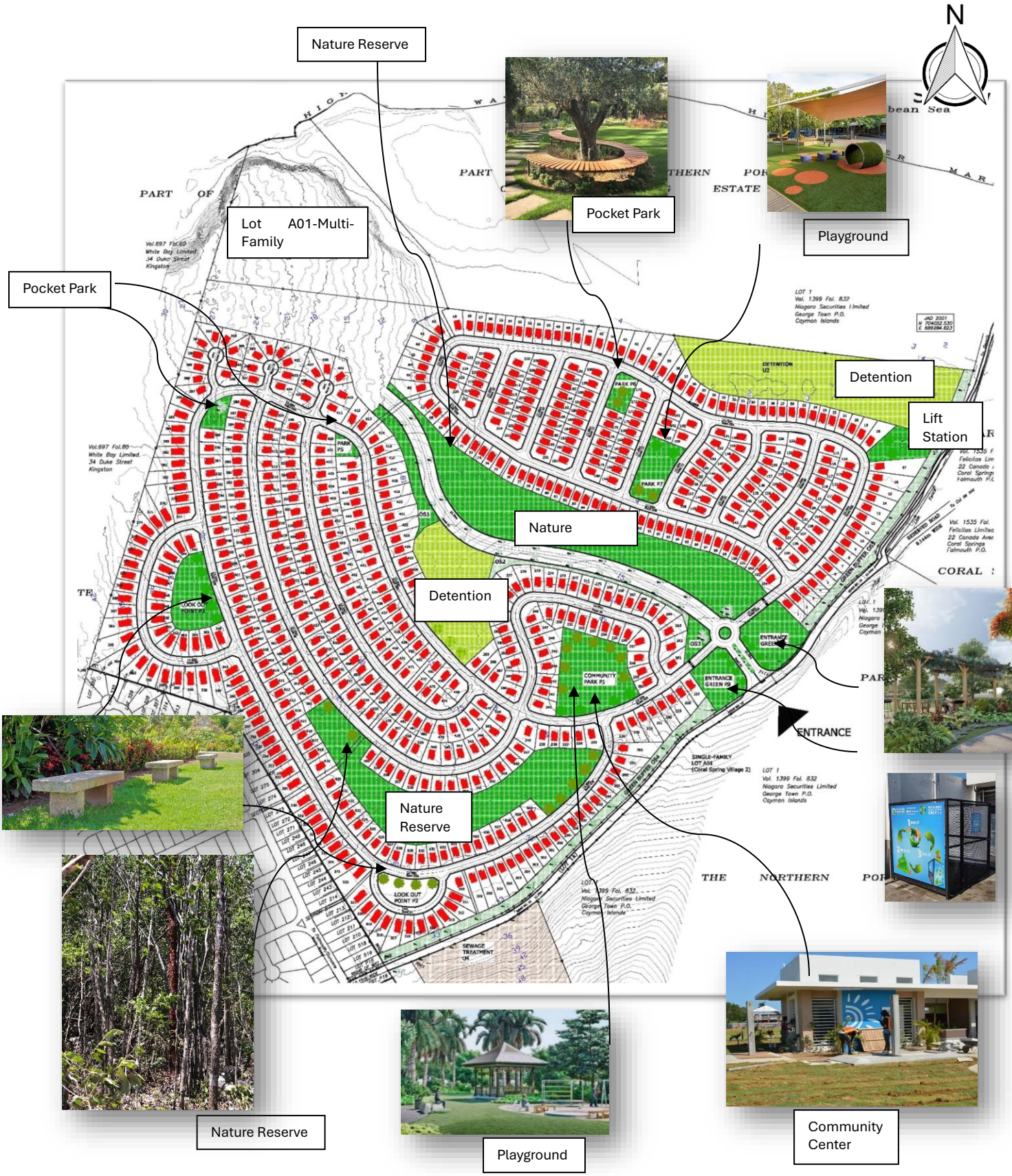
3.2.4 Landscape Design

The landscape design for the Coral Spring development prioritizes the integration of native and endemic species identified in this EIA. The development plan includes significant open spaces, parks, and nature reserves to enhance the community's livability and ecological value (see Figure 3-3). For the 660 proposed lots, a total of 66,759 square meters of open space is required. However, the actual open spaces included in the project amount to 104,359 square meters, significantly exceeding the minimum requirement. This generous allocation of open space ensures ample recreational areas and preserves natural habitats, fostering a harmonious relationship between the built environment and the local ecosystem. Table 3-5 below provides a detailed breakdown of the open spaces included in the project while Figure illustrates the proposed distribution of these spaces.

Table 3-5: Summary Open Spaces and Requirements

	OPEN SPACES	21,511.585	5.316
	PARKS	32,293.338	7.980
	NATURE RESERVE	50,554.199	12.492
	Total:	**104,359.122**	**25.788**
Open Space requirement:			
	for 660 lots	66,759.000	16.50

Figure 3-3: CSV II Preliminary Landscaping/ Open Space Design



The proposed open space and landscaping design incorporates a diverse array of native and endemic plant species, as outlined in Table 3-6 below. This approach not only promotes biodiversity but also ensures that the vegetation is well-suited to the local climate and soil conditions. By predominantly utilizing native and endemic species, the landscape design supports local wildlife, reduces maintenance needs, and enhances the overall sustainability of the development.

Table 3-6: Proposed Open Space/ Landscaping Plant List

Selected Plants for Development Landscaping:				
Plants for LANDSCAPED areas:	Common Name	Species/Family	Habitat	Distribution Status
	Oleander *	Nerium oleander	shrub	exotic
	Wild Jasmine *	Tabernaemontana laurifloria	shrub	native
	Tank Bromeliads *	Wittmakia penduliflora	herb	native
	Queen of the Night *	Selenicereus grandiflorus	vine	native
	Hibiscus *	Hibiscus sabdariffa	bush	native
	Bougainvillea	Nyctaginaceae	shrub	exotic
	Bellflower *	Portlandia grandiflora	small tree	endemic
	Crown of Thorns	Euphorbiaceae	shrub	exotic
	Monstera	Araceae	edible	
	Aralia Ming	Polyscias fruticosa	shrub	native
	Snake plant	Asparagaceae		exotic
Selected Palms:				
	Coconut *	Cocus nucifera	tree	exotic
	Thatch Pole *	Thrinax parviflora Sw. subsp. parviflora **	tree	endemic
	Bull Thatch	Arecaceae/Sabal Maritima	tree	
	Foxtail	Arecaceae	tree	native
	Thrinax	Arecaceae/Thrinax radiata	tree	native
	Sago	Gymnosperm	tree	native
	Christmas Palm	Adonidia Merrillii/Arecaceae	tree	native
Selected Trees:				
	White Cedar *	Tabebuia heterophylla (DC.) Britton	tree	native
	Spanish Elm *	Cordia gerescanthus	tree	native
	Red Birch *	Betulaceae/Betula Occidentalis	tree	native
	Sea Grape *	Coccoloba uvifera (L.) L.	tree	native
	Almond *	Terminalia catappa L.	tree	exotic
	Fig *	Ficus citrifolia Mill.	tree	native
	Lignum Vitae *	Guaiacum officinale L.	tree	native
	Seaside Mahoe *	Thespesia populnea (L.) Sol. ex Correa	tree	exotic
	Poinciana	Fabaceae	tree	
** = Listed in EIA-Flora Assessment May 2024, ESL Consultants*				

3.2.5 Stormwater Drainage Design

The drainage designs for this subdivision adhere to the 2015 NWA Guidelines for preparing Hydrologic and Hydraulic Design Reports for Drainage Systems of Proposed Developments. The Coral Spring catchment area spans around 72 hectares. Prior to development, the flow rates vary from 2.98 m^3/s during the 10-year storm event to 6.3m^3/s in the 100-year storm event. To manage the increased flow resulting from development, detention features with a total capacity of 65,000 cubic meters have been incorporated to ensure that post-development flow rates remain below pre-development levels. For drainage, the outlet will be through a covered U drain that discharges into the sea. To prevent erosion and provide scour protection, large boulders will be strategically positioned at the outlet.

The stormwater drainage design for the project site involves several components to manage runoff effectively:

1. Stormwater with curb inlets will be installed along roadways to convey runoff from a 10-year storm event to detention features.
2. Improved vegetated swales will be implemented to convey runoff from a 25-year storm event.
3. Detention features covering 2.4 hectares will be utilized to reduce the outflow from a 25-year storm event to pre-development levels.
4. Concrete U drains will be constructed as needed to facilitate the conveyance of stormwater.
5. Floor levels will be set between 0.3 to 0.45 meters above roads to accommodate a 100-year storm event.

Additionally, excess runoff will be conveyed to the sea via covered U drains, and large boulders will be placed at the outfall to prevent erosion. This comprehensive approach aims to mitigate flooding, control sediment, and manage stormwater effectively within the project site.

3.2.6 Domestic water Supply

Potable water for Coral Spring Village 2 will be sourced from the Martha Brae water treatment plant operated by the National Water Commission (NWC). This facility currently provides water to the adjacent existing Coral Spring Village. To accommodate the new development, the existing distribution main will be extended into Coral Spring Village 2. A formal request for water supply was submitted to the NWC, and GDL has received verbal confirmation of this solution. This confirmation provides assurance that the water needs of Coral Spring Village 2 will be adequately met, ensuring a reliable and sustainable water supply for residents. The following table (Table 3-7) outlines the estimated water demand for the proposed development.

Table 3-7: Water Demand Estimates- Coral Spring Village 2, Trelawny

Coral Springs 2, Trelawny			
Water Demand Estimate			
Item	Description	Qty	Unit
1	Number of Residential Lots	670	No
2	Estimate of the number of persons per unit	5.00	No
3	Population Estimate	3,350	No
4	Average per capita consumption per household	230	Liters
5	Estimate of domestic water use	770,500	Liters/day
6			
7	Other water use (5%)	38,525	Liters
8	Average day demand	809,025.00	Liters
9		213,722	US gal
10		809.03	cu m/d
11			
12	Peak day in peak month factor	1.40	
13	Peak hour factor	1.50	
14	Peak factor	2.10	
15	Leak factor	10%	
16			
17			
18	Average day including leaks	889,927.50	Liters
19		889.93	cu m/d
20		235,094.02	US gpd
21		195,756.63	UK gpd
22			
23	Peak day water demand	1,132.64	cu m/d
24		13.11	lps
25		299,210.57	US gpd
26		249,144.80	UK gpd
27	Monthly water need	7,474,343.98	UK gpd
		33,979.05	cu m/d

3.2.7 Sewage Collection

The Coral Spring Village 2 subdivision will require 856 cubic metres of water and generate 770 cubic meters of sewage each day. The sewage generated in Coral Springs Village 2 will be collected by a street mains system and treated onsite. Sewerage will be collected in 200mm pipes via gravity and conveyed to the lift station at the north before being pumped to the treatment plant site. The daily volume of sewage is estimated to be 90% of the water consumed in the development with a factor for infiltration. An average of 769.85 m^3/day with a peak of 23.17 lps is expected for sewage flows (see Table 3-8).

Table 3-8: Expected Sewage Flows

1	Average Sewage Flows (90% of Average day water demand)	769.85	m^3/d
2		8.91	lps
3			
4	Peak Factor	2.50	
5	Peak Sewage Flow	22.28	lps
6			
7	Infiltration is 10% of average sewage flow	76.99	m^3/d
8		0.89	lps
9			
10	Estimated peak sewage flow including infiltration	23.17	lps
11			

3.2.8 Sewage Treatment

As depicted in Figure 3-4, sewage treatment facilities will occupy a 10-acre area to the east of the project site (highlighted blue). The proposed layout of the Sewage Treatment Plant (STP) is provided in Figure 3-5.

Figure 3-4: Coral Spring Village 2 Sewage Treatment Plant Location

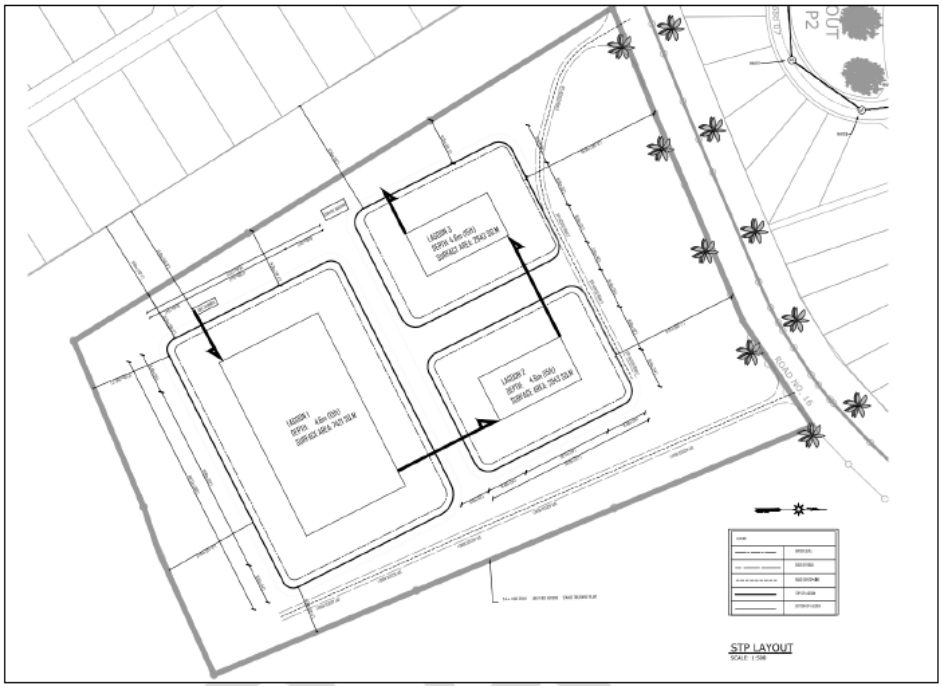


Figure 3-5: Layout of Proposed STP

The proposed STP is designed to treat an average of 856m^3/day. In order to produce treated effluent which will adhere to the standards established by the National Environment and Planning Agency (NEPA), the facility will be comprised of the following components (see Figure 3-6):

Lift Station
- Pump
- Trash basket

Grit Removal Chamber
- Coarse Screen
- Fine Screen

Aerated Lagoons
- Fine Bubble aerators

UV Disinfection

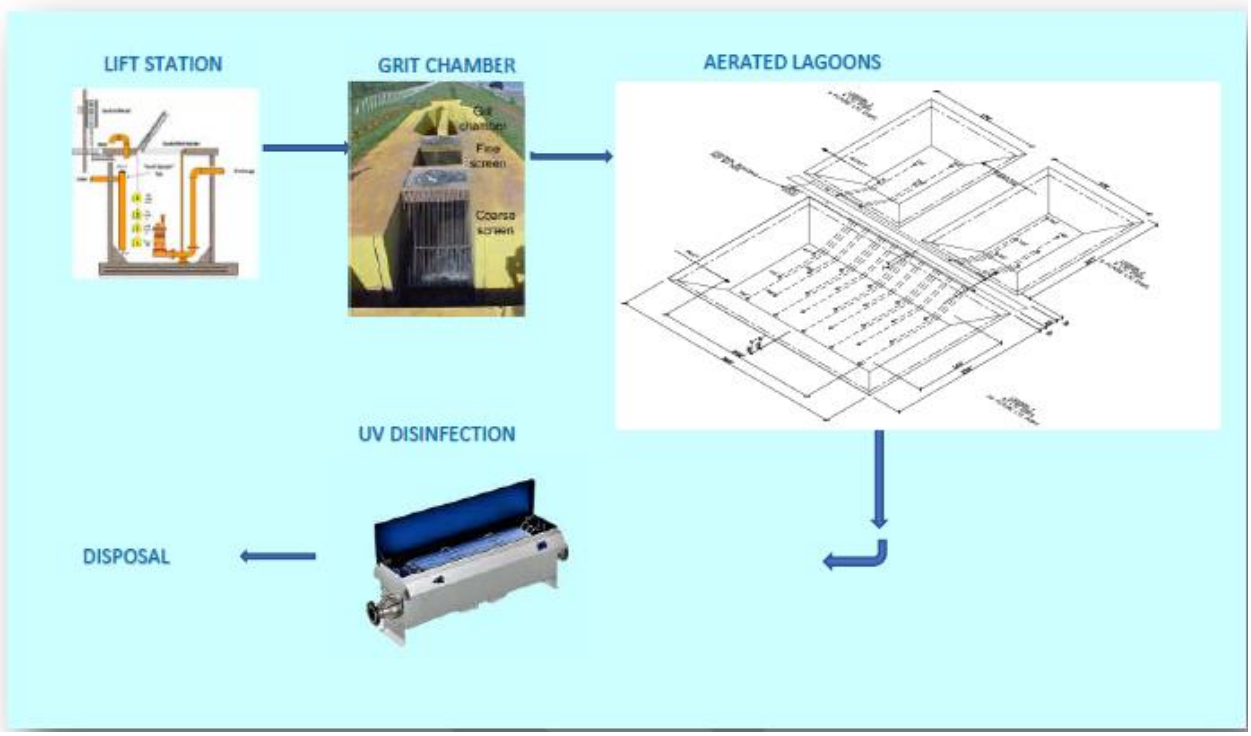


Figure 3-6: Schematic Diagram of Proposed Treatment Plant

Lift Station and Grit Chamber

This component of the facility is responsible for collecting, screening and pumping the sewage to the treatment plant. The lift station will be a reinforced concrete tank equipped with a submersible pump and trash basket. The sewage will be pumped from the tank to the grit chamber at the treatment plant. The grit removal chamber will be a small reinforced concrete tank with trash screens that will serve to remove large solids (the start of primary treatment) from the sewage before allowing it into the ponds (see Figure 3-7).

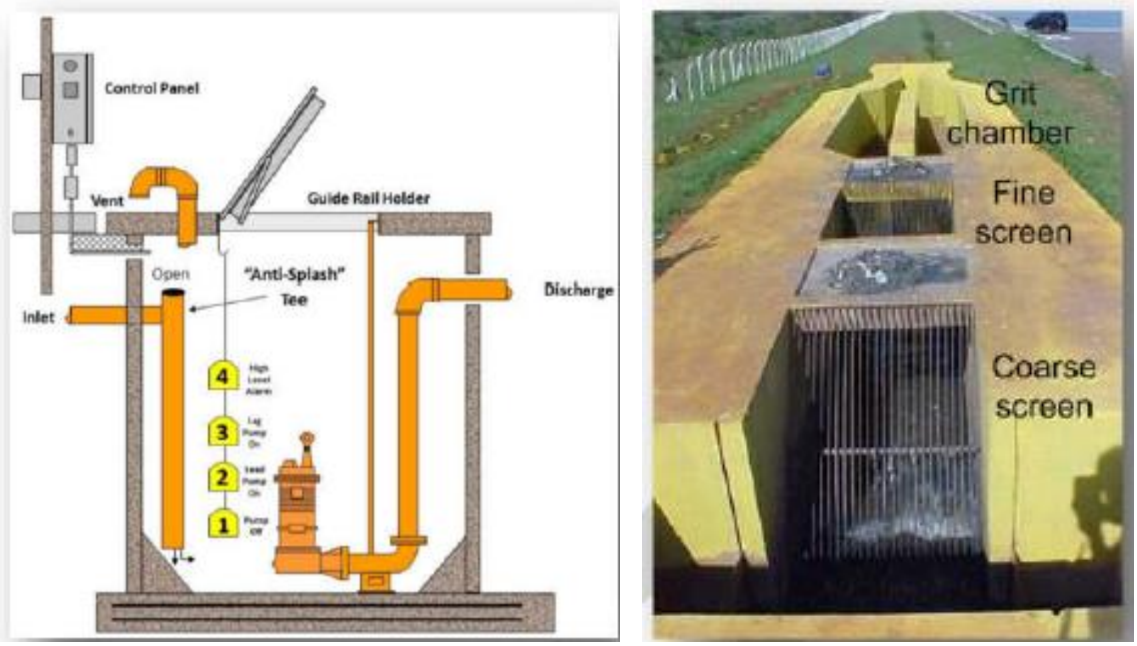


Figure 3-7: (Left) Typical Lift Station; (Right) Typical Screening of Grit Chamber

Design Characteristics

The lift station will transfer the subdivision flows (769 cubic metres per day) into the new headworks. The working volume is 5.21m^3 while the pump flow rate is 23.2 lps.

Aerated Lagoons

These components of the facility are responsible for the biological treatment of the sewage and the start of the nutrient removal, tertiary treatment. This component will facilitate nitrification and the reduction of the Biological Oxygen Demand and Total Suspended Solids as well as phosphate reduction, through dosing with alum.

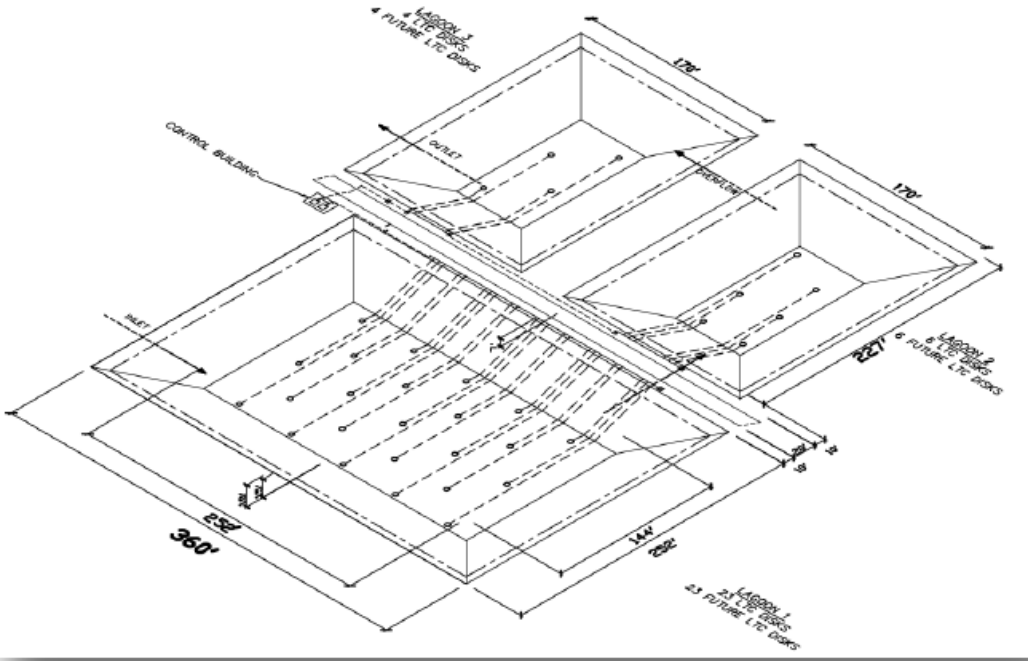


Figure 3-8: Proposed Aerated Lagoons

Design Characteristics

The aerated lagoons will be one primary and two secondary lined earthen lagoons in series with Air Diffusion Systems (ADS) fine bubble aeration discs, thirty-three (33) in total. Atmospheric air is transferred into the wastewater through a series of manifold and feeder piping, which connect the "air supply" (compressor or blower) to the disk modules. ADS fine bubble aeration creates a steady stream of small bubbles that provide oxygenation, mixing, and homogenization of each wastewater basin.

UV Disinfection

This component of the facility is responsible for removal of pathogens (disinfection) and allows the treated wastewater to be disposed of safely into the environment. The Enaqua non-contact M5 series has been chosen for this location (see Figure 3-9). It can treat a flow rate of 81.8 m_3/h which is in excess of the estimated peak flow rate from the lift station.

Figure 3-9: Enaqua UV Disinfection – M5 Series

Design Characteristics

- Flow rate - 32-80 m_3/
- Operating pressure - 2.8 bar
- Number of tubes - 6
- Inlet/ Outlet configuration - 200mm flange connection
- Operating Voltage 50/60 Hz - 110 V 1 PH/220V 3PH, 415V 3PH
- Ballast Type - Auto Ranging 110-277 VAC 50/60 Hz with 5 Year Warranty
- LCD Sttus Display

3.2.9 Waste Management

Heavy-duty equipment, including excavators, loaders, compactors, rollers, and pavers, will be utilized during the construction phase. To manage waste generated by these activities, designated areas will be established on-site at the proposed location, specifically at the eastern boundary (see Figure 3-10 below).

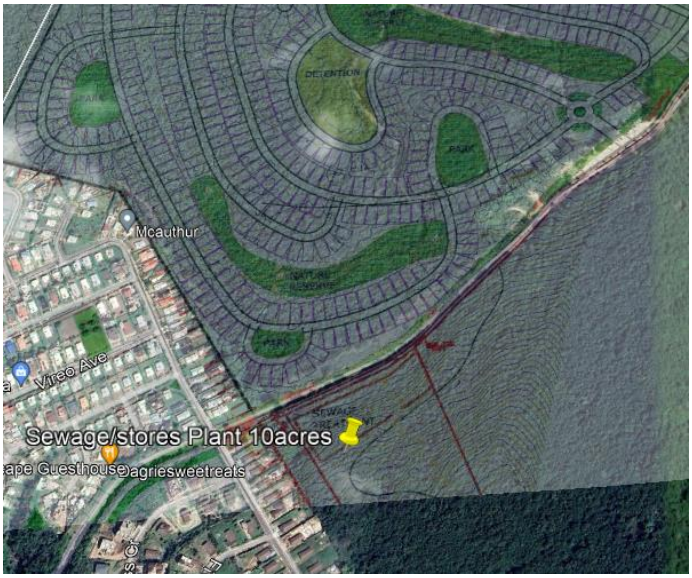


Figure 3-10: Proposed Heavy Equipment storage and office locations

The primary generators of waste expected on-site will include topsoil, sand, bushes, and trees. Traditional building waste, such as tailings, iron, shattered metal, broken tiles, and municipal solid waste, which are non-hazardous materials, will be managed separately according to a designated management plan. There will be no servicing of heavy-duty equipment on-site. Waste oil, used batteries, and oil filters are classified as hazardous trash, and maintenance activities will take place outside the site boundaries.

Considering the site's characteristics, topsoil will be removed as necessary, with materials stored and repurposed for filling and landscaping. Waste and construction materials will be managed in accordance with NSWMA guidelines, and storage will be near the eastern boundary of the site. The NSWMA will routinely collect municipal solid waste, with disposal bins provided for workers who will also undergo training sessions on proper waste disposal procedures. The nearest dump site operated by NSWMA is located in St. James at the Retirement Dump.

The site manager will be notified of any hazardous waste identified for appropriate action, and training sessions will focus on identifying waste materials beyond municipal solid waste and regular construction debris. Mobile chemical toilets will be provided by an approved company contracted for construction. These units will be serviced by the chemical toilet providers, who will remove the waste from the site.

3.2.10 Machinery and Equipment

The construction at Coral Spring will utilize various types of equipment, including:

- Excavators: for cut and fill operations and trenching for infrastructure,
- Excavator hammers: for cutting and trenching,
- Trencher machines,
- Bulldozers: for land clearance,
- Heavy-duty trucks (trailers): for transporting construction materials,
- Backhoes,
- Graders: for road construction,

- Rollers: for compaction,
- Water trucks,
- Loaders,
- Pavers.

These equipment types will be employed for site preparation, including the transportation of equipment to and from the location. Additionally, they will be utilized for earthwork construction and heavy lifting during building construction. The listed equipment is commonly used in construction operations.

A concrete batching facility will be installed on-site to enhance construction efficiency. This facility will primarily mix water, fine aggregate (a combination of sand and coarse aggregate, including gravel and/or crushed stone), and cement. Mineral admixtures may also be utilized to improve the strength, permeability, and consistency of the cement slurry.

3.2.11 Workforce Mobilization

During the peak of construction activities, it is anticipated that approximately 600 workers with various skill sets will be required on the site. These workers will include laborers, subcontractor equipment operators, and supervisors. To minimize the need for housing facilities, the local area will be the primary source of construction workers. If additional accommodation is necessary, it will be sourced from existing housing in the surrounding area.

Temporary structures will be erected on-site to serve as offices, stores, and welfare facilities; however, no living areas will be constructed. Subcontractors are required to hire workers from the local area, although this may not always be feasible. In such cases, contractors are responsible for ensuring proper living conditions for their workers. Offsite accommodation options are available for workers if needed.

3.2.12 Project Schedule & Timelines

3.2.12.1 Pre-Construction

Land Clearing and Filling (5 months)

This initial phase, estimated to take 5 months, involves preparing the site for construction. Activities include the removal of vegetation, rocks, and any existing structures. The land will be leveled and graded to ensure a stable foundation for subsequent construction activities. This stage is crucial for addressing any geotechnical issues, such as sinkholes or cavities, which could impact the stability and safety of the development.

Set Up Property Office, Storage Areas, and Batching Plant (6 months)

Following land clearing, temporary facilities will be established to support the construction process. This phase is expected to take 6 months. The property office, storage areas, and batching plant will be located in the southern section of the property on sloped lands (~10 acres). The strategic location minimizes transportation time and ensures a steady supply of concrete for foundation and structural works. The batching plant will be essential for concrete production, while the storage areas will house construction materials and equipment. The property office will serve as the hub for project management and coordination.

Foundation Works (12 months)

The foundation phase is estimated to take 12 months. It involves laying the groundwork for the buildings and infrastructure. Activities include excavating trenches, pouring concrete for footings and slabs, and installing necessary reinforcements. Given the site's geological characteristics, such as potential sinkholes and cavities, careful engineering and design will be employed to ensure robust foundations capable of supporting the planned structures. This phase is critical for ensuring the structural integrity of the development.

Proposed Location for STP (Sewage Treatment Plant)

The Sewage Treatment Plant will also be situated in the southern section of the property, in close proximity to the property office, storage areas, and batching plant. This centralization facilitates efficient management and monitoring of construction activities and environmental controls.

Throughout these phases, continuous monitoring and quality control will be implemented to ensure compliance with environmental and safety standards. This includes managing runoff and erosion during land clearing, ensuring proper handling and storage of materials, and maintaining construction equipment to prevent leaks and spills. These measures are essential for minimizing the environmental impact of the construction activities and ensuring the long-term sustainability of the development.

3.2.12.2 Operational

The anticipated timeline for the project is four (4) years. Each phase will follow a systematic sequence:

Roadway Formation and Grading: Establishing the basic road network and grading the land to ensure proper drainage and stability.

Detention Features: Constructing detention areas to manage stormwater runoff and prevent flooding.

Main Drain Channels: Installing the primary drainage channels to facilitate efficient water flow and drainage.

Sewer Installation: Laying down the sewer infrastructure to ensure proper wastewater management.

Building Erection: Constructing the buildings according to the project plans.

Water Installation: Setting up the water supply infrastructure to provide reliable access to water for all buildings.

Pavements: Constructing pavements and other hardscaping features for pedestrian and vehicle access.

Building Completion: Finalizing the construction of buildings, ensuring they meet all required standards and specifications.

Landscaping: Completing the project with landscaping efforts, including planting trees, shrubs, and other vegetation to enhance the aesthetic and environmental quality of the area.

4 Description of the Environment

4.1 Physical Environment

4.1.1 Geomorphology and Geology

A review of the 1:50,000 Geological Sheet (1974) for Falmouth reveals that the site is underlain by Coastal Limestone (Mp) to the north and the Montpelier Formation (Mm) to the northwest and south (see Figure 4-1). The Coastal Limestone Formation (Mp) consists of poorly bedded to massive, moderately weak, older reef deposits, marls, and rubbly limestone. Outcrops of the Coastal Limestone display a honeycomb structure with numerous dissolution cavities towards the south-central section of the site.

The Montpelier Formation (Mm) is older than the Coastal Limestone and is the youngest member of the larger White Limestone Group. It typically comprises well-bedded, hard, and dense cream-white chalky limestone with a few fissures. The Mm is associated with chert bands and flint nodules and can be up to 460 meters (1500 feet) thick. The Montpelier Limestone has extensive secondary openings, such as caves, due to the enlargement of fissures over time by percolating waters. These secondary solution fissures likely occupy the upper 5 meters of the bedrock, resulting in a significant increase in porosity in the upper zones of the bedrock.

During the soil investigation in August 2023 and the site reconnaissance, the Montpelier Formation (Mm) in this locality was found to be comprised of cream-white, well-bedded, strong to moderately weak chalky limestone. Limestone rock material mapped as the Montpelier Formation was readily exposed at ground level and observed across the Southern section of the site. According to the soil investigation conducted by Geo-Consultants Ltd. in 2024, the subsurface soil comprises predominantly coarse-grain calcareous sands, gravels, and limestone rock. Sands were described as compact to very dense, gravel as very dense, and limestone as moderately weak to moderately strong, with the latter dominating shallow foundation depths within the southern and central sections of the site. Outside of the subsurface, the northwestern section of the site, potentially proposed for the construction of townhouses, comprises an elevated limestone hillock underlain by moderately strong limestone with many cavities.

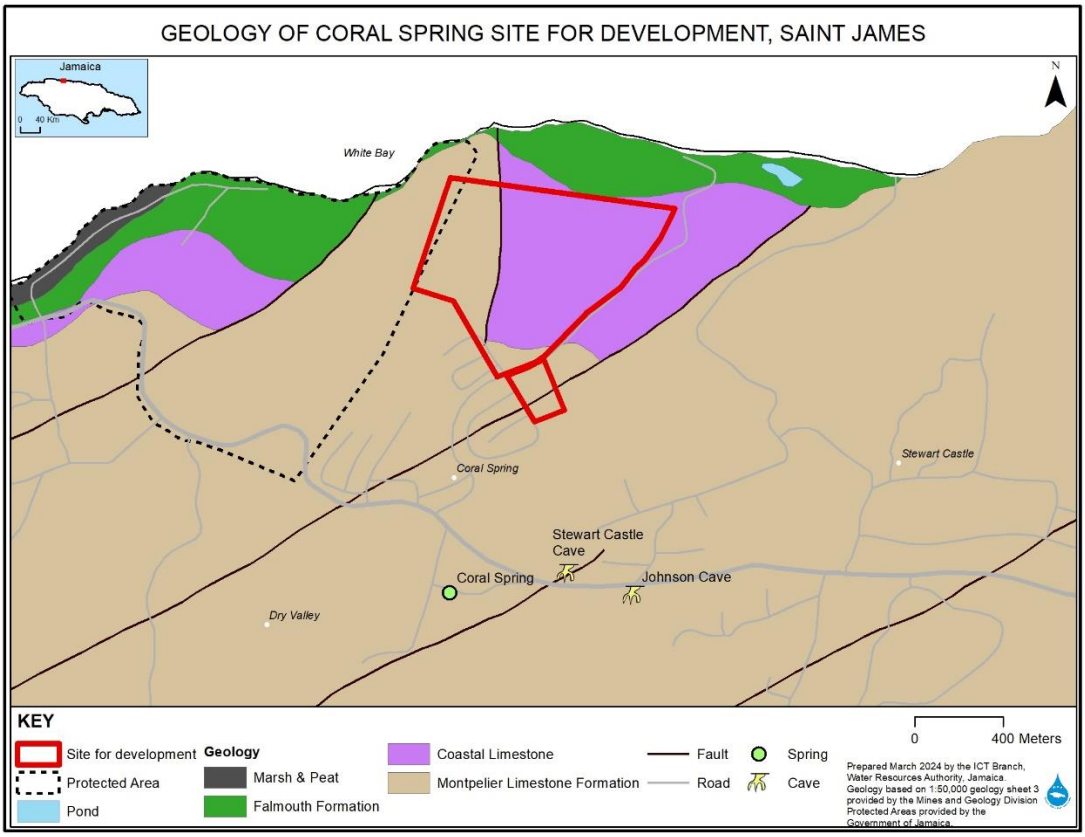


Figure 4-1: Geology of the Coral Spring project area

4.1.1.1 Karst Features

The project area is situated within the North Coast Belt. The geomorphology of the northern coast of Jamaica consists of raised reef terraces, beaches, bays, and headlands. The project site comprises a low-lying limestone platform, fault-influenced bluff, and karst features. Karstic features such as mature karst, small cavities, voids, fractures, and other dissolution features were observed in the limestone outcrops and on the northwestern areas of the site. Additionally, in the northwestern areas, there was an increase in the number of voids, more visible interconnectedness of the voids, presence of dissolution features and fractures along the surface of the joints and pinnacle karst at the edge of the bluff. Limestones mapped towards the central and eastern sections of the site are characterized by highly irregular surfaces penetrated by hollow dissolution cavities, sharp points, and pits. Cavities do not prohibit development and can be managed. However, the dimensions, interconnectedness and strength and structural integrity cannot be determined until the site is cleared.

Figure 4-2: Karst Features Observed at Project Site

Based on the observations, the engineering karst classification could be described as Type kII or kIII Karst (Youthful to Mature), where solutions for foundations include controlling drainage, grouting small open fissures, using raft foundations, employing geogrid, or using piles to rockhead. Caves were not found on the site, however, two caves, Stewart's Cave and Johnson's Cave, are located within 500 meters southeast of the project site. Additionally, a potential small and shallow collapsed cavern was observed in the north-central part of the site. It is highly recommended that these features be better identified and observed during site clearance. Excavations during foundation excavation at shallow depths would also expose and allow for a greater examination of these features.

4.1.1.2 Structural Geology and Seismic Hazard

During the Miocene period, Jamaica experienced tectonic uplift, leading to the exposure of the White Limestone Group and Coastal Group on the north coast, forming raised reef terraces, beaches, and headlands. Evidence of this uplift was observed during the site reconnaissance, with a wave-cut notch present in the bluff of the Mm (see Figure 4-3).

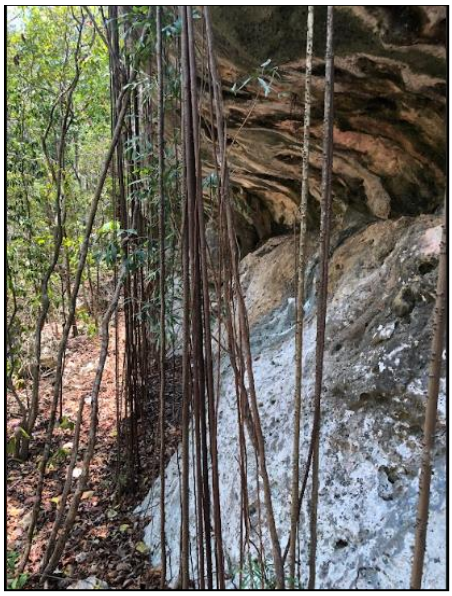


Figure 4-3: Old Wave-cut platform observed in the Mm after it was uplifted due to tectonic uplift.

A review of the 1:50,000 Metric Geology Sheet 03 (Falmouth) indicates that the site is affected by three prominent faults. The site is bounded to the west and east by northeast-southwest trending faults. The northeast to southwest trending fault zone is evident as a steep fault-bounded escarpment. These faults displace the older reef deposits. Although relatively young, this fault does not appear to be seismically active. The project area is not expected to generate large earthquakes and in fact has a lower risk of seismic activity compared to other parts of Jamaica. Historical earthquake data from 1997-2007 and 2010-2020 indicate that earthquake epicenters have been recorded offshore near Falmouth. The seismic hazard map of Jamaica indicates that the project site falls within an area where a Modified Mercalli Intensity (MMI) of 6 can be expected, with a 10% chance of exceedance in any 50-year period.

4.1.2 Topography, Soil and Land use

4.1.2.1 Topography

The property occupies an undulating terrain with rolling hills that slope toward the sea. Elevations range from 71m in the southern part of the property to approximately 5m at the northern boundary (refer to Figure 4-4). The Digital Elevation Model (DEM) was utilized to delineate catchments and drainage lines using the Terrain Processing function of Arc Hydro in ArcGIS 10.7. These drainage lines, depicted below, represent a network of drainage channels derived from elevation data rather than perennial rivers. Notably, they originate from the hills in the southeastern section of the property and flow northward, corresponding to the mapped sinkholes. Perennial rivers are absent in the area due

to its impermeable surface geology (coastal aquiclude) and karst limestone composition. Steep slopes are observed primarily on the eastern side of the property (see Figure 5b), indicated by closely spaced contours (refer to

Figure 4-5). A notably steep hill is situated in the northeastern section of the site, where the elevation is high (approximately 65 degrees), gradually transitioning into gentler terrain characterized by rounded hilltops and an undulating landscape. The slope and elevation map suggest that surface runoff would flow northward, toward the mangroves and sinkholes (as indicated by the arrow in Figure 4-4).

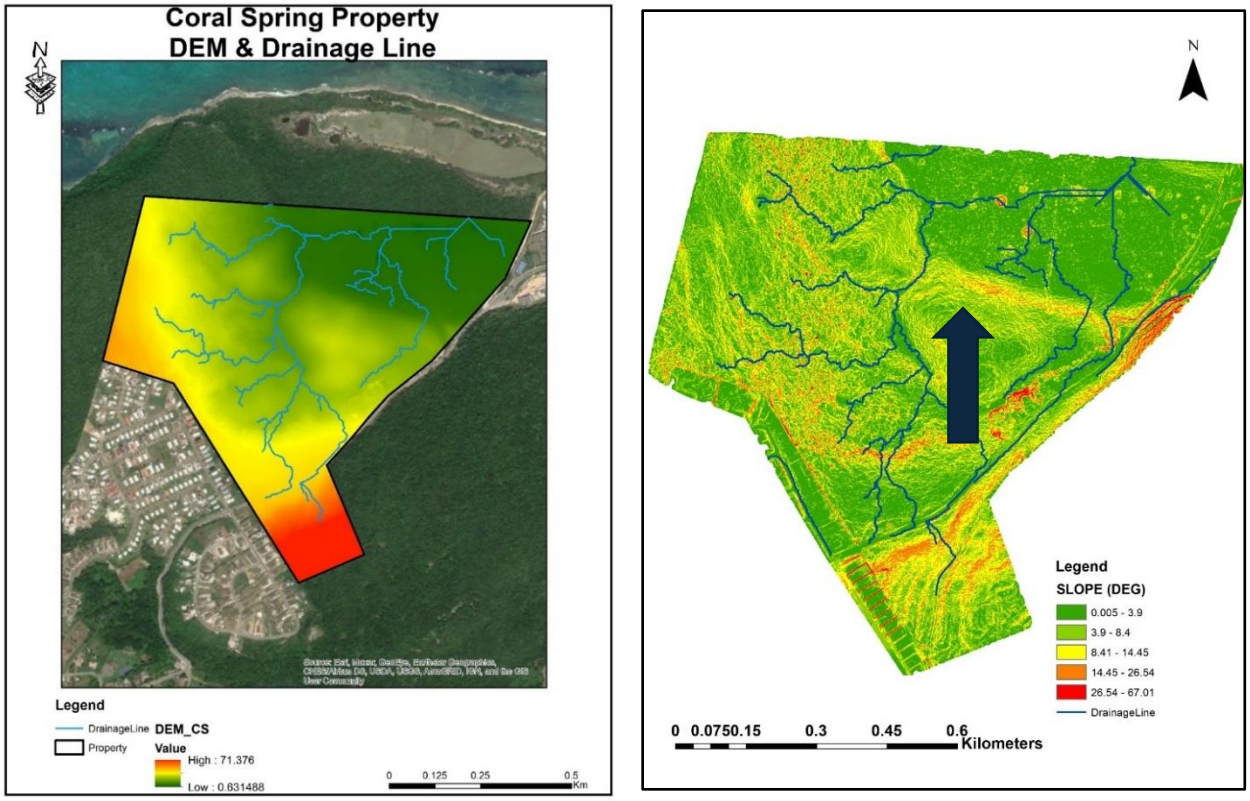


Figure 4-4: a) Map showing the elevation of the Coral Springs property site and b) Slope of the Coral Springs Property site.

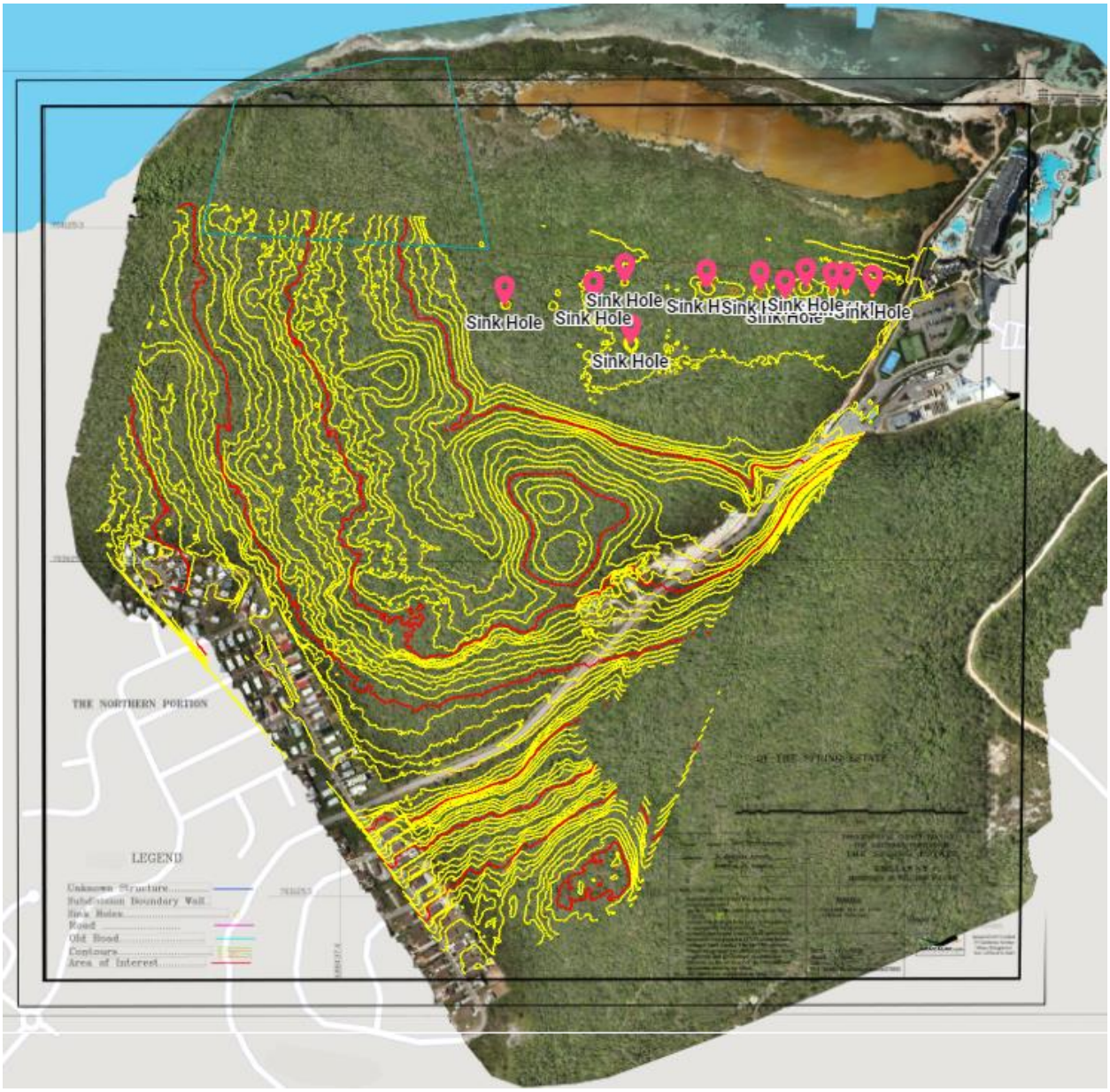


Figure 4-5: Map showing the contour lines as surveyed in the property and the mapped sinkholes in the northern boundary.

4.1.2.2 Soil and Land Use

The northern sections of Trelawny parish predominantly feature bauxitic soils associated with White Limestone. Across the entire project site, the prevailing soil type is Bonnygate stony loam, also linked with White Limestone. This soil type is distinguished by its brown or reddish hue, rapid internal drainage, low moisture retention, and slightly alkaline pH. During the geotechnical investigation and site reconnaissance, it was noted that soil was generally shallow or absent, with bedrock exposed in numerous areas. This aligns with the typical soil profile of raised reef platforms, which characterize the geological formation of the project area. According to the Trelawny Local Sustainable Development Plan, areas with this soil type, particularly along raised reefs, are recommended for residential development. The soil composition of the area reflects the underlying geology, mainly

consisting of stony loam and clay with low permeability, categorized under Hydrological Soil Group B (Figure 4-6).

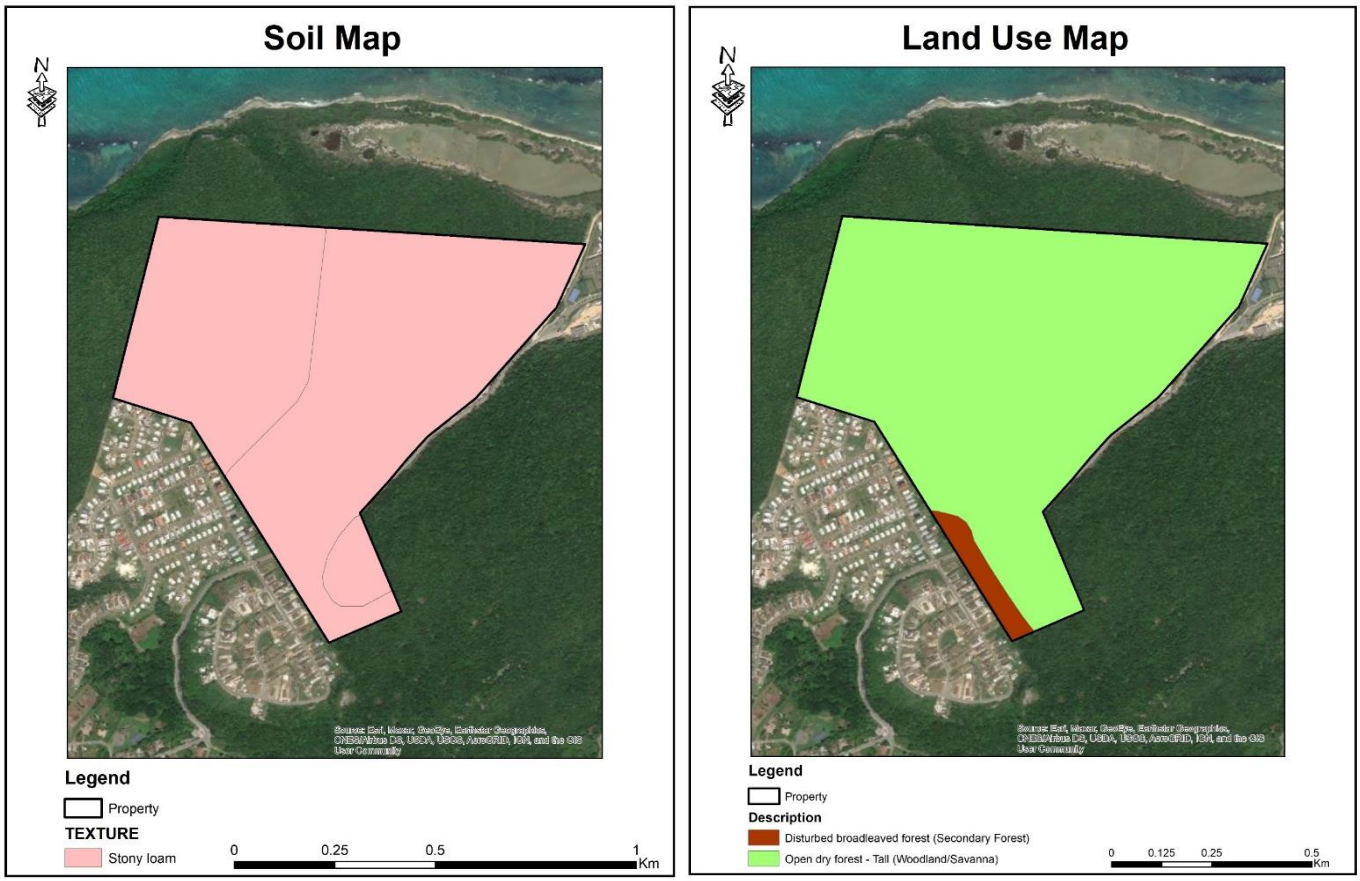


Figure 4-6: a) Soil and b) Land Use map of the Coral Springs property site.

4.1.3 Hydrology and Drainage

The site lies within the Limestone and Coastal Aquiclude hydrostratigraphic units, as indicated by maps sourced from the Water Resources Authority (WRA), Jamaica (see Figure 4-8 and Figure 4-9). Much of the area is characterized by karst limestone formations, resulting in limited surface drainage and a predominance of underground drainage systems. The site has sloping terrain with an elevation difference of 35m from south to north. The western boundary is on the Roslin Castle ridge. The general flow direction is towards the north where there are several depressions or cavities. Runoff from the eastern ridge (Stewart Castle) flows onto the access road, along the channel and into the salina (see Figure).

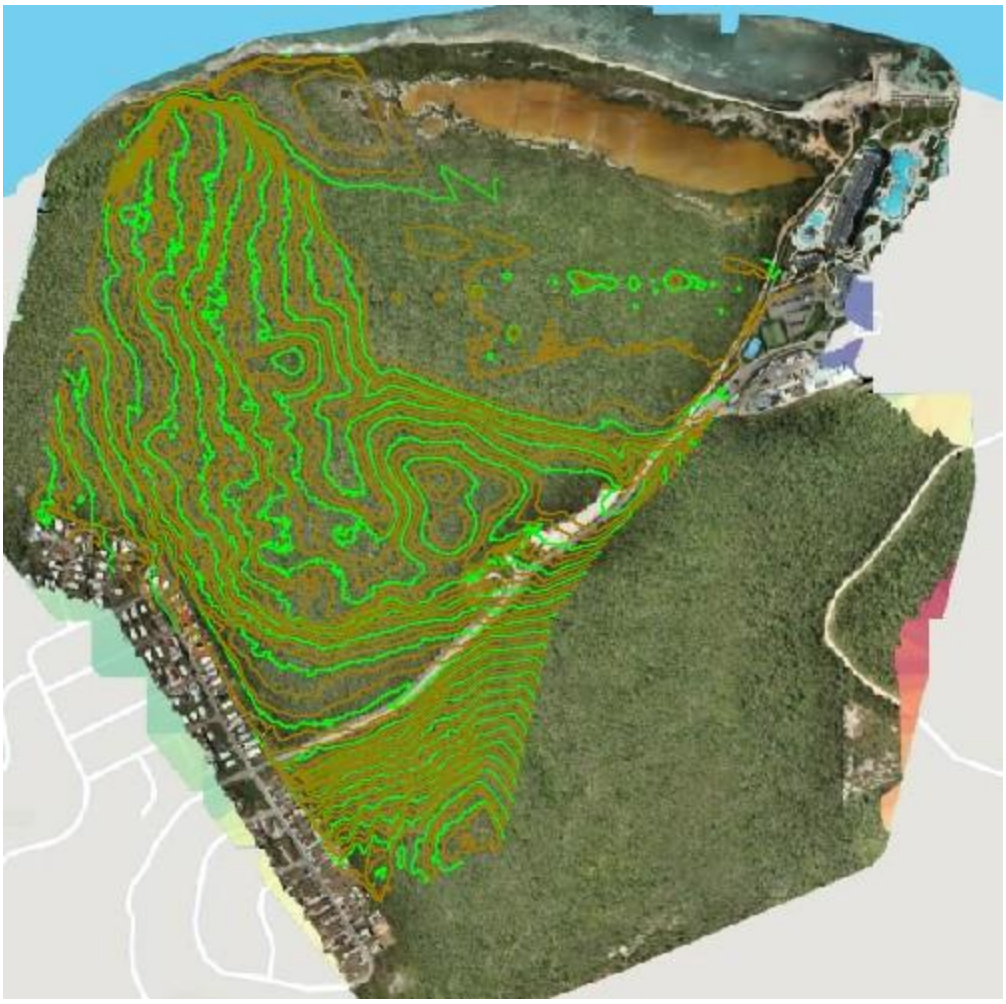


Figure 4-7: Coral Springs Village 2 site plan with 1m contours over aerial image

The region exhibits significant faulting, visible from the provided maps, which, combined with the karst landscape, suggests the presence of streams. Hydrogeological studies conducted previously (ASI report, 2012) indicate that the primary drainage direction of the site is controlled by the sinkhole, with all temporal drainage lines leading to it. The lithology consists mainly of permeable and soluble well-bedded chalk of the Montpelier Formation, facilitating higher infiltration rates compared to surface runoff. Site visits confirmed the presence of karst limestone, eroded in places covering the entire area. The Sink Hole evaluation study conducted by ASI in 2012 revealed that groundwater levels average about 6m ±1.7m above sea level (asl) based on data from 1965-1967. The presence of fault lines suggests potential groundwater discharge as springs, draining toward the sinkhole located at the northern boundary of the area. Groundwater level readings from boreholes drilled during the 2012 study indicate water levels approximately 17m above the lowest level of the existing pond surface. A perennial spring contributes constant baseflow to the sinkhole, emerging from groundwater at the surface.

Data from WRA indicates the presence of five wells within the Duncans sub-watershed management unit, with depths ranging from 88ft (Orange Grove) to 160ft (Oxford) at the southern boundary. Water level records show an average depth of 24m below ground level (BGL) during the period of 1965-1967 for the well at Oxford. Three wells near the Coral Springs hotel (Coral Springs Wells #1-3) are drilled

to a depth of 164ft, with an average static water level approximately 10m below ground level. Other wells exhibit varying static water levels, reaching depths of 163 ft (Stewart Castle) and deeper in the southern section of the sub-watershed management unit. Two caves, Stewart Castle and Johnson caves, located south of the property, indicate subsurface discharge of groundwater, characteristic of karst regions. Additionally, a spring (Coral Spring) is situated along a fault line as shown in Figure 4-9. Several sinkholes are observed on the northern margin of the property (Figure 4-9), suggesting that drainage from development may lead to ponding in these sinkholes, requiring attention post-development.

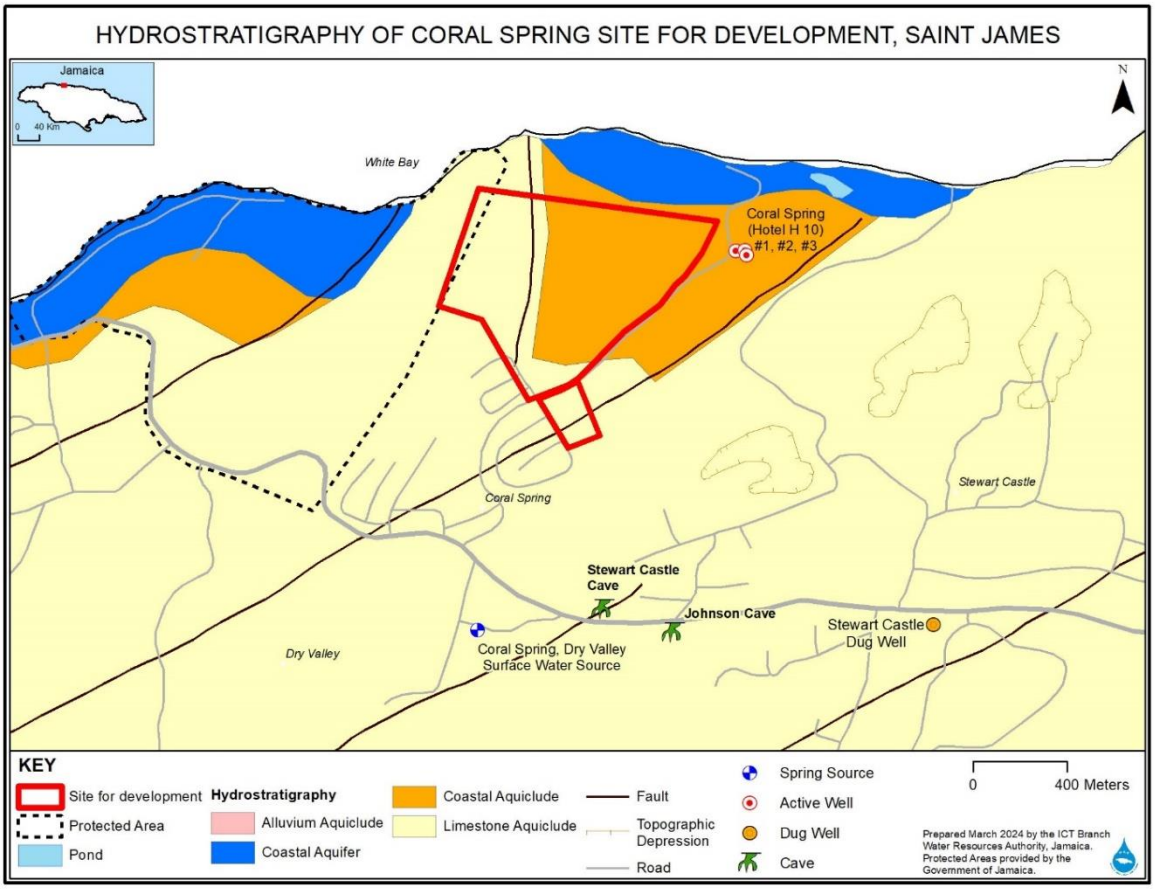


Figure 4-8: Hydrostratigraphic map for the Coral Springs property (WRA).

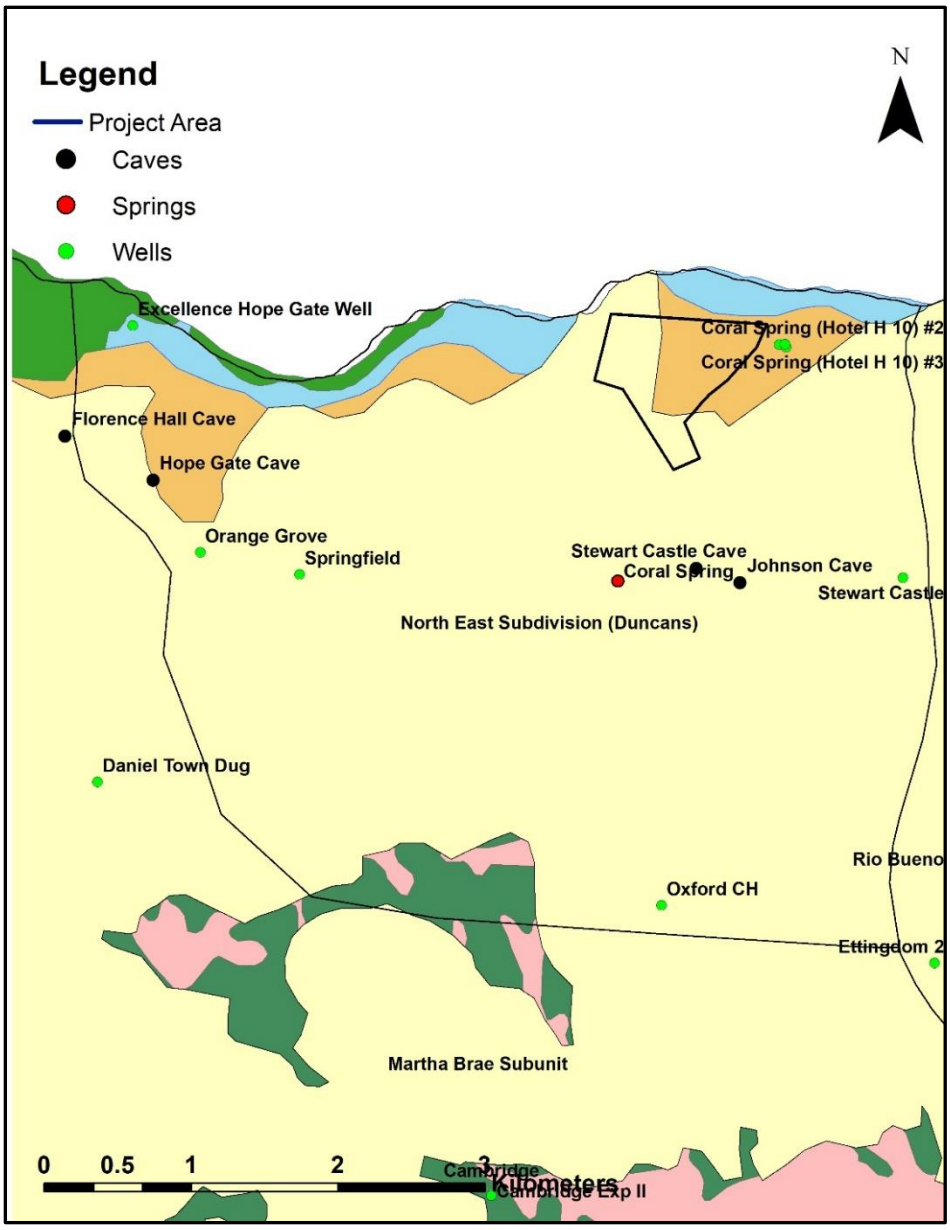


Figure 4-9: Wells, caves, and springs in the Coral Springs area (WRA 2011).

4.1.3.1 Estimation of Peak Discharge (Rational Method)

The runoff estimation was conducted using the Rational Method, which calculates the peak runoff by considering rainfall intensity, catchment area, and the runoff coefficient as input variables. Rainfall intensity values were obtained from the National Works Agency's Drainage Guidelines corresponding to different return periods, while the runoff coefficient (C) was estimated based on available C values from the NWA's Drainage Guidelines.

The peak discharge is calculated using the following equation:

$Q = 0.0028CiA$

Where: Q = peak storm water runoff (m3/s)
C = runoff coefficient
i = rainfall intensity (mm/hr)
A = drainage area (ha)

The Montego Bay intensity duration frequency (IDF) regression equations, developed by Mr. Ruddy Harrison and previously utilized in the area (e.g., EIA Report – Proposed Hotel Resort Development at Coral Springs, Trelawny by Felicitas Ltd., 2016), were employed to calculate rainfall intensities (refer to Figure 8). These regression equations allow for the use of IDF curves with localized 24-hour rainfall totals. An average of the 50 and 100-year 24-hour rainfall depths from all stations listed in Table 4-1 is utilized to estimate the 50 and 100-year peak discharge.

Table 4-1: Rainfall IDF relationships at the Sangster's International Airports developed by Mr. Ruddy Harrison in 2009.

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

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

4.1.3.2 Catchment Area Delineation

A catchment defines the area leading to the final outfall. A total of 63 catchments were delineated from the DEM. This project includes 20 catchment areas within the residential subdivision and 3 adjacent to and impacting the property as tabled and illustrated in Table 4-2 below. Two catchments flow through the subdivision, the other flows beside the development.

Table 4-2: Catchment areas location and size

ID	Description	Area (Ha)	C
SA#6	NEIGHBOUR	10.084	0.45
SA#7	NEIGHBOUR	1.9713	0.45
SA #21	East Catchment	51	0.3
CA1	Lots & Park	2.87	0.40
CA2	Lots & Park	4.083	0.42

ID	Description	Area (Ha)	C
CA3	Lots & Park	3.4205	0.40
CA4	Lots no Pond	4.928	0.45
CA5	Lots & Park	2.918	0.43
CA6	Lots	2.5743	0.45
CA7	Lots & Park	2.14	0.42
CA8	Lots	2.671	0.45
CA9	Lots	1.278	0.45
CA10	Lots	1.2317	0.45
CA11	Park	1.3853	0.3
CA12	Lots	0.5295	0.45
CA13	Lots & Park	2.4906	0.43
CA14	Lots & Park	2.1621	0.43
CA15	Lots & Park	3.725122	0.45
CA16	Lots & Park	6.3867	0.45
CA17	Lots & Park	2.2533	0.45
CA18	Lots & Park	5.836	0.3
CA19	Lots	1.05	0.45
CA20	Lots	5.27	0.6

Figure 4-10 displays the catchments delineated from the DEM, while Figure 4-11 illustrates the same catchments overlaid with the draft plan of the property. Peak discharge was estimated for each catchment using the Rational Method equation under both pre- and post-development scenarios. A runoff coefficient (C) value of 0.3 was assigned for the pre-development scenario for all catchments, considering the undeveloped nature of the entire area. For the post-development scenario, a C value of 0.6 was assigned based on values from the NWA's Drainage Guideline for "Multi-units" detached family housing and paved roads. Results of the analysis are presented in Table 4-3 and Table 4-4 below for pre- and post-development conditions. Although discharge was estimated for all 63 catchments, for clarity and flow direction understanding, catchments are grouped into twelve groups (CAT A-L) as shown in Figure 4-11. Catchments draining toward a common point are grouped together, as flow at downstream junctions would be a combination of all upstream flows.

Under pre-development conditions, peak discharge of 8.142 and 9.038 cumecs is observed for 50 and 100-year periods, respectively. Catchment I, with the largest area, exhibits the highest peak flow. The drainage network generally flows northward, with three main drainage networks originating from higher elevation areas in the south of the property, flowing through catchments A-D, and then

draining into catchments G, J, K, and L. The final outlet point is at A, where the flow volume would be the sum of all upstream flows. Peak discharge of 8.14 and 9 cumecs is estimated at Junction A for the pre-development condition. For the post-development condition, an increase in peak discharge to 16 and 18 cumecs is observed for the 50 and 100-year periods at Junction. A 50% increase in flow is expected following development, however, the addition of the proposed detention ponds reduces the peak discharge to pre-development levels.

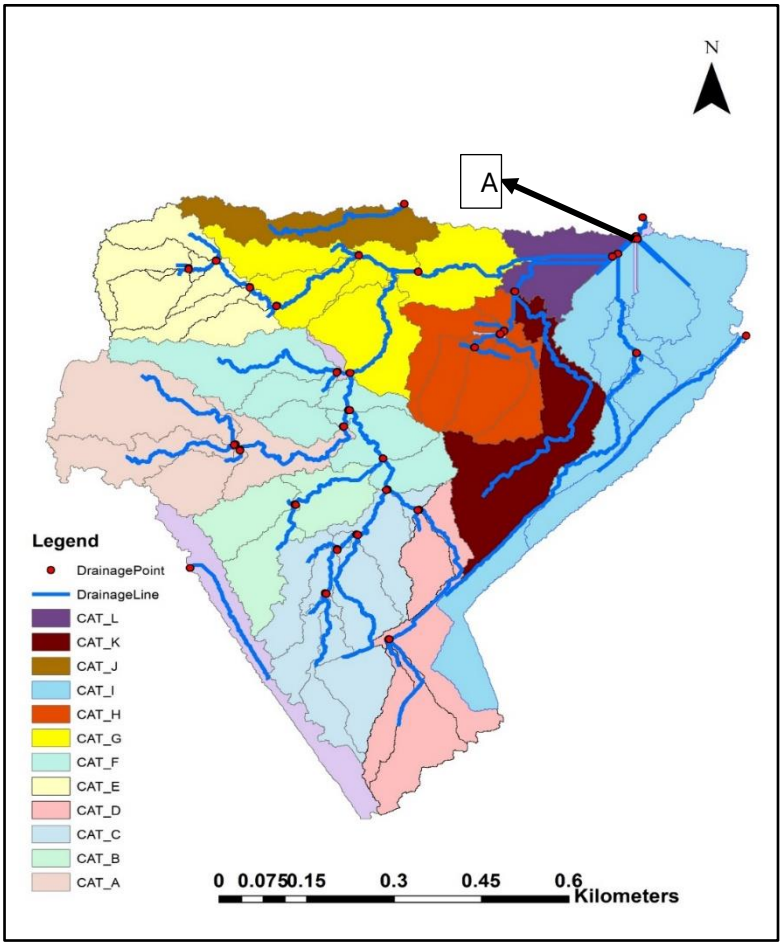


Figure 4-10: Map showing the different catchments and the drainage network for the property site.

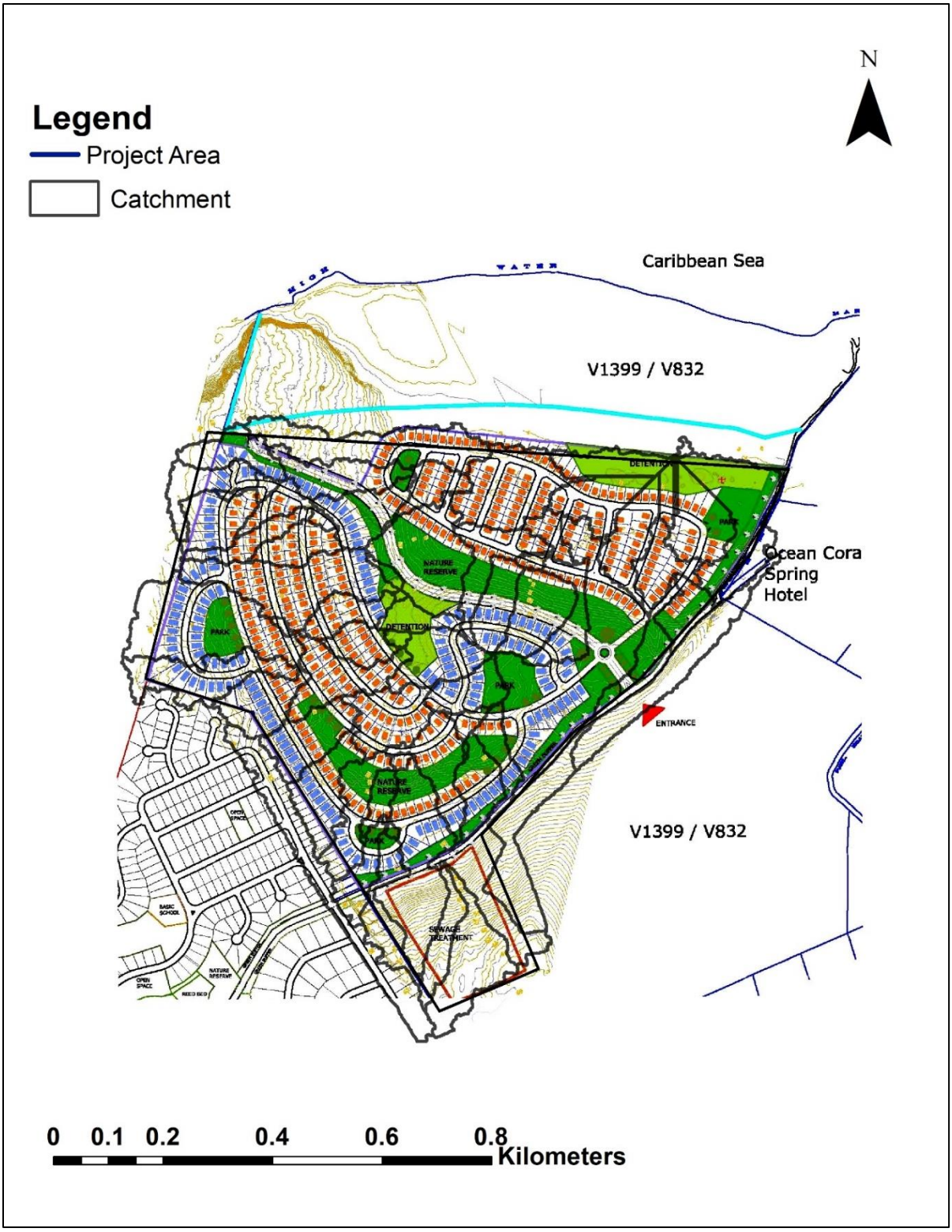


Figure 4-11: Map showing the different catchments and the draft layout plan for the development.

Table 4-3: Peak Discharge for the Catchments for a 50 and 100yr return period under a Pre-Development Scenario.

		PEAK DISCHARGE (CMS) PRE-DEVELOPMENT						
CATCHMENT	**AREA (HA)**	**Rainfall Intensity**		**C**		**Peak Discharge**		
		i- 50yr (1hr)	**i- 100yr (1hr)**			**Q (50 yr)**	**Q (100 yr)**	
A	8.14	153.12	171.19	0.3	0.0028	1.047	1.171	
B	4.2					0.540	0.604	
C	8.2					1.055	1.179	
D	6.01					0.773	0.864	
E	5.4					0.695	0.777	
F	7.28					0.936	1.047	
G	8.01					1.030	1.152	
H	5.16					0.664	0.742	
I	11.97					1.540	1.721	
J	2.48					0.319	0.357	
K	5.25					0.675	0.755	
L	2.06					0.265	0.296	
				TOTAL FLOW (CMS)		9.539	10.664	

Table 4-4: Peak Discharge for the Catchments for a 50 and 100yr return period under a Post Development Scenario.

		PEAK DISCHARGE (CMS) POST DEVELOPMENT					
CATCHMENT	**AREA (HA)**	**Rainfall Intensity**		**C**		**Peak Discharge**	
		i- 50yr (1hr)	**i- 100yr (1hr)**			**Q (50 yr)**	**Q (100 yr)**
A	8.14	153.12	171.19	0.6	0.0028	2.094	2.341
B	4.2					1.080	1.080
C	8.2					2.109	2.109
D	6.01					1.546	1.546
E	5.4					1.389	1.389
F	7.28					1.873	1.873
G	8.01					2.061	2.061
H	5.16					1.327	1.327
I	11.97					3.079	3.079
J	2.48					0.638	0.638
K	5.25					1.351	1.351
L	2.06					0.530	0.530
				TOTAL FLOW (CMS)		19.077	19.324

4.1.4 Geotechnical Assessment

The geotechnical assessment is included in Appendix 4* of this document.

4.1.5 Climate

Jamaica experiences a tropical marine climate characterized by an average annual rainfall of approximately 2250.99 mm (78 inches) (CSGM 2020). Traditionally, the island observes a bimodal rainfall pattern, with two distinct peaks occurring in April and May, as well as in September and October, coinciding with the Atlantic Hurricane Season. The bulk of Jamaica's rainfall typically occurs during the latter part of the year, with May and October registering as the rainiest months, while February and March are comparatively drier. The mean annual temperature in Jamaica ranges from 24 to 27°C, with variations influenced by the island's topography. Coastal areas generally experience warmer temperatures, while the interior tends to be cooler, with differences of up to 6°C (see Figure 4-12).

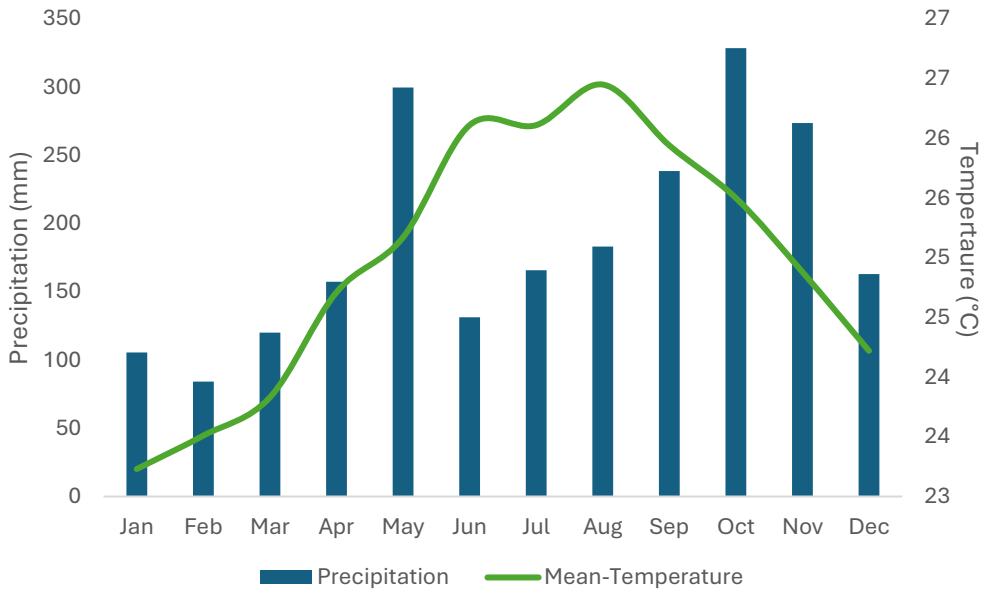


Figure 4-12: Jamaica Monthly Mean Temperature and Precipitation 1991-2020 (World Bank Group, n.d.)

Jamaica's climate exhibits seasonal changes, particularly during the Tropical Atlantic Hurricane Season, which spans from June to November annually. During this period, the Caribbean region, including Jamaica, faces the impacts of low-pressure systems and hurricanes. Additionally, prolonged drought conditions, attributed mainly to the El Niño phenomenon, have affected rainfall patterns in recent years. The summarized climate information presented in Table 4-5 below is based on the State of the Jamaican Climate 2019 report, which provides the most recent climate projection data for Jamaica. This data, published by the PIOJ in 2021, offers valuable insights into Jamaica's climate trends and projections.

Table 4-5:Summary of Jamaica's Climate

Climate Variable	Description
Temperature	Variations in surface temperature is due largely to the variation in solar insolation. Jamaica's temperature is unimodal with peak temperatures occurring during the summer months from June to September and coolest temperatures occurring from December through March. • Mean temperature values range between approximately 24°C and 27°C. • The mean maximum (daytime) temperatures can go as high as 33°C during the warmest months for some locations. • Mean minimum (night-time) temperatures can be as low as 19°C during the coolest months.
Solar Radiation	Solar radiation data from 12 stations throughout Jamaica from 1978 to 1987 suggest a peak in solar radiation in June-July and a minimum in January. Highest irradiation occurs on the flat coastal plains, while the smallest amounts occur in eastern Jamaica over high mountain regions.
Rainfall	Jamaica has a bimodal pattern of rainfall • The dry season is December-March • The rainy season spans April-November. This can be divided into an early rainfall season (April-June) and a late rainfall season (September–November). • A mid-summer minimum in July (termed the midsummer drought or MSD) separates the early and late wet seasons. • The most rainfall for the island is during the late rainfall season, with May and October being the rainiest months, while February and March are the driest months of the year.
Hurricanes	The North Atlantic hurricane season runs from June 1 to November 30. This coincides with the period when the Caribbean Sea is most conducive to convective activity and with Jamaica's rainfall season. Mid- August to late October is the peak of the North Atlantic season. However, hurricanes may occur at any time during the season.
Wind	Winds in Jamaica are a combination of the prevailing winds, sea breezes and mountain and valley winds which arise because of heating and cooling in valleys. Winds are strongest in Portland, St. Thomas, Manchester, and St. Elizabeth.
Relative Humidity, Sunshine	Data is limited to Norman Manley and Sangster International Airports. There is no significant variation in relative humidity. Average humidity at the airport stations is

Climate Variable	Description
Hours and Evaporation	higher during morning hours, ranging from 72-80%, and lower in the afternoon at 59-65%. This could be due to afternoon showers. Sunshine hours vary little throughout the year, ranging between seven and nine hours per day. There are more sunlight hours in the dry season and less in the main rainy season, with this being directly related to cloudiness. Evaporation tends to be a function of both temperatures and available moisture. For both stations, the values peak during the months approaching July (month with the highest mean temperatures) but following the onset of the rainy season (May).

4.1.5.1 Rainfall and Temperature

Variations in temperature and rainfall across Jamaica are primarily driven by the island's Tropical Marine climate. While temperatures generally remain consistent throughout the year, significant variations can occur in localized contexts due to factors such as altitude, distance from the coastline, and proximity to the island's hilly interior. It's noteworthy that temperatures tend to be cooler in the island's interior compared to coastal areas. Summer months, from June to September, typically record the highest temperatures, while cooler temperatures are experienced from December through March. The annual range of mean monthly temperatures is relatively small, ranging from approximately 23.0 to 27.1°C. Mean maximum daytime temperatures can reach up to 31°C during the warmest months, while mean minimum nighttime temperatures may drop to around 18.4°C during the coolest periods.

Jamaica's climatic pattern also features a bimodal rainfall distribution, characterized by two distinct wet seasons (April-June and September-November) separated by a dry season (December-March). The majority of rainfall occurs during the late rainfall season, particularly in September-November, with May and October emerging as the wettest months. May typically receives around 12% of the total annual rainfall, while October receives approximately 14%. However, recent trends indicate more equal rainfall distribution between May and October. Figure 4-13 illustrates the spatial distribution of mean rainfall across the island, highlighting that eastern parishes such as Portland and St. Thomas receive notably higher rainfall compared to other areas. This disparity is attributed to their location on the Windward side of the Blue Mountains range, exposing them to orographic rainfall. Figure 4-13 also indicates that northern parishes experience more moderate levels of rainfall, typically ranging from 1000 to 2000 mm/year. Given the Project area's proximity to the northern coastline, its temperature and rainfall patterns naturally differ from the more extreme conditions observed in the western and eastern parishes, especially.

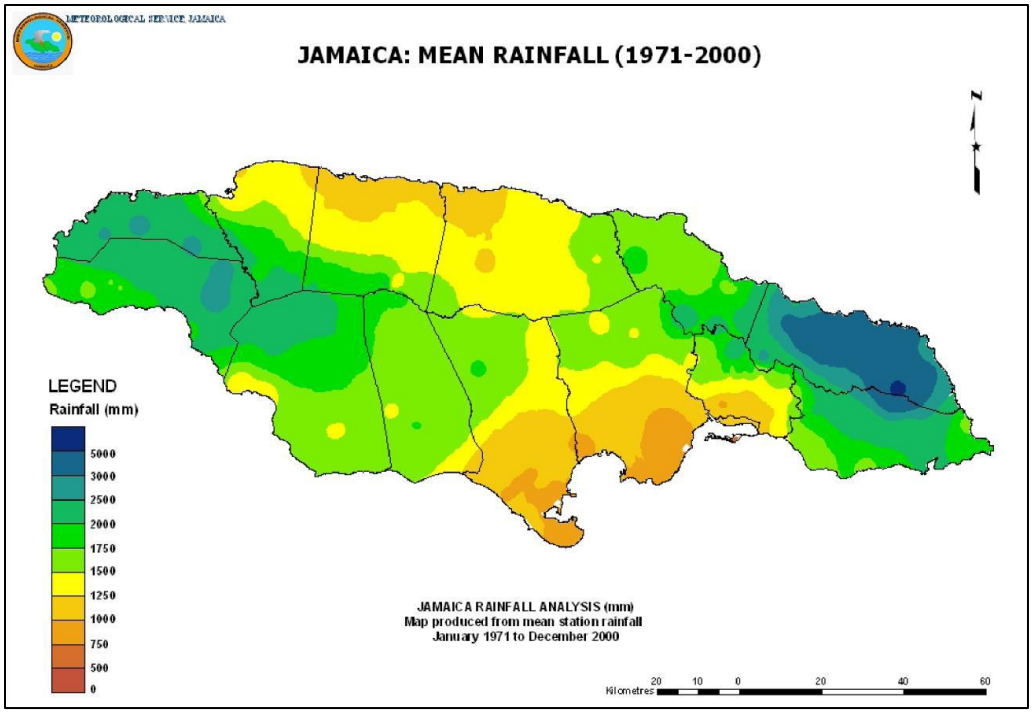


Figure 4-13: Distribution of mean annual rainfall for Jamaica (in millimetres) Source: Meteorological Service of Jamaica

Figure 4-14 below illustrates the temperature and rainfall climatology of the Project area over a 30-year period. As depicted, the temperature recorded for the area aligns with the temperature patterns typically observed across the island, with the coolest period spanning from December to March and temperatures reaching their peak during the summer months. However, there is a noticeable anomaly in temperature decrease during the month of August, which contrasts with the usual trend of peak temperatures across the island during this time. Instead, July and September emerge as the hottest months, with average temperatures peaking at just under 28°C. May stands out as the wettest month, experiencing higher levels of rainfall compared to any other month in the late wet season. Apart from May and the period between September and November, all other months of the year receive less than 100mm of rainfall on average.

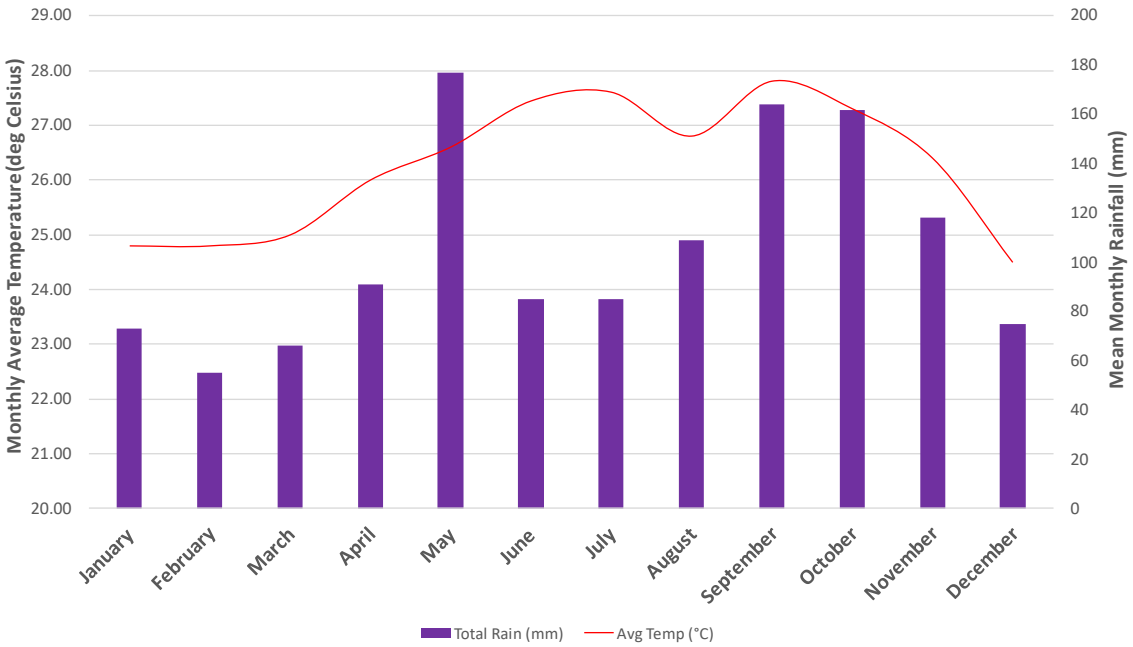


Figure 4-14: Temperature and Rainfall Climatology for the Coral Spring Project Area over a 30-year period

4.1.5.2 Rainfall Analysis

Over a 30-year period, the monthly mean rainfall ranges from 69 mm (minimum) to 222 mm (maximum). The drier months typically occur between December and March, with average rainfall rarely exceeding 130 mm. There are two distinct periods of above-average rainfall: from October to January and during May. For this study, rainfall return periods were estimated using weather stations from the Meteorology Service of Jamaica located within the parish and in proximity to the project area. Figure 4-9 illustrates the various stations in Trelawny parish, with the selected stations highlighted. Stations with consistent data records from 1992 to 2020 were utilized. Daily rainfall data from rain gauges in the watershed, covering a continuous period of 29 years (1992-2020), was also employed for computing rainfall return periods. The chosen stations are depicted in Table 4-6. It is noteworthy that analysis before 1992 couldn't be conducted due to a fire at the Meteorological Service of Jamaica, resulting in data loss. Runoff analysis for different return periods was performed using the 24-hour annual maximum data from the stations shown in Figure 4-15

Rainfall return periods for the selected stations, presented in Figure 4-15 (below) were estimated using the Gumbel moment of means method, utilizing mean and standard deviation parameters. This method relies on the Gumbel or Extreme Value Type 1 (EV 1) distribution, commonly used for extreme value analysis (Viessmann et al, 1977). The 24-hour maximum values for each year were derived from daily datasets for each station spanning from 1992 to 2020, sourced from the Meteorological Service of Jamaica, facilitating the calculation of mean and standard deviation for each station. The cumulative distribution function (CDF) of the Gumbel or Extreme Value Type 1 (EV 1) distribution [1] takes the form:

$$F(X \le x) = F(x) = \exp\left\{-\exp\left[-\frac{(x-\mu)}{\alpha}\right]\right\} \qquad (2)$$

Where the parameters μ and α are functions of the first moment about the origin, and the second moment about the mean respectively. Two of the commonly used methods of estimating the parameters of the extreme value distribution from observed data are the methods of moments and the graphical method. The method of moments uses Chow (1951) general equation for hydrologic frequency analysis:

$x = \bar{x} + Ks$ $F(x) = \left(1 - \frac{1}{T}\right)$ where T = return period.

The above method has been in existence since 1995 when it was used to develop the IDF curves for the NMIA (Norman Manley International Airport) and SIA (Sangster International Airport) for Jamaica (UWA, 1995) as well as by Burgess et al. 2015.

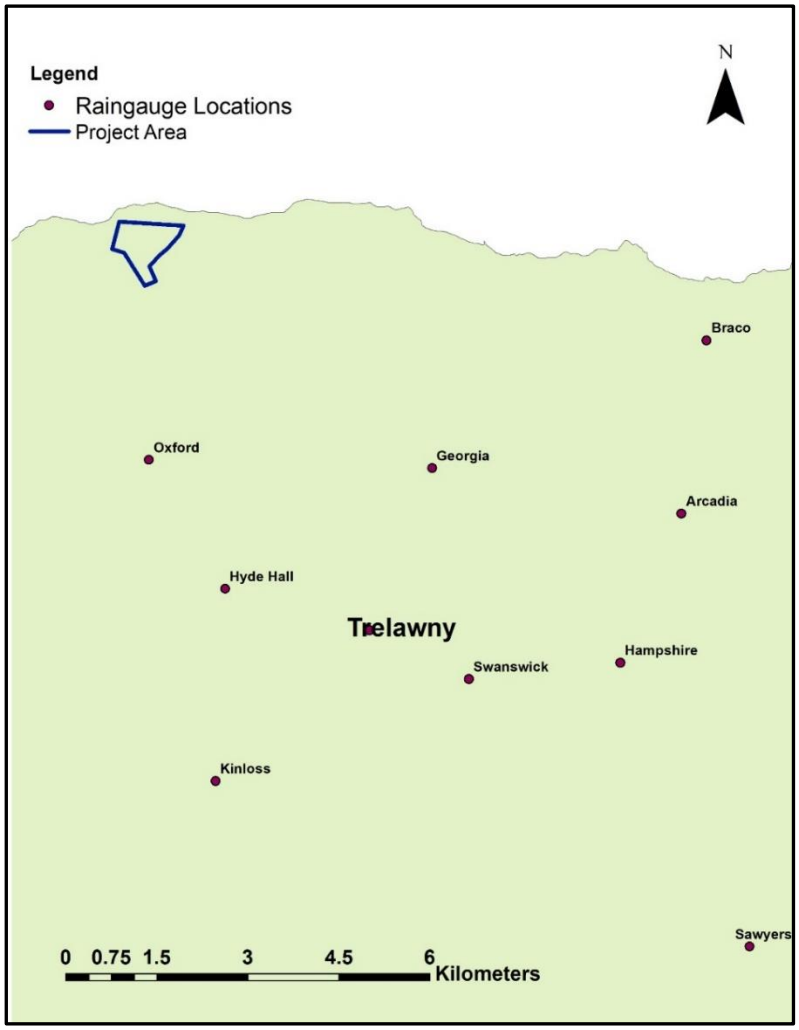


Figure 4-15: Rain gauge stations near the project site.

The rainfall depths used for the stations around the study area are shown in Table 4-6. The stations Oxford, Georgia, Arcadia and Kinloss had inconsistent records and thus were not selected in this study.

Table 4-6: Rainfall depths for the different return periods.

STATIONS	BRACO	HAMPDEN	ORANGE VALLEY	HAMPSHIRE	HYDE HALL	SAWYERS	SWANSWICK
5	151.8	155.5	104.1	164.2	129.3	131.6	164.3
10	193.1	199.6	124.5	210.7	163.2	156.1	213.4
25	245.1	255.0	150.1	268.9	205.7	186.8	275.0
50	283.7	296.3	169.1	312.3	237.4	209.6	320.9
100	322.3	337.5	188.2	355.6	269.0	232.5	366.7

4.1.6 Water Quality

As mentioned in section 1.3.1.4, eight sites were assessed for water quality in both the dry season (April 2024) and the wet season (September 2024). The description and results of each of the eight (8) locations examined are presented in Table 4-7 and Table 4-8 respectively.

4.1.6.1 General Classification of Water Quality

Based on the results obtained from the samples collected during the time of assessment, all samples could be classified as saline or highly saline water samples. Saline samples exhibit salinities between 33 and 38 ppt while hypersaline samples are those that have salinities above 38 ppt.[1] In the dry season, sampling points WQ1 - WQ3 were classified as hypersaline water while sampling points WQ4 – WQ8 were classified as saline or marine water samples (see Figure 4-16: Water Quality Sampling Locations. However, in the wet season, all samples could be classified as marine or saline samples.

Figure 4-16: Water Quality Sampling Locations

In both seasons, all samples collected in the marine environs (WQ4- WQ8) exhibited alkalinity values characteristic of marine water samples (between 100 – 130 mg $CaCO_3$/L). [2] The alkalinity values for these samples ranged from 118.5 – 126.1 mg $CaCO_3$/L in the dry season and between 111.8 – 118.5 mg $CaCO_3$/L in wet season.

However, for samples collected from the pond north of the proposed development (WQ1 – WQ3), the alkalinity values obtained were higher. Values ranged from values ranged from 250.2 – 253.4 mg

[1] https://manoa.hawaii.edu/exploringourfluidearth/physical/density-effects/measuring-salinity
[2] https://wetlandinfo.des.qld.gov.au/wetlands/ecology/components/water-chemical/alkalinity/

$CaCO_3$/L in the dry season and 163.0 – 179.1 mg $CaCO_3$/L in the wet season which could be due to the presence of a higher concentration of ions in these water samples.

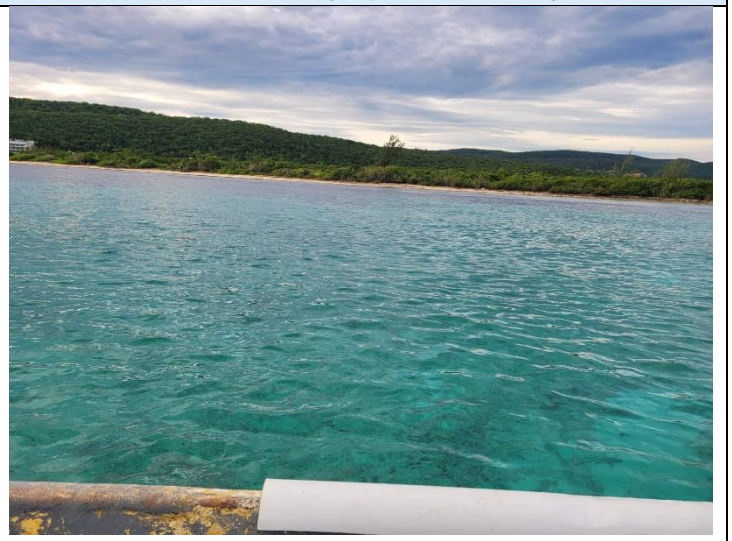
Table 4-7: Description of Water Quality Assessment Points

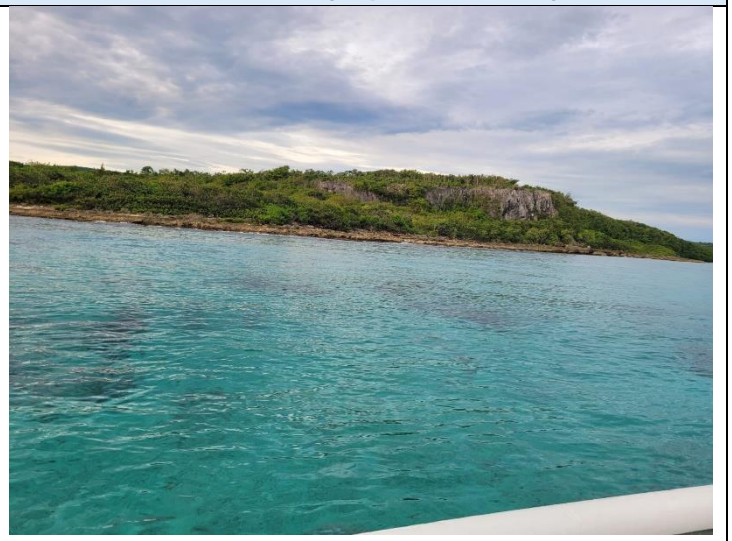
Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	**Wet Season (September 2024)**
WQ1	18°29'19.26"N 77°34'28.59"W	The sample was collected at the eastern end of a pond – reported to have been used as a salt evaporation pond. The boundary of this pond was located approximately 30 feet west of the western end of the Ocean Coral Spring Hotel. The water in the pond appeared turbid and a slight pungent odour was detected at this sampling location. The area to the north of the sampling point was polluted with solid waste associated with anthropogenic activities. Horse manure was also observed along the pathway to the sampling area. The sand in this area was waterlogged, while the entire pond was bordered with mangroves. The sample collected appeared to be pale yellow-grey, translucent with a slight pungent odour as well as settled and suspended particles.	The general description of the sampling location was similar to that observed in the dry season. However, leaf litter was seen on the surface of the water during this sampling exercise and there was a notable increase in the volume of water present within the pond The sample collected was pale brown, translucent, foamy and had small dark animals present within it.  **Environmental Conditions: Cool, overcast, light rainfall**

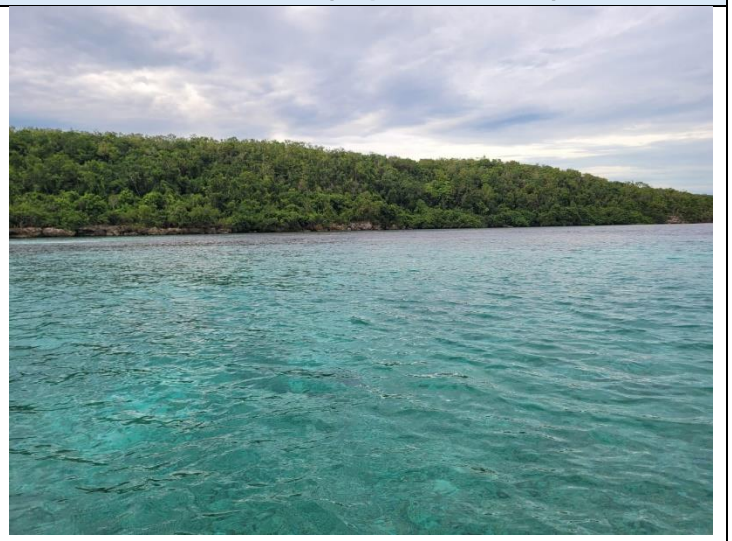
Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	Wet Season (September 2024)
		 **Environmental Conditions: Cool, sunny with clear skies**	
WQ2	18°29'21.15"N 77°34'39.06"W	The sample was collected from the mid-section of a large pond. The pond area around the sampling point was approximately 280 feet wide. Small channels approximately 1.5 feet deep were observed adjacent to the sampling location. Cranes and other birds were observed at this sampling area. Bird tracks were also observed on the waterlogged sand. Mangroves were observed bordering the pond area. The sample collected appeared pale brown-grey and translucent with settled and suspended particles. Small black bugs were observed in the sample also.	The general description of the sampling location was similar to that observed in the dry season. However, leaf litter was seen on the surface of the water during this sampling exercise and there was a notable increase in the volume of water present within the pond. The sample collected was pale brown, translucent, foamy and had small dark animals present within it.

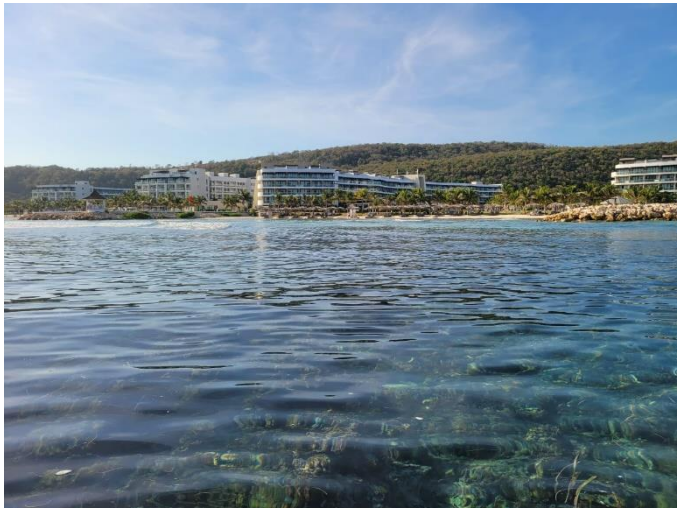
Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	Wet Season (September 2024)
		 **Environmental Conditions: Cool, sunny with clear skies**	 **Environmental Conditions: Cool, sunny with clear skies**
WQ3	18°29'22.10"N 77°34'43.42"W	The sample was taken close to the western end of the pond. This area was noticeably dryer, and water levels were lower than the mid and eastern end of the pond. A pungent odour was detected at this location. As per the other sampling locations, mangroves bordered the pond area, and some crystalline/salt particles were observed on the dryer sandy areas. The sample collected appeared pale yellow, translucent with a slight pungent odour and small black bugs .	The sample was taken at the western end of a large open pond. Similar to the sample collected in the dry season, mangroves bordered this sampling area, however, there was no odour detected during this exercise. Additionally, birds were observed at this location. The sample collected appeared brown and translucent.

Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	Wet Season (September 2024)
		 **Environmental Conditions: Cool, sunny with clear skies.**	 **Environmental Conditions: Cool, broken clouds, sun starting to rise.**
WQ4	18°29'29.00"N 77°34'40.00"W	The sample was collected in the marine environs north of the proposed project area. The sample was collected approximately 300 ft north of a beach. The water at this location was extremely clear and a shallow reef structure that was approximately 5-6 feet deep was observed at the bottom of this sampling area. Small bubbles were seen on the surface of the water body. The Ocean Coral Spring/ Eden Bay Hotels were seen towards the east of the sampling location while Hotel Riu (Aquarelle) and cruise ships docked at the Falmouth Cruise Ship Pier were seen clearly towards the west of the sampling area.	The general description of the sampling location was similar to that observed in the dry season. The sample collected was clear and colorless.

Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	**Wet Season (September 2024)**
		The sample collected appeared clear and colourless.  **Environmental Conditions: Cool, sunny with clear skies.**	 **Environmental Conditions: Cool, broken clouds, sun rising**
WQ5	18°29'27.00"N 77°34'56.00"W	The sample was collected in the marine environs north of the proposed project area. The sample was collected approximately 100 ft north of a limestone outcrop. The water at this location was extremely clear and a shallow reef structure that was approximately 7 feet deep was observed at the bottom of this sampling area. The Ocean Coral Spring/ Eden Bay Hotels were seen towards the east of the sampling location while Hotel Riu (Aquarelle) and cruise ships docked at the Falmouth Cruise Ship Pier were seen clearly towards the west of the sampling area. The sample collected at this location appeared clear and colorless	The general description of the sampling location was similar to that observed in the dry season. The sample collected was clear and colorless.

Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	**Wet Season (September 2024)**
		 **Environmental Conditions: Cool, sunny with clear skies**.	 **Environmental Conditions: Cool, broken clouds, sun rising**
WQ6	18°29'23.00"N 77°35'11.00"W	The sample was collected in the marine environs north of the proposed project area. The sample was collected approximately 350 ft north of the center of a limestone bluff. The water at this location was extremely clear and a shallow reef structure that was approximately 7 feet deep was observed at the bottom of this sampling area. A brown pelican was observed in this area and small amounts of grassy matter was seen on the surface of this sampling location. A boat was observed towards the north of the sampling area. The Ocean Coral Spring/ Eden Bay Hotels were seen towards the east of the sampling location while Hotel Riu (Aquarelle) and cruise ships docked at the Falmouth Cruise Ship Pier were seen clearly towards the west of the sampling area.	The general description of the sampling location was similar to that observed in the dry season. However, no pelican or grassy matter was seen during this sampling exercise. The sample collected was clear and colorless.

Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	**Wet Season (September 2024)**
		The sample collected at this location appeared clear and colourless.  **Environmental Conditions: Cool, sunny with clear skies**.	 **Environmental Conditions: Cool, broken clouds, sun beginning to rise**
WQ7	18°29'27.00"N 77°34'22.00"W	The sample was collected in front of a groyne structure at the Ocean Coral Spring Hotel. Natural debris was observed on the surface of this sampling area. The water at this location was clear and a shallow reef structure that was approximately 7 feet deep was seen at the bottom of the sampling area. Jackfish were seen nearby to the sampling area. This sampling area was north-east of proposed project area and approximately 300 ft in front of the Ocean Coral Spring Hotel beach.	The general description of the sampling location was similar to that observed in the dry season. However, no fish were observed during the sampling exercise and very few persons were seen bathing. The sample collected was clear and colorless.

Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	**Wet Season (September 2024)**
		The sample collected at this location appeared clear and colorless.  **Environmental Conditions: Cool, sunny with clear skies.**	 **Environmental Conditions: Cool, broken clouds, sun beginning to rise**
WQ8	18°29'34.44"N 77°34'44.39"W	The sample was collected in the marine environs north of the proposed project area. The sample was collected approximately 900 ft north of a beach. The water at this location was extremely clear and the sandy bottom interceded with rocks approximately 18 feet deep was clearly seen. The surface of the water at this location was free from any debris. The Ocean Coral Spring/ Eden Bay Hotels were seen towards the east of the sampling location while Hotel Riu (Aquarelle) and cruise ships docked at the Falmouth Cruise Ship Pier were seen clearly towards the west of the sampling area.	The general description of the sampling location was similar to that observed in the dry season. However, grassy material was seen on the surface of the water body. The sample collected was clear and colourless.

Sample Location	GPS Coordinates	Description	
		Dry Season (April 2024)	**Wet Season (September 2024)**
		The sample collected appeared clear and colourless.  **Environmental Conditions: Cool, sunny with clear skies.**	 **Environmental Conditions: Cool, broken clouds, sun beginning to rise**

All marine water samples assessed could also be described as having high clarity, low oxygen demand, low nutrient concentrations and were typically free from enterococci, *E. coli* and faecal coliform. However, there was evidence of low levels of total coliform in the water (see Table 4-8).

For the samples collected from the pond, all samples exhibited high microbial levels in the wet season whereas the samples collected in the dry season exhibited elevated levels of total coliform whencompared to the Draft Jamaican National Ambient Water Quality Standard – Marine Water, 2009. Additionally, in the dry season, points WQ1 and WQ2 had low levels of faecal coliform and *E. coli* in the water while enterococci was detected at sampling point WQ1 only. The water clarity at these locations were lower while the oxygen demand was higher than that of the marine water samples in both seasons. The oxygen demand of these samples was also higher compared to the marine water samples; this could be due to stagnation of the water bodies in which these samples were collected.

4.1.6.2 Marine Water Quality (WQ4 – WQ8)

All marine water samples collected were compliant with the Draft NRCA Ambient Water Quality Guideline – Marine (2009) for biochemical oxygen demand suggesting that the areas sampled were relatively unpolluted from substances that could cause the depletion of oxygen in the marine environment.

The Ambient Water Quality Standards for Marine Environments in Trinidad and Tobago (Protection of Aquatic Life and Aquatic Ecosystems) indicate that the concentration of dissolved oxygen (DO) obtained should be greater than 5 mgO_2/L. During the time of the assessment, all sites except for the DO concentration obtained at site WQ8 and WQ5 during both seasons were lower than this specified value which could be as a result of the time of sampling. Furthermore, although the values were lower than this specified value, organisms will begin to react to low dissolved oxygen conditions at values below 4 mgO_2/L; all samples taken were higher than this concentration.[3] The oil and grease concentration obtained for all water quality locations was not detected at any location.

All five water samples had low values of turbidity and total suspended solids indicating the relative clarity of the water samples collected. The turbidity of these samples ranged from 0.47 – 0.72 NTU while the total suspended solids ranged from 1.7 – 6.9 mg/L in the dry season. The turbidity was undetected at all locations with the exception of the value obtained at sampling point WQ4 (0.46 NTU) while the total suspended solids ranged from 2.0 – 6.9 mg/L in the wet season.

According to the Canadian Water Quality Guidelines for the Protection of Aquatic Life, '*nutrient enrichment of coastal waters is one of the greatest threats to the integrity of coastal ecosystems*'[4]. Nutrients are typically used to define the nitrates and phosphates in a water body. Nutrients are particularly of concern for aquatic environments as they can increase the risk of eutrophication in a water body which can in turn impact its oxygen demand and water clarity. For this sampling exercise, it was seen where the phosphates were undetected for most samples, and although the nitrates were non-compliant with the Draft Jamaica National Ambient Water Quality Standard - Marine Water (2009) remained low throughout all samples collected. Although the concentrations obtained were relatively low in the samples collected, there was a slight increase seen in the samples collected at sampling stations WQ4 and WQ7; these sampling stations are most likely to be impacted by

[3] https://www.vims.edu/research/topics/dead_zones/impacts/

[4] https://ccme.ca/en/res/nutrients-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf

anthropogenic activities given their proximity to a fishing beach village and hotel activities respectively.

Microbial parameters during both seasons were either undetected or within the specifications of the Draft Jamaica National Ambient Water Quality Standard - Marine Water (2009) indicating that the marine water samples were relatively free from faecal matter.

Chlorophyll-a is a measure of the number of phytoplankton organisms growing in a particular waterbody and an increase in chlorophyll-a concentrations are typically used to indicate the condition of a water body. In both seasons, the chlorophyll-a concentrations were generally low, however, it was noted that the chlorophyll concentrations were higher in the wet season than in the dry season. This could point to an impact that anthropogenic activities may have on the water body in the wet season due to increased run off and influences from possible freshwater inflows in the area. The salinities of the water sampling locations during the wet season (~35 ppt) were slightly lower than that observed in the dry season (~37 ppt) further concretising the fact that the marine environs may be impacted by increased freshwater flows during the wet season.

4.1.6.3 Pond Water Quality (WQ1 – WQ3)

Based on the results obtained from the wet season and dry season assessments, seasonal variations, as well as the geology of the area may have a significant impact on the quality of the water obtained from the pond north of the proposed development as shown by the varied pHs obtained in both seasons.

The classification of the water in the ponds ranged from saline in the wet season to hypersaline in the dry season. During the wet season sampling exercise there was an increased volume of water as compared to the dry season which may have resulted in the decrease in salinity, conductivity and total dissolved solids obtained. Given the possible decreased presence of ions that contribute to these parameters, the decrease in alkalinity in the wet season may be explained by this as well.

The nutrient concentration obtained remained similar across both seasons, however, the microbial content in the wet season was greater than that observed in the dry season across all three samples taken. This could possibly be due to the increased surface water flows carrying pollutants from nearby land-use activities into the ponds.

However, with the increase in water flow and volume, the general clarity and oxygen demand of the samples improved. The TSS seen in the dry season ranged from 36. 5- 112 mg/L while the turbidity ranged from 28.8 – 265 NTU; in the wet season, these parameters ranged from 30.0 – 98.0 mg/L and 32.10 – 46.65 NTU respectively. The BOD of the samples ranged from 8.8 to 17.9 mg O_2/L in the dry season and 1.7 to 2.7 mg O_2/L in the wet season which could be due to the decrease in solids which can carry organic matter. Similarly, the dissolved oxygen concentration was lower in the dry season as compared to the wet season. There was also a slight decrease observed in the chlorophyll-a concentrations obtained when the dry season was compared to the wet season. However, chlorophyll-a levels remained higher than seen in the marine environs; this suggests that the ponds may have a greater impact from anthropogenic activities. The oil and grease concentration remained undetected and unchanged across both seasons.

Table 4-8: Results of Water Quality Assessment

Parameter (units)	Sampling Exercise	Pond Samples			Marine Samples					Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009
		WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	
pH (pH Units)	April 2024 (Dry)	7.70	7.67	7.60	7.95	8.00	7.98	7.90	8.00	**8.00 – 8.40**
	September 2024 (Wet)	8.36	8.45	8.45	7.81	8.02	8.00	7.95	8.00	
Dissolved Oxygen (mg O_2/L)	April 2024 (Dry)	0.19	2.04	0.00	4.39	5.16	4.41	4.01	5.65	-
	September 2024 (Wet)	0.81	3.24	3.27	4.33	5.04	4.98	4.08	6.63	
Conductivity (µS/cm)	April 2024 (Dry)	87.4	107.4	123.6	59.3	59.5	59.4	59.4	59.7	-
	September 2024 (Wet)	56.1	56.9	57.1	56.9	58.7	58.2	57.3	58.5	
Total Dissolved Solids (mg/L)	April 2024 (Dry)	56401	68473	70954	36799	36788	36740	36807	36766	-
	September 2024 (Wet)	35541	36450	36962	34511	34670	34560	34424	34687	
Salinity (ppt)	April 2024 (Dry)	61.47	>70.00	>70.00	37.61	37.58	37.52	37.61	37.55	-

Parameter (units)	Sampling Exercise	Pond Samples			Marine Samples					Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009
		WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	
	September 2024 (Wet)	36.18	37.25	37.84	34.87	35.08	34.97	34.86	35.06	
Temperature (°C)	April 2024 (Dry)	25.4	27.6	31.9	27.5	27.7	27.7	27.5	27.9	-
	September 2024 (Wet)	26.4	25.8	25.2	28.9	30.2	30.0	29.3	30.1	
Biochemical Oxygen Demand (mg O_2/L)	April 2024 (Dry)	11.0	8.8	17.9	1.0	0.9	0.8	0.9	0.5	**0.0 – 1.16**
	September 2024 (Wet)	2.7	1.9	1.7	0.9	1.0	0.6	0.7	0.7	
Total Suspended Solids (mg/L)	April 2024 (Dry)	112.0	76.0	36.5	5.3	5.2	1.7	5.5	6.9	-
	September 2024 (Wet)	45.0	98.0	30.0	2.9	6.9	2.5	2.0	3.2	
Turbidity (NTU)	April 2024 (Dry)	266	295	28.80	0.72	0.49	0.55	0.54	0.47	
	September 2024 (Wet)	46.65	35.90	32.10	0.46	<0.41	<0.41	<0.41	<0.41	
Orthophosphates as Phosphorus	April 2024 (Dry)	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	**0.001 – 0.003**

Parameter (units)	Sampling Exercise	Pond Samples			Marine Samples					Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009
		WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	
(mg PO_4^{3-}-P/L)	September 2024 (Wet)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Nitrates as Nitrogen (mg NO_3^--N/L)	April 2024 (Dry)	0.04	0.02	0.06	0.02	0.02	0.02	0.02	0.02	0.007 – 0.014
	September 2024 (Wet)	0.06	0.04	0.04	0.06	0.02	0.02	0.04	0.02	
Total Coliform (MPN/100mL)	April 2024 (Dry)	>1600	920	14	<1.8	13	2.0	2.0	<1.8	2 - 256
	September 2024 (Wet)	>1600	350	170	<1.8	<1.8	2.0	<1.8	<1.8	
Faecal Coliform (MPN/100mL)	April 2024 (Dry)	14	2.0	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<2-13
	September 2024 (Wet)	49	22	110	<1.8	<1.8	<1.8	<1.8	<1.8	
E.coli (MPN/100mL)	April 2024 (Dry)	14	2.0	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	-
	September 2024 (Wet)	49	17	110	<1.8	<1.8	<1.8	<1.8	<1.8	
Enterococci (MPN/100mL)	April 2024 (Dry)	3.6	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	<1.8	-

Parameter (units)	Sampling Exercise	Pond Samples			Marine Samples					Draft Jamaica National Ambient Water Quality Standard – Marine Water, 2009
		WQ1	WQ2	WQ3	WQ4	WQ5	WQ6	WQ7	WQ8	
	September 2024 (Wet)	>1600	17	350	<1.8	<1.8	<1.8	2.0	<1.8	
Total Alkalinity (mg $CaCO_3$/L)	April 2024 (Dry)	250.2	253.4	343.5	118.5	122.2	124.3	126.1	123.6	-
	September 2024 (Wet)	179.1	169.9	163.0	118.5	111.8	113.2	116.1	115.5	
Chlorophyll-a (mg/m^3)	April 2024 (Dry)	4.99	5.37	3.79	0.28	0.30	0.27	0.63	0.21	-
	September 2024 (Wet)	4.82	3.52	3.09	1.06	1.26	0.87	0.63	0.86	
Fats, Oil and Grease (mg/L)	April 2024 (Dry)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	-
	September 2024 (Wet)	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	

****Values highlighted in red are non-compliant with the cited standard.**

4.1.7 Air and Noise Assessment

4.1.7.1 Air Quality

As mentioned in section 1.3.1.5, four sites were assessed for respirable particulates in the dry season (April 2024) and the wet season (September 2024). The description and results of each of the four (4) air quality locations examined are presented in Table 4-9 below.

Table 4-9: Air Quality Sampling Points and Descriptions

Sample Location	GPS Coordinates	Description of Sampling Location
Dry Season (April 2024)		
AQ1	18°29'0.70"N 77°35'5.70"W	This air quality sampling location was located nearby the south-western end of the proposed property location. This sampling area was located in the yard of a residential home. Fruits and decorative trees were seen nearby to the pump location. An unfinished house was located to the west of the air quality sampling location. The ground was sparsely vegetated. A few concrete blocks and ply boards were seen towards the south of the pump set up location. Gravel and a dirt heap was seen approximately 20 feet north west of the pump set up location.  **Environmental Conditions: Moderate winds, sunny & cool.**
AQ2	18°28'40.90"N 77°34'50.50"W	This air quality sampling location was located approximately 300 meters south-east of the south-eastern proposed project boundary in an established community area. The pump was set up north-east of a small apartment and north-west of an unfinished house. Light construction appeared to be taking place towards the west of the air quality location. Towards the north of the pump set up area was densely vegetated

Sample Location	GPS Coordinates	Description of Sampling Location
		and the ground at the pump set up locations was moderately grassed. An asphalt road was located south of the pump set up area. Several parked cars were located north of the pump set up area.  **Environmental Conditions: Moderate winds, sunny & cool.**
AQ3	18°29'15.80"N 77°34'34.90"W	This air quality sampling station was located close to the north-eastern end of the proposed project boundary. This assessment point was located in a clearing approximately 170 meters west of the western boundary of the Ocean Coral Springs hotel. Sections of the hotel were clearly seen from the pump set up location. The ground was rocky with areas of exposed dirt and gravel. Tall grassy plants and short shrubs were also observed close to the pump set up location. Areas around the pump was moderately vegetated with tall narrow-trunked trees.

Sample Location	GPS Coordinates	Description of Sampling Location
		 **Environmental Conditions: Moderate winds, sunny & cool.**
AQ4	18°29'17.40"N 77°34'52.90"W	This air quality sampling location was located near to the north-western end of the proposed development boundary. The sampling area was located approximately 300 meters west of a limestone bluff. The pump was placed in an approximately 15-foot-wide pathway; this pathway was lined with moderate vegetation. The ground at this sampling location was sparsely to moderately vegetated with grasses and short shrubs. There were rocks embedded in the ground, however, there were also pockets of exposed dirt and gravel.

Sample Location	GPS Coordinates	Description of Sampling Location
		 **Environmental Conditions: Moderate winds, sunny & cool.**
Wet Season (September 2024)		
AQ1	18°28'58.14"N, 77°35'4.46"W	This air quality sampling location was located approximately 100 meters south-east of the south-western end of the proposed property location. This sampling area was located in the yard of a unoccupied residential home on a gently sloping hill. Fruit trees and tall grasses were seen near to the pump location. An area where items were burned was seen to the northwest of the pump set up area. The main roadway was clearly observed approximately 30 meters to the west of the pump set up location and approximately 10 meters to the south of the pump set up area.

Sample Location	GPS Coordinates	Description of Sampling Location
		 **Environmental Conditions: Overcast, humid.**
AQ2	18°28'41.59"N. 77°34'51.37"W	This air quality sampling location was located approximately 300 meters south-east of the south-eastern proposed project boundary in an established community area. The pump was set up in a grassed area north of a residential dwelling. An unfinished pool and heavily vegetated areas were located north of the pump set up area. A large tree, as well as a bird cage was located to the east of the pump set up area.

Sample Location	GPS Coordinates	Description of Sampling Location
		 **Environmental Conditions: Light sporadic rainfall, overcast, humid.**
AQ3	18°29'15.80"N 77°34'34.90"W	This air quality sampling station was located close to the north-eastern end of the proposed project boundary. This assessment point was located in a clearing approximately 170 meters west of the western boundary of the Ocean Coral Springs hotel. Sections of the hotel were clearly seen from the pump set up location. The ground was rocky with areas of exposed dirt and gravel. Tall grassy plants and short shrubs were also observed close to the pump set up location. Areas around the pump were heavily vegetated with tall narrow-trunked trees.

Sample Location	GPS Coordinates	Description of Sampling Location
		 **Environmental Conditions: Light sporadic rainfall, overcast, humid.**
AQ4	18°29'17.40"N 77°34'52.90"W	This air quality sampling location was located near to the north-western end of the proposed development boundary. The sampling area was located approximately 300 meters west of a limestone bluff. The pump was placed in an approximately 15-foot-wide pathway; this pathway was lined with moderate vegetation. The ground at this sampling location was moderately vegetated with grasses and short shrubs. There were rocks embedded in the ground, however, there were also pockets of exposed dirt and gravel.

Sample Location	GPS Coordinates	Description of Sampling Location
		 **Environmental Conditions: Light sporadic rainfall, overcast, humid.**

To minimize the potential impact of particulate matter on the health of people and the environment, the United States Environmental Protection Agency (USEPA) and the Natural Resources Conservation Authority have a published national air quality standard which states that the maximum daily concentration should not exceed 150 µg/m^3. The results of the air quality assessment are presented in Table 4-10.

Based on the results of the assessment, all sites, in both seasons, were compliant with the PM_{10} standard value of 150 µgm^{-3} presented in both the Ambient Air Quality Standards Regulation for Jamaica and from the USEPA. Values ranged from a low of 13.8 µgm^{-3} at assessment point AQ4 to a high of 20.6 µgm^{-3} at assessment point AQ1 in the dry season, whereas they ranged from a low of 6.0 µgm^{-3} at assessment point AQ4 to a high of 13.6 µgm^{-3} at assessment point AQ3 in the wet season.

Table 4-10: Respirable Particulate Concentrations obtained during Both Seasons Assessed

Respirable Particulate Concentration (µgm^{-3})		
Sample Location	**Dry Season (April 2024)**	**Wet Season (September 2024)**
AQ1	20.6	6.9
AQ2	17.2	7.2
AQ3	19.0	13.6
AQ4	13.8	6.0

Given the results and observations made in the field, sources of particulate matter originate from both human and natural activities. Natural sources of particulate matter observed at the assessment locations include wind-blown dust while anthropogenic (human) sources of particulate matter include several residences under active construction, un-covered marl/ dirt heaps as well as vehicular movement and emissions.

These observations highlight the susceptibility of the area to increased impacts from anthropogenic activities such as land clearance, as well as fine earth material transportation and stockpiling. As such, the area may be impacted by the additional anthropogenic activities arising from the pre-construction and construction phases if sound mitigative measures are not strictly adhered to.

There was a notable decrease in the respirable particulate concentrations when the wet season was compared to the dry season (see Figure 4-17). During the wet season assessment, the general area experienced rainfall prior to and during the sampling period. Rainfall is a natural process that can reduce the amount of particulate matter in the ambient air due to its ability to deposit particulate matter onto hard surfaces. Additionally, some areas were more vegetated in the wet season as compared to the dry season which could have also contributed to the decrease in the respirable particulate concentration. Plants contribute to the decrease in particulate concentrations through their interception of particulate matter onto their surfaces such as leaves.

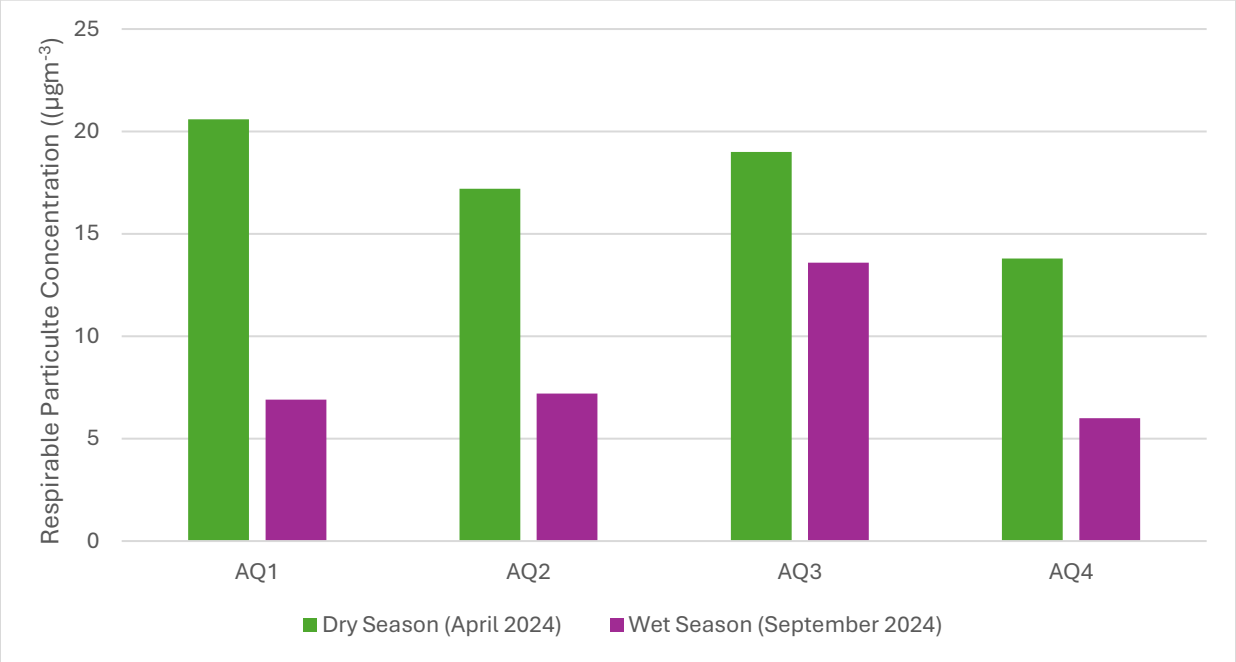


Figure 4-17: Comparison of Respirable Particulate Concentrations obtained at Each Site during Both Seasons Assessed

Based on information obtained from the Meteorological Station of Jamaica, the closest automatic weather stations (AWS) to the proposed development are those located in Braco, Trelawny and Hampden, St. James located approximately 10 km east and 16 south-west of the Coral Springs location. The predominant wind direction for both locations were determined to be NE winds (see

Figure 4-17 and Figure 4-18) classified based on the Beaufort Wind Scale as calm to light breezes in the Braco area and calm to moderate breezes in the Hampden area (see Table 4-9).

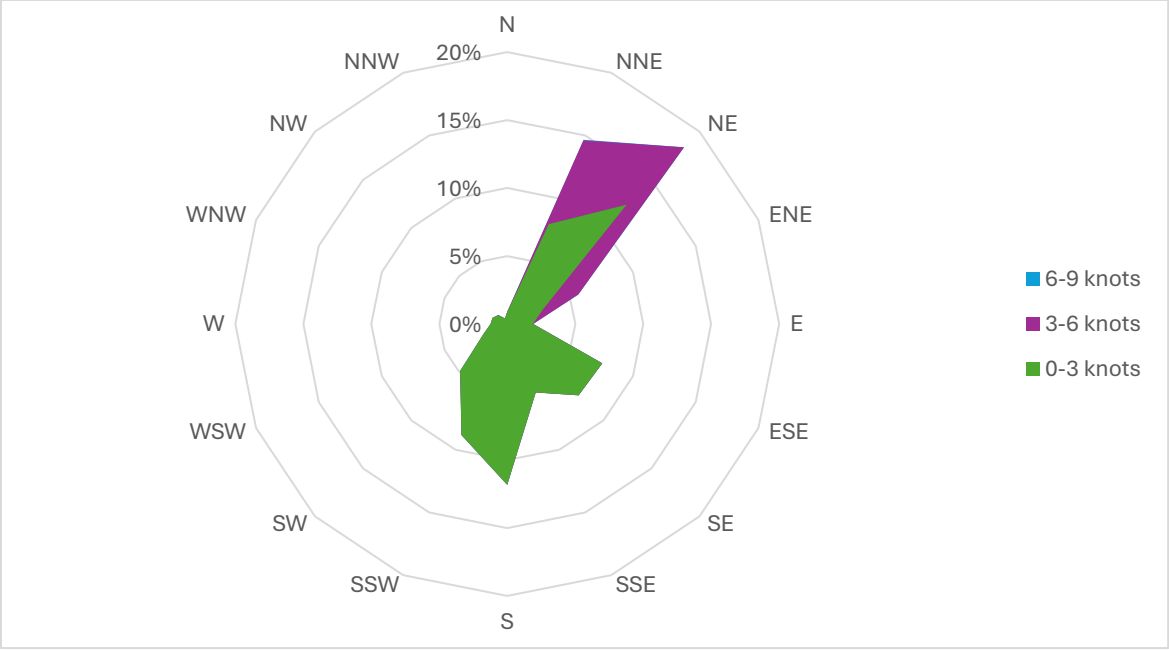


Figure 4-18: Windrose Diagram for Braco Trelawny (January 2022 - 2024)

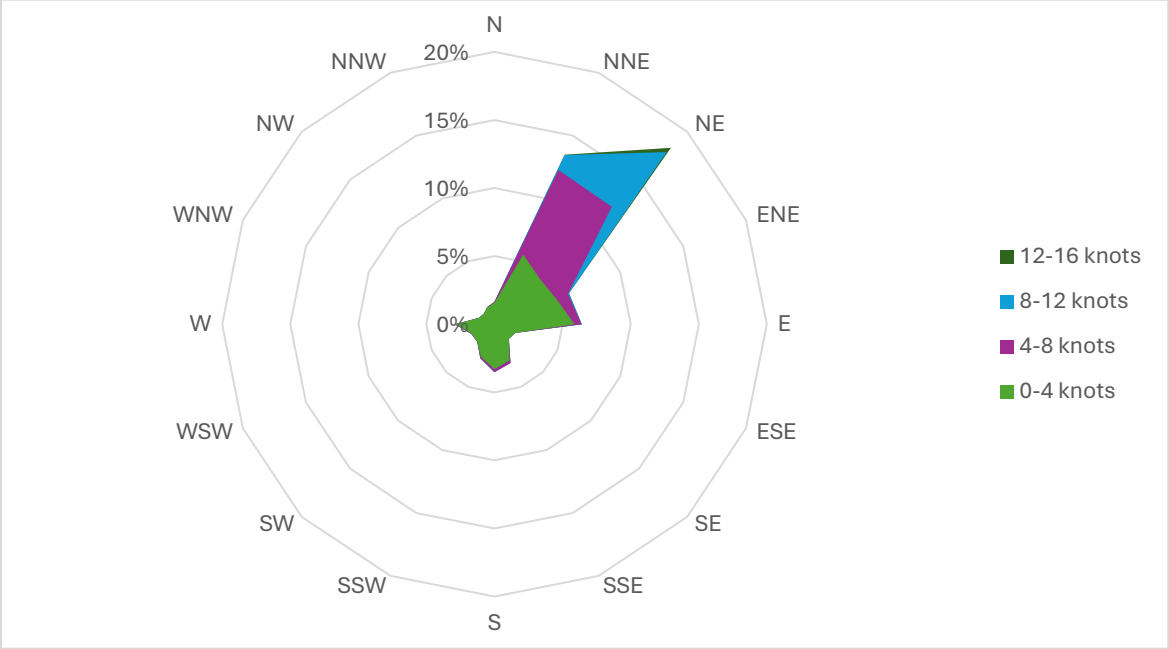


Figure 4-19: Windrose Diagram for Hampden, St. James (January 2022 - 2024)

Table 4-11: Beaufort Wind Scale

BEAUFORT WIND SCALE

Beaufort Number	Description	Wind speed	Wave height	Sea conditions	Land conditions	
0	Calm	< 1 knot < 1 mph < 2 km/h	0 ft 0 m	Sea like a mirror	Smoke rises vertically	
1	Light air	1–3 knots 1–3 mph 2–5 km/h	0–1 ft 0–0.3 m	Ripples	Direction shown by smoke drift	
2	Light breeze	4–6 knots 4–7 mph 6–11 km/h	1–2 ft 0.3–0.6 m	Small wavelets	Wind felt on face	
3	Gentle breeze	7–10 knots 8–12 mph 12–19 km/h	2–4 ft 0.6–1.2 m	Large wavelets	Leaves and small twigs in constant motion	
4	Moderate breeze	11–16 knots 13–18 mph 20–28 km/h	3.5–6 ft 1–2 m	Small waves	Raises dust and loose paper	
5	Fresh breeze	17–21 knots 19–24 mph 29–38 km/h	6–10 ft 2–3 m	Moderate waves	Small trees and leafs begin to sway	
6	Strong breeze	22–27 knots 25–31 mph 39–49 km/h	9–13 ft 3–4 m	Large waves	Large branches in motion	
7	High wind, moderate gale, near gale	28–33 knots 32–38 mph 50–61 km/h	13–19 ft 4–5.5 m	Sea heaps up	Whole trees in motion	
8	Gale, fresh gale	34–40 knots 39–46 mph 62–74 km/h	18–25 ft 5.5–7.5 m	Moderately high waves	Twigs break off trees	
9	Strong/severe gale	41–47 knots 47–54 mph 75–88 km/h	23–32 ft 7–10 m	High waves	Slight structural damage	
10	Storm, whole gale	48–55 knots 55–63 mph 89–102 km/h	29–41 ft 9–12.5 m	Very high waves	Trees uprooted, considerable structural damage	
11	Violent storm	56–63 knots 64–72 mph 103–117 km/h	37–52 ft 11.5–16 m	Exceptionally high waves	Widespread damage	
12	Hurricane force	≥ 64 knots ≥ 73 mph ≥ 118 km/h	≥ 46 ft ≥ 14 m	Exceptionally high waves, sea is completely white	Devastation	

Given the information obtained from the Met Service above, it is likely that the predominant winds are NE winds in the Coral Springs area. This would suggest that communities located south-west of the proposed development (i.e., Coral Spring Village) would most likely be impacted, especially during the pre-construction and construction phases.

4.1.7.2 Noise Levels

Noise levels were surveyed at the same sites as the air quality samples. The sources of noise and the readings obtained at each site are presented in Table 4-12 below.

Table 4-12: Sources of and Average Noise Levels obtained for Each Site

Sample Location	Noise Level (dBA)			Sources of Noise	
	Day 1	Day 2	Avg	Day 1	Day 2
Dry Season (April 2024)					
AQ1	67.2	49.1	58.2	Rustling leaves from moderate winds, light background chatter and ringing cellphone in close proximity.	Rustling leaves from light winds, throttling engine in distance and background chatter
AQ2	65.3	45.1	55.2	Rustling leaves from moderate winds and chirping birds	Rustling leaves from light winds, chirping birds and humming from A/C condenser unit
AQ3	67.0	47.4	57.2	Screaming and music in distance, waves, rustling leaves from moderate winds and birds chirping in distance.	Birds chirping, screaming in distance, waves in distance and rustling leaves from light winds.
AQ4	64.3	45.3	54.8	Rustling leaves from moderate winds, waves and birds chirping	Chirping birds and waves in distance.
Wet Season (September 2024)					
AQ1	48.9	42.9	45.9	Light rainfall, chatter in distance, car throttling and dog barking in distance	Construction and vehicular noises in distance, light background chatter, birds chirping
AQ2	61.7	54.8	58.3	Light winds, doves, crunching undergrowth, light rainfall	Light winds, doves in background
AQ3	55.9	45.0	50.5	Rainfall, birds chirping, waves in background, light machinery noise in background	Birds chirping, waves in background, vehicles and machinery noise in background

Sample Location	Noise Level (dBA)			Sources of Noise	
	Day 1	Day 2	Avg	Day 1	Day 2
AQ4	77.7	45.8	61.8	Rainfall on hard surfaces; light chatter	Birds chirping; vehicular sounds in distance

The average noise levels ranged from a low of 54.8 dBA (site AQ4) to a high of 58.2 dBA (site AQ1) in the dry season while it ranged from a low of 45.9 dBA (site AQ1) to a high of 61.8 dBA (site AQ4) in the wet season (see Table 4-12). All average noise levels in the dry season with the exception of that obtained for site AQ4 exceeded the Ambient Noise Standard of 55dBA for residential areas while in the wet season, the average noise levels for sites AQ2 and AQ4 exceeded the aforementioned standard (see Figure 4-19).

Sites AQ1 and AQ2 were located in pre-established communities south of the proposed project area while sites AQ3 and AQ4 were located in undeveloped areas close to the proposed development boundaries.

Despite the difference in type of locations, the relative standard deviations (RSDs) across each day for the noise levels obtained (i.e., 2.1% for Day 1 and 4.1% for Day 2), suggest that the major sources of influences of sounds in all areas were similar across all sites during the dry season. The major sources of sound observed at all locations included mainly natural sources of sound such as the rustling of leaves from winds in the area. The winds observed on Day 1 versus that on Day 2 were notably stronger and could be a possible reason for the elevated noise levels seen on Day 1.

During the dry season survey, the noise levels obtained for sites AQ1 and AQ3 on both days were slightly higher than that seen for sites AQ2 and AQ4. Additional sounds from human based activities such as chatter, music and screaming were observed at these locations and could contribute to the slightly higher noise levels obtained at these sites.

During the wet season, the noise levels obtained were more varied than the dry season, possibly due to a combination of the variation in environmental and residential conditions on Day 1 and the variation in residential conditions on Day 2 (i.e., RSD of 20.1% on Day 1 and 11.2% on Day 2 were obtained). For example, there was heavier rainfall observed at site AQ4 during the Day 1 survey as compared to the other sites whereas there was very light rainfall observed at site AQ1 during the Day 1 survey.

In the Day 2 survey, site AQ2 was elevated as compared to the other survey stations which could be due to the fact that the owner of this residential property owned birds which were in close proximity to the sampling station. Nonetheless, all sites surveyed on Day 2 were below the requirement of the Jamaica National Noise Standard of 55dBA for residential areas.

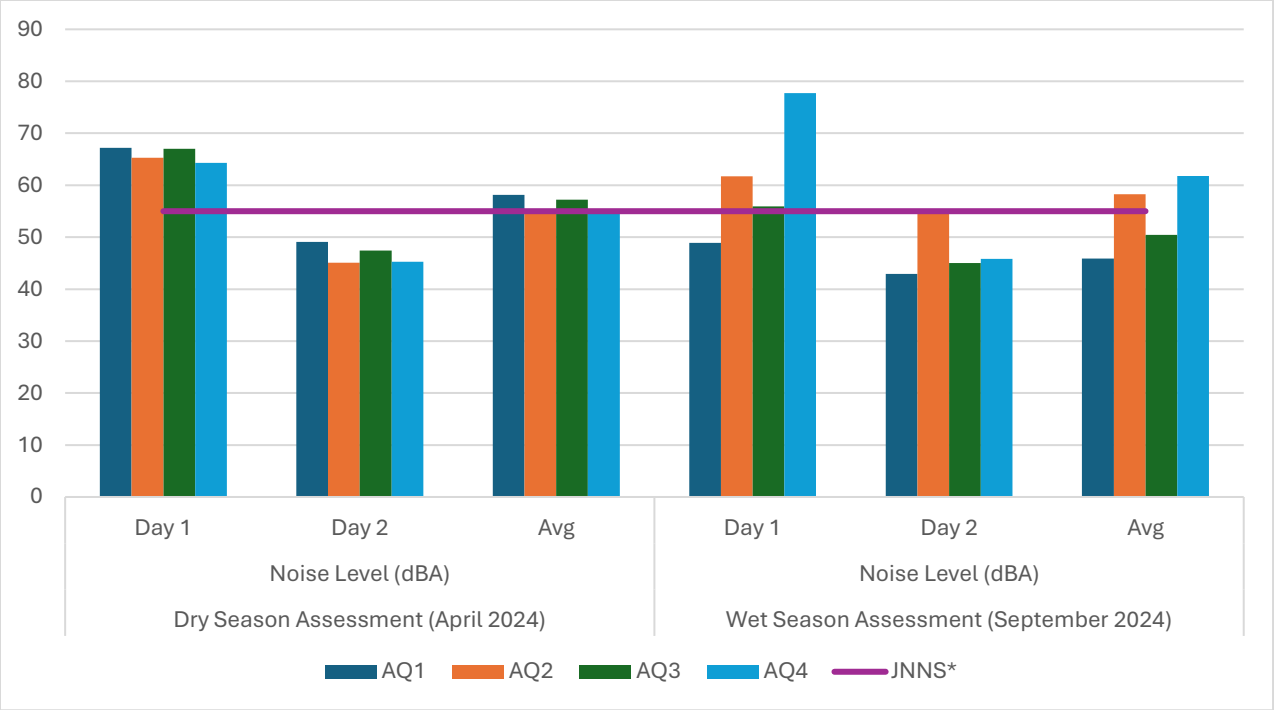


Figure 4-20: Noise Levels obtained at Each Site in both the Dry and Wet Season

***JNNS – Jamaica National Noise Standard (Residential)**

It is imperative that a maintenance and transportation schedule be developed during the pre-construction and construction phases to ensure that: -

- Trucks and other machinery being operated are maintained to prevent additional noise arising from poorly maintained vehicles.
- Operations are done within specified time frames to prevent unwanted noise in neighbouring communities, especially during the nighttime.

Noise barriers can also be instituted as a mitigation measure to reduce unwanted noise from construction activities.

During the operational phase, unwanted noise can arise from additional traffic in the area from additional traffic in the area; as such, speed bumps or other mechanisms to reduce the speed in which communities are driven through can be instituted to reduce noise arising from vehicles.

It must be noted that trees can help to reduce noise pollution in an area. Based on this, the clearance of the area may result in an increase of noise impacts from the hotel and other sources of noise in the area when the development is in operation. As such, the development can consider the use of tree barriers to minimise the impacts of hotel activities on the development and vice versa.

4.2 Natural Hazards

The proposed project site at Coral Spring, Trelawny, Jamaica, is subject to various natural hazards that can pose risks to the community and its infrastructure. Among these hazards are storms and hurricanes, characterized by heavy rains and strong winds, which can cause widespread damage and disruption. Flooding is another significant concern, especially during periods of intense rainfall or when water bodies exceed their capacity. The area also experiences variability in rainfall patterns, including declining trends that may impact water availability and agricultural productivity. Storm surges, associated with tropical storms and hurricanes, present additional threats, particularly to coastal areas. Furthermore, the region is susceptible to earthquakes, sinkholes, and landslides, which can result in structural damage and endanger lives. Understanding and mitigating these natural hazards are essential for promoting resilience and safeguarding the well-being of Coral Spring residents. Table 4-11 below presents a summary of the probability, potential impacts, and projected occurrences of natural hazards relevant to the project area.

Table 4-13: Probability of Natural Hazard Incidence within the Project Site

Hazard/Extreme Event	Likelihood of Occurrence	Details of Potential Impacts	Projections
Storms/Hurricanes (Heavy Rains and Winds)	Likely	Jamaica is exposed to Atlantic tropical cyclones during the June-November period, the Atlantic Hurricane Season. Hurricanes to have impacted Jamaica tended to do so the most during August and October, coinciding with one of the wettest periods for the Coral Springs area. According to the Office of Disaster Preparedness and Emergency Management (ODPEM), on average, six Atlantic hurricanes occur per year which bring winds between 74mph and 200 mph capable of destroying buildings, infrastructure, disrupting agriculture and other economic activities, disrupting utilities and uprooting trees. Rains from hurricanes could induce mass erosion and landslides especially where unstable soil exists.	For global warming of 2 degrees Celsius there will be an increase in category 4 and 5 hurricanes with associated peak wind intensities, rainfall for the same period. It is projected that there will be stronger storms by 2100. The intensity of storms are projected to increase from 2 to 11% with a shift in distribution towards higher wind speeds and potential damage. Rainfall associated with hurricanes will increase, ranging from 5 to 25%.
Flooding	Likely	Figure 3 indicates that May and September-October are the wettest months in the area, so the risk of flooding is greatest during these months. Pre-construction and construction activities may also influence the likelihood and impacts of flooding due to changes to existing waterways.	Projections indicate that rainfall associated with hurricanes will increase, ranging from 5 to 25%.
Rainfall Variability (Declining Rainfall Patterns)	Likely	Overall drying trend which is especially severe along the coast. It is possible that this	**Rainfall** has shown significant year to year variability due to the

Hazard/Extreme Event	Likelihood of Occurrence	Details of Potential Impacts	Projections
		declining water availability will lead to increased water lock offs due to declining water availability in nearby reservoirs. Residents of this community may be encouraged to engage in water conservation techniques.	influence of phenomenon like the El Nino Southern Oscillation. It is projected that the 2030s will be up to 4% drier, the 2050s up to 9% drier while by 2100, Jamaica may be up to 21% drier. It is suggested that the change in the late rainfall season (August, September, October, November) is the primary driver of this drying trend. Dry season rainfall generally shows small increases or no change.
Storm Surge	Unlikely	The area is located 0.5 km inland and according to the storm surge risk analysis (Morin, 2010), a 150-year return period event would extend to approximately 200-300m inland, with maximum water levels of 2.6m. North of the project site is bordered by coastal vegetation which would serve as a natural barrier minimising the risk of storm surge.	All projections for sea level rise across parishes like Trelawny along the North Coast would be averaging ranges from 0.58-0.87m by 2100. Storm surge is defined as the abnormal rise in seawater level during a storm measured as the height of the water above the normal predicted astronomical tide (Source: NOAA)
Earthquakes	Unpredictable	In western Jamaica, the topography is influenced by the South Coast, Spur Tree and Montpelier-Newmarket faults that exhibit large downthrows to the south and west, respectively. Earthquakes occurring across the country today predominantly exhibit strike-slip faulting. The most recent earthquakes felt on the island were concentrated in the eastern parishes of St. Thomas, Portland and Saint	NA

Hazard/Extreme Event	Likelihood of Occurrence	Details of Potential Impacts	Projections
		Andrew where the Plantain Garden fault runs into the Yallahs, Blue Mountain, Wagwater, and Silver Hill faults, which together control the tectonics of the Blue Mountain block. According to Jamaica's Earthquake Unit, about 200 earthquakes are in and around the island per year, with the majority being no greater than magnitude 4.0. Since 2019, Falmouth has experienced two earthquakes ranging from 2.0 to 4.5 on the Richter Scale. Falmouth is 8 kilometres away from the project site. Between the period 2010 – 2020, the parish of Trelawny felt approximately ten earthquakes, all of magnitude <4.0. Earthquakes can induce devastating damage to property and infrastructure and could lead to landslides and erosion.	
Sinkholes	Unlikely occurrence	Unlikely possibility of impact	NA
Landslides	Likely Occurrence	Unlikely possibility of impact	NA

(Sources: UWI Mona Earthquake Unit; State of the Jamaican Climate 2019: Information for Resilience Building, National Oceanic and Atmospheric Administration).

4.3 Terrestrial Ecology

4.3.1 Flora

The vegetation types observed within the proposed development site was typical of coastal formations along the north coast of Jamaica. The coastal communities include beach, dune, Salinas, mangroves, coastal woodlands and dry limestone forest. The development site however is predominantly dry limestone forest with narrow transitional areas where the dry limestone forest intersects other ecosystems or habitat types, particularly beach and wetland (see Figure 4-20).

Figure 4-21: General habitat types at proposed development site (Coral Spring Village II)

During the vegetative assessment a total of 108 species were observed which consists of 47 different families and 99 genera (Appendix II). According to Acevedo and Strong (2010) there are 164 seed plant families recorded from Jamaica with 810 different genera and 3175 taxa.

Appendix 8.3 – Plant Species Checklist for Coral Springs provides a species list with all plants encountered during sampling. Analysis of the species documented also facilitated the determination of their status. The results showed that there was a dominance of native species commanding approximately 79% of the documented flora followed by exotic species with approximately 20%. Of the 84 native species 6 were endemic which means the endemism is approximately 5.5% (see Figure 4-21).

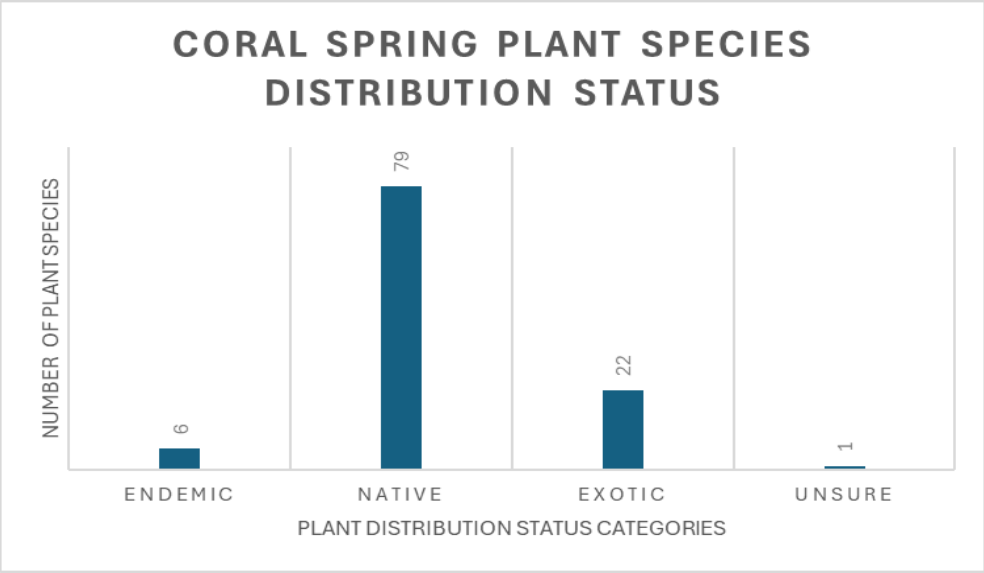


Figure 4-22: Plant distribution status categories observed across species.

The analysis of plant habits within the proposed development site showed that 35% of the species are trees while herbs, shrubs and vines represent approximately 31%, 23% and 10% respectively. Figure 4-22 shows the absolute numbers related to these percentages.

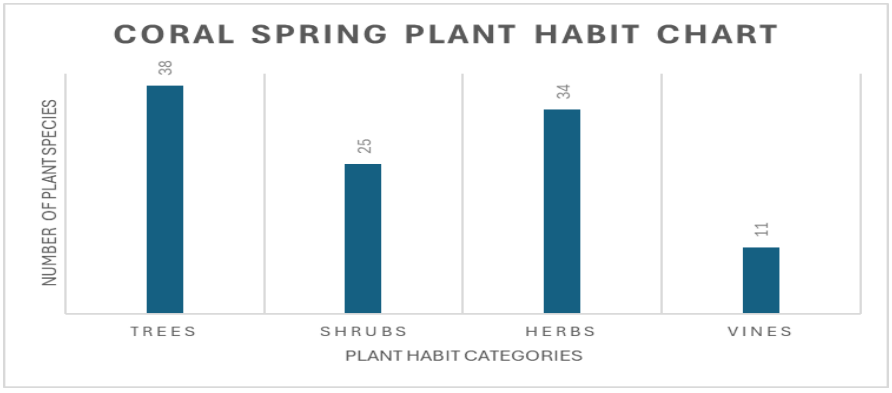


Figure 4-23: Habit type/ class observed.

Figure 4-23 below shows the most dominant plant families observed during sampling the area was dominated with species from the family Fabaceae, which includes species such as Logwood, Lead Tree and Bull Hoof Trees, as well as Malvaceae which includes species like Raichie Tea bush, Seaside Mahoe and Broomweed. There were little to no shrubs and herbs except for in areas of disturbance, such as the clearances observed.

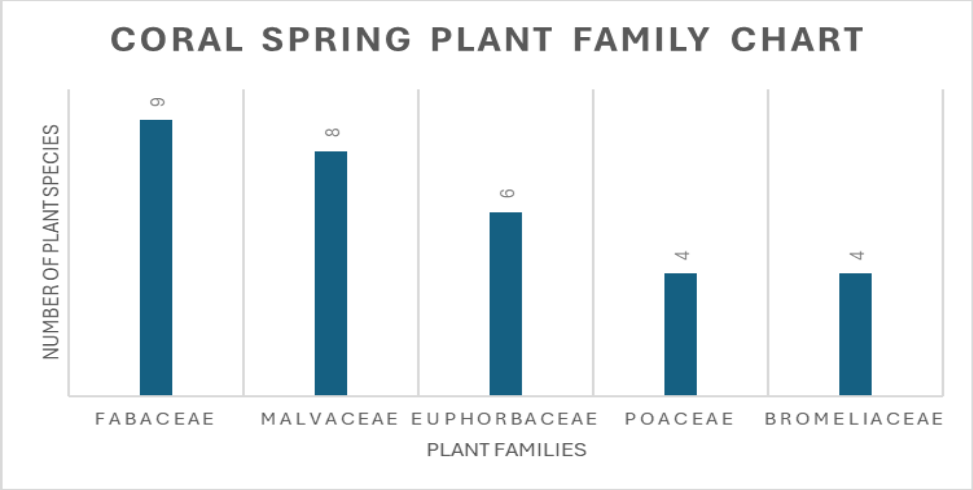


Figure 4-24: Dominant/ Abundant plant families at Coral Spring

The DAFOR chart examines the relative abundance of each species encountered through the areas that were traversed. Sampling results indicated that most species were observed occasionally and second to that were species observed a few times which fall in the category 'rare'. Species that fall under the category frequent and abundant follow respectively (see Figure 4-24).

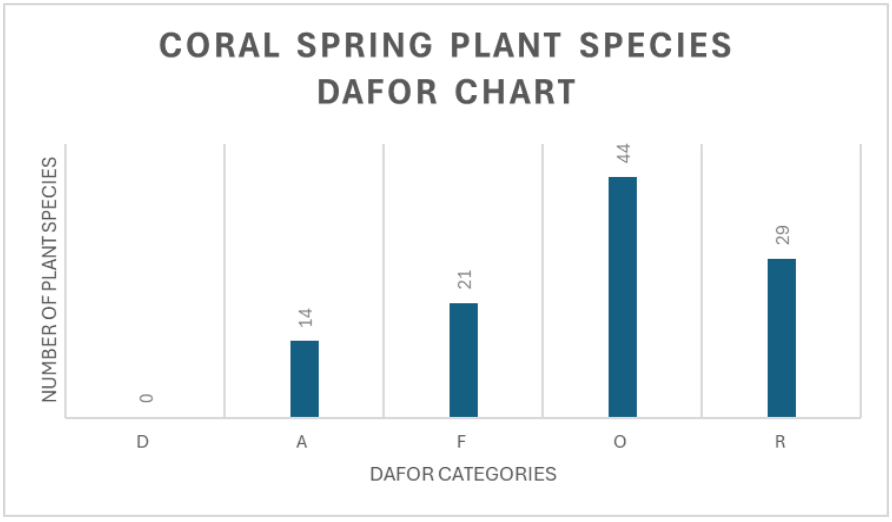


Figure 4-25: Chart displaying DAFOR summary statistics for species observed.

The majority of species observed in the study area fell into the IUCN category of least concerned, comprising 46% of the total, while 44% of the species were not listed on the IUCN Red List of Threatened Species at the time of data collection. Additionally, the assessment revealed that at least one species- *Guaiacum officinale*, is listed as endangered, with two species, *Tabernaemontana laurifolia* and *Portlandia grandiflora*, classified as near threatened. Another species, *Celtis trinervia*, was categorized as data deficient. Furthermore, six species could not be identified down to the species level and thus remain unknown. For a visual representation of these findings, refer to Figure 4-25 (below), which illustrates the absolute numbers corresponding to these percentages.

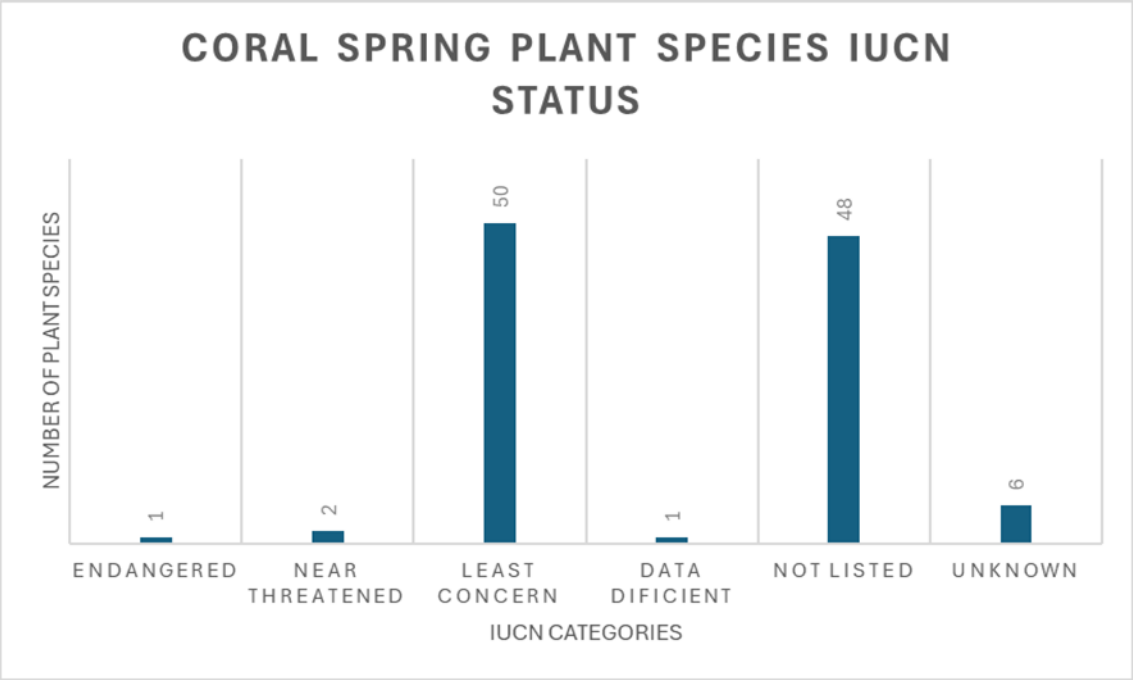


Figure 4-26: IUCN status statistics for species observed.

Primack (2000) defines sustainable development as the achievement of economic growth that meets current and future human needs for resources and employment while mitigating its impact on biological diversity. During the assessment of the development site, it was evident that anthropogenic pressures were adversely affecting the existing plant biodiversity and the surrounding ecosystems. One of the primary challenges observed was habitat fragmentation resulting from the development of multiple clearings, seemingly forming a network of roads (see Appendix 8.1 – Plates 14-21). Additionally, the area appeared to be utilized as a bird shooting site, as indicated by several sightings of spent shells (see Figure 4-26).

Figure 4-27: Spent shells associated with bird shooting.

Observations revealed several young trees with their trunks cut, branches stripped, and left as refuse, along with small stacks of cut trunks scattered throughout the clearings running from east to west of the proposed development site (see Figure 4-27). The trunks positioned along the edges of these clearances (see Figure 4-28) may represent opportunistic cuttings, taking advantage of access points into the dry limestone forest. Further north, towards the wetlands, similar cuttings appear to have been made opportunistically, possibly utilizing older clearances also frequented by bird shooters. Additionally, the presence of exotic species was noted primarily in areas adjacent to the roadway bordering the proposed development site to the east, as well as in areas where vegetation had been recently cleared.

Figure 4-28: Evidence of trees being harvested/cleared.

Figure 4-29: Posts cut and stored along clearances.

4.3.2 Fauna

A variety of wildlife species was observed, contributing to the area's ecological richness. Species observed ranged from colorful avian species to butterflies and reptiles, the adjacent ecosystem appeared to harbor a diverse array of fauna, each fulfilling a distinct role in maintaining the delicate

balance of nature. Appendix 8.4 – Bird Species List and Butterfly Species List shows a summary of birds observed and the butterfly species encountered and their associated DAFOR ranking.

4.4 Marine/ Coastal Environment

4.4.1 Mangroves/ Wetlands

Table 4-12 below provides the GPS location and salinity (ppt) observed in each sampled quadrat. During sampling, general observations were made regarding the visible hydrology and impacts to the site. Key points of interest that were potentially threatening to the area or are important to the conservation of the site were noted.

Table 4-14: Sample Area Coordinates and Salinities Observed

Sample Areas	Coordinates		Salinity (ppt)
Quadrat 1	18.4903160	-77.5796546	
Sal 1	18.490056	-77.580125	>100
Quadrat 2	18.490007	-77.581029	
Sal 2	18.489858	-77.581384	20
Quadrat 3	18.489775	-77.581459	
Quadrat 4	18.489368	-77.579862	90
Quadrat 5	18.489269	-77.577944	98
Quadrat 6	18.489855	-77.577043	70
Quadrat 7	18.489667	-77.576165	
Quadrat 8	18.48925	-77.574788	68
Quadrat 9	18.488879	-77.574063	59
Quadrat 10	18.488316	-77.575223	

Findings:

4.4.1.1 Mangrove Forest Characteristics

The mangrove forest surveyed in the study exhibited diverse species composition and structural attributes across different quadrats. Dominant species such as Black Mangrove (*Avicennia germinans*), White Mangrove (*Laguncularia racemosa*), and Buttonwood (*Conocarpus erectus*) were observed, each showing variations in tree density, height, diameter, and seedling density among the quadrats. These variations in the mangrove forest's characteristics are summarized in Table 4-13, providing insight into the diverse structure and composition of the mangrove ecosystem at Coral Spring. The table reflects differences in ecological conditions and habitat preferences across the study area.

Table 4-15: Data table with Mangrove species observed throughout the impact area with Tree Density, Mean Height (m), Mean DBH (cm) and Seedling Density

Quadrats	Mangrove Species	Tree Density	Mean Height (m)	Mean DBH (cm)	Seedling Density (per m^2)
1	Black Button wood White	13 2 1	6.5 5 6	12.5 6 20	146
2	Black White	29	3.7	2.8	12 2
3	Black Button wood	1 11	3 2.9	2 2.1	
4	Black	5	4.2	26.2	9
5	Black	9	3.7	9.4	4
6	Black Button wood White	3 2 3	3.8 8.5 3.1	12.4 97 36.2	23
7	Buttonwood	23	10.1	25.8	
8	Black White Buttonwood	6 7 12	4.3 2.9 4	14.6 2.9 7.7	80
9	Black White Red	3 11 4	4.6 4.4 3.4	34.3 4.9 2.1	37 53
10	Black White	11 4	3 2.6	4.6 6.8	4

In Quadrat 1, Black Mangrove had a tree density of 13, Buttonwood 2, and White Mangrove 1. The mean height ranged from 6.5 meters for Black Mangrove to 5 meters for Buttonwood and 6 meters for

White Mangrove. Quadrat 2 showed a higher density of Black Mangrove with 29 trees, while White Mangrove had 2 trees. The mean height for Black Mangrove was 3.7 meters. Quadrat 3 exhibited a low tree density, with Black Mangrove at 1 tree and Buttonwood at 11 trees, with heights of 3 meters and 2.9 meters, respectively. In terms of diameter, Quadrat 4 had Black Mangrove trees with a mean diameter at breast height (DBH) of 26.2 centimeters and a tree density of 5. Quadrat 5 showed similar characteristics for Black Mangrove, with a tree density of 9 and a mean DBH of 9.4 centimeters. Quadrat 6 demonstrated a mix of Black Mangrove, Buttonwood, and White Mangrove, with varying tree densities and heights. Black Mangrove had a mean height of 3.8 meters, Buttonwood 8.5 meters, and White Mangrove 3.1 meters. Quadrat 7 was dominated by Buttonwood, with a tree density of 23 and a mean height of 10.1 meters.

Quadrat 8 presented a mix of Black Mangrove, White Mangrove, and Buttonwood, with Black Mangrove having a mean height of 4.3 meters and a tree density of 6, White Mangrove with a tree density of 7 and Buttonwood with a tree density of 12. Quadrat 9 exhibited Black Mangrove, White Mangrove, and Red Mangrove, with Black Mangrove having a mean height of 4.6 meters and a tree density of 3, White Mangrove with a tree density of 11, and Red Mangrove with a mean height of 3.4 meters and a tree density of 4. Quadrat 10 was characterized by Black Mangrove and White Mangrove, with Black Mangrove having a mean height of 4 meters and a tree density of 11, while White Mangrove had a mean height of 2.6 meters and a tree density of 4.

4.4.1.2 Non- Mangrove/ Coastal- Affiliated Species

Throughout the sample area, a variety of non-mangrove flora were observed, each contributing to the ecological diversity of the region. These non-mangrove coastal-affiliated species contribute to the overall biodiversity and ecological dynamics of the coastal habitat, providing important habitats and resources for various organisms These species, along with their DAFOR ranking (Dominant, Abundant, Frequent, Occasional, Rare), are summarized in Table 4-14 and described further below.

Table 4-16: Additional non-mangrove Flora Observed throughout the Sample area and DAFOR ranking. (D – Dominant, A- Abundant, F- Frequent, O – Occasional and R – Rare).

Flora	DAFOR Index
Acacia	A
Seaside Mahoe	O
Batis	A
Sesuvium	A
Seaside daisy	O
Cacti	R

Acacia: This species was observed to be Abundant in the sample area, indicating its significant presence in the coastal ecosystem.

Seaside Mahoe: Seaside Mahoe was found to be Occasional, suggesting a less frequent but still notable occurrence within the sample area.

Batis: With an Abundant ranking, Batis exhibited a strong presence in the coastal habitat.

Sesuvium: Similar to Batis, Sesuvium was also classified as Abundant, indicating its high occurrence throughout the sample area.

Seaside Daisy: This species was categorized as Occasional, implying a moderate presence within the coastal environment.

Cacti: Cacti were observed to be Rare in the sample area, indicating their infrequent occurrence.

4.4.2 Coral Reefs

During the surveys, multiple bleached coral colonies were observed with varying degrees of bleaching noted. This included scleractinian species such as *Siderastrea siderea*, *Orbicella annularis*, *Pseudodiplora strigosa, Pseudodiplora clivosa, Porites porites, Porites furcata, Porites asteroides,* and *Orbicella faveolata*, along with non-scleractinian species like *Millipora complanata* (see Figure 4-29 to Figure 4-35 below).

Figure 4-30: (Left) Moderately bleached colonies of Orbicella annularis and (Right) Siderastrea siderea.

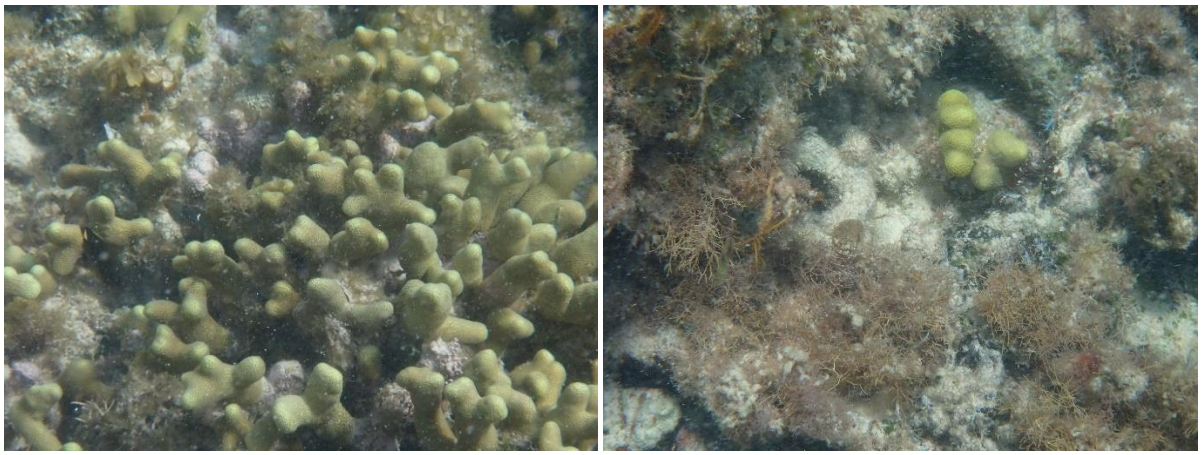


Figure 4-31: Porites spp. observed (left: Porites furcata; right: Porites porites) with comparatively less bleaching

Figure 4-32: (Left) Siderastrea siderea, (Right) Orbicella faveolata

Figure 4-33: (Left) Pseudodiplora strigosa, (Right) Orbicella annularis; moderate levels of bleaching

Figure 4-34: Severely bleached colonies of P. strigosa observed

Figure 4-35: S. siderea colonies observed with moderate bleaching

Figure 4-36: Severely bleached P. clivosa colony

4.4.3 Seagrass

The seagrass surveys revealed that the area is predominantly dominated by turtle grass (*Thalassia testudinum),* with some patches of *Syringodium sp*. present, although less extensively distributed. The substrate consists mainly of sand along with coral rubble, and crustose coralline algae (CCA) was also observed. Notably, a variety of benthic species were observed, including urchins (including *Diadema sp*.), sea cucumbers, and starfish. Additionally, several algal species were identified (see Figure 4-36), including *Dictyota sp*., *Padina sp*., *Penicilla sp*., *Sargassum sp*., and *Caulerpa sp*. A summary of the seagrass quadrats surveyed, and the parameters assessed are provided in Appendix 8. These observations provide useful insights into the diverse benthic and algal communities present in the surveyed area.

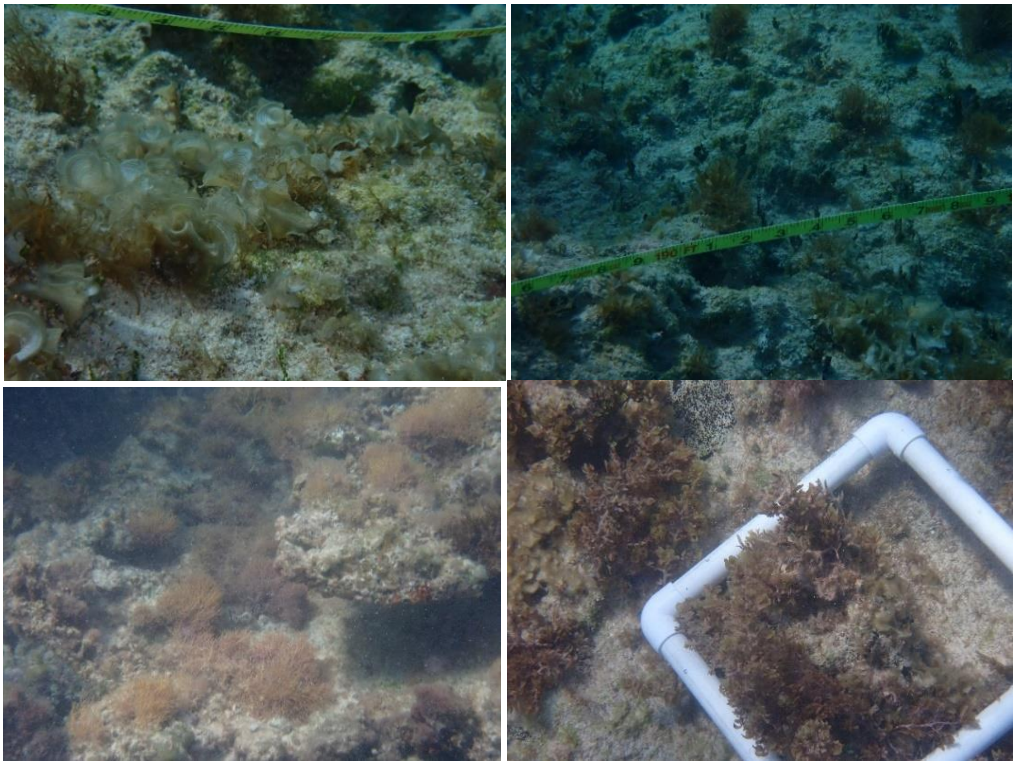


Figure 4-37: Various Algal species (Padina sp., Halimeda sp., Dictyota sp. and Sargassum sp.) observed

4.4.4 Fish/ Pelagic Species

Overall, low fish numbers and diversity were observed, with mostly non-commercial species such as common cleaner fish, damselfish, sergeant majors, and angelfish noted. Other species observed included benthic species such as stingrays and spotted cleaner fish. Appendix 8.5 – Species List for Fish presents the species, abundance, and DAFOR ranking of observed fish species.

Figure 4-38: (A) Spotted Flatfish (B&C) Common cleaner fish

Figure 4-39: (Left/ Middle) Patchy to (Right) moderate seagrass (T. testudium) distribution observed

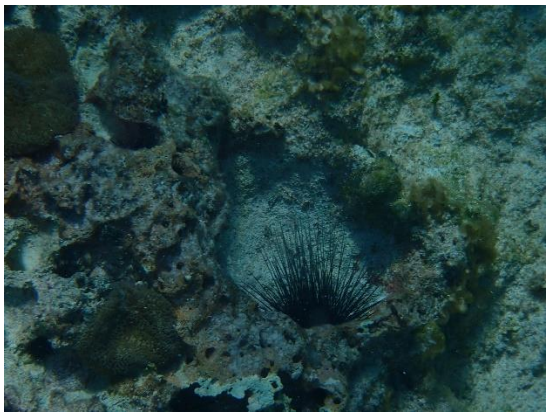


Figure 4-40: Moderate numbers of Diadema antillarum observed

Figure 4-41: Extensive sand patches/ sandy substrate observed

5 Socio-economic Environment

5.1 Land Use Patterns

The overarching framework guiding proposed developments in this jurisdiction is the Town and Country Planning (Trelawny Parish) Provisional Development Order, 2013, which was confirmed in 2015. The Order states that the strategy for the parish of Trelawny is 'to provide support and encouragement for the local economy within a framework to protect and improve the environment.' The proposed site falls within the Greater Falmouth development area, where there is great need for additional housing units to support the parish's growing population and commercial demands. The following policy guidelines are to be implemented in accordance with the Trelawny development order (among others):

I. The local planning authority will seek to ensure provisions for a range of housing types and tenures to meet the needs of all sectors of the parish through adequate land use zoning proposals.
II. Provisions must be made for access to appropriate services and facilities to meet the needs of the likely resident population.
III. Planning permission will only be granted for housing development or the subdivision of land only if they are provided with adequate and suitable outdoor spaces.
IV. Housing developments should incorporate a mix of housing types and sizes appropriate to the needs of the locality, particularly where the development is on a large scale.

The proposed project site is located adjacent to the Coral Spring – Mountain Spring Protected Area. It is currently covered by secondary woodland, with clearly defined tracks leading onto the site. Evidence of small ruminant and / or equestrian grazing was observed. The site shares a northeastern boundary with the Ocean Coral Spring, a five-star resort, boasting 513 rooms. The southern boundary is shared with a prior Coral Spring Village housing development. To the west lays the Coral Spring – Mountain Spring protected woodland. The area forms a part of Trelawny's Resort Corridor and is projected to experience further hotel developments.

The proposed development is situated in the Greater Falmouth Local Planning Area. The area has seen brisk growth in the last 15 years, driven mainly by investments in tourism infrastructure. These include the development of the Historic Falmouth Port (2011), Ocean Coral Spring and Eden Bay Hotel (2019), Royalton Blue Waters (2016), and Excellence Oyster Bay (2018). An accompanying surge in housing developments has seen the establishment of new communities including Coral Spring Village Phases 1 and Florence Hall Village. The named developments account for an additional 1350 residential lots and units.

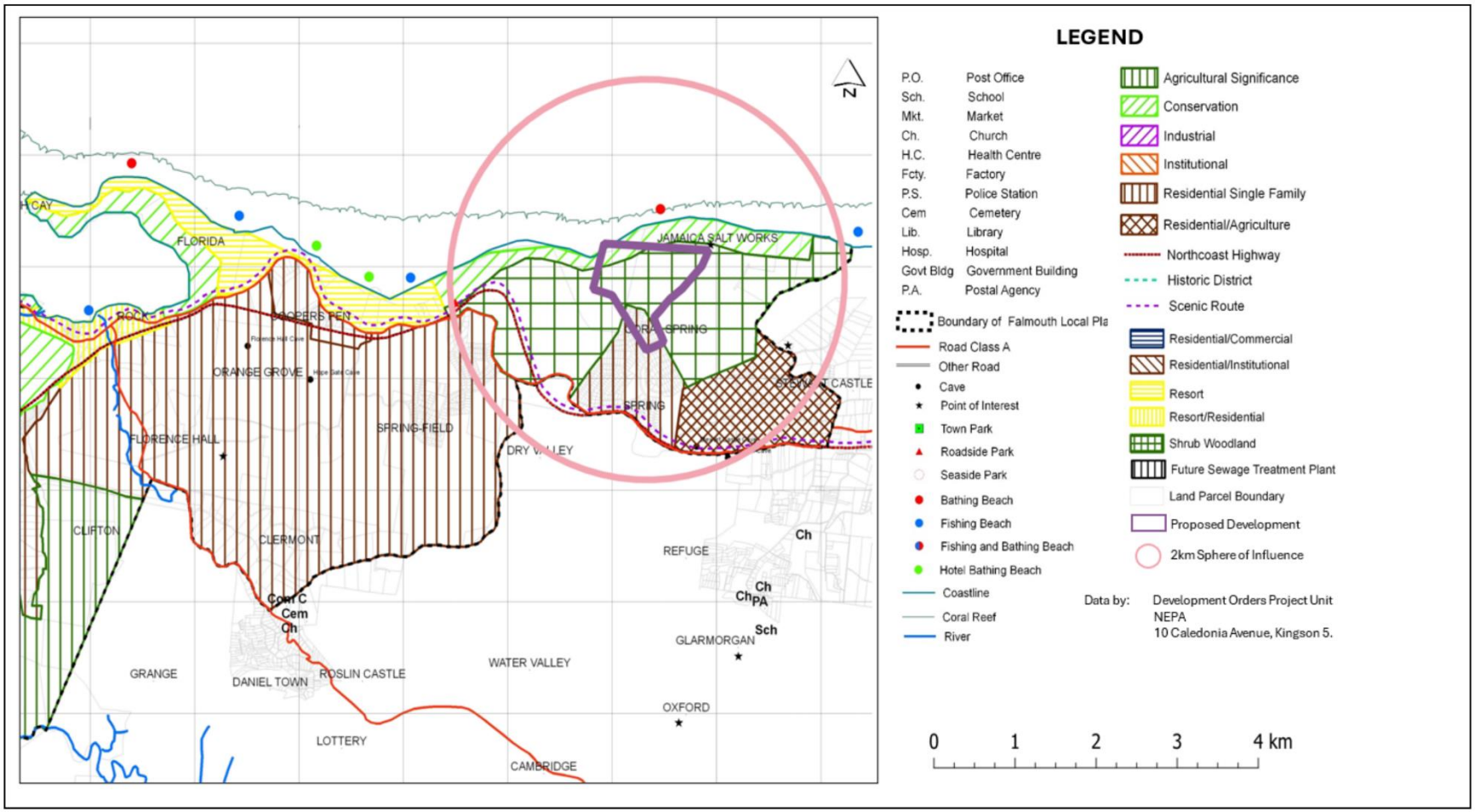


Figure 5-1: Land Use Map of Project Area

5.2 Population and Household Demographics

According to Statin's 2011 Census data, the population within the SIA was 765 persons. However, there have been significant changes since the development of the Coral Spring Housing Development in 2016, which added an additional 517 housing units to the enumeration district. Demographic information for this study will therefore be derived from the ESL administered community surveys.

Of the residents surveyed, 46.5% were males, and 53.5% females. Thirty eight percent of males indicated that they were the head of the households, compared to 32.5% of females surveyed (Figure 52).

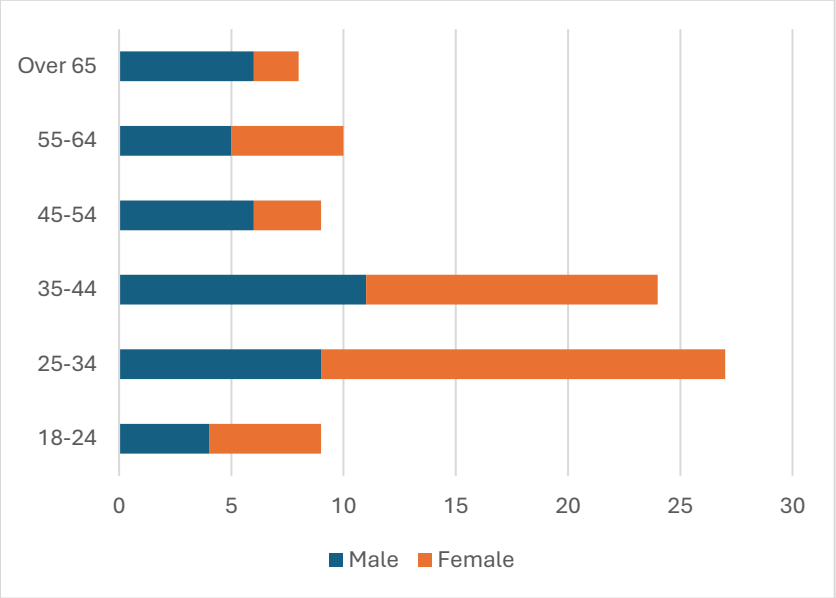


Figure 5-2: Respondents by Age and Sex

The community boasts high employment levels, with 80% of respondents indicating that they were currently employed. Of the 86 individuals surveyed, 35% said their main source of income came from employment in the public sector, 21% were employed in the tourism sector and 14% derived earnings from retail/ commercial activities. It is important to note that 19% of individuals were retirees, whose main source of income was their pension (Figure 53).

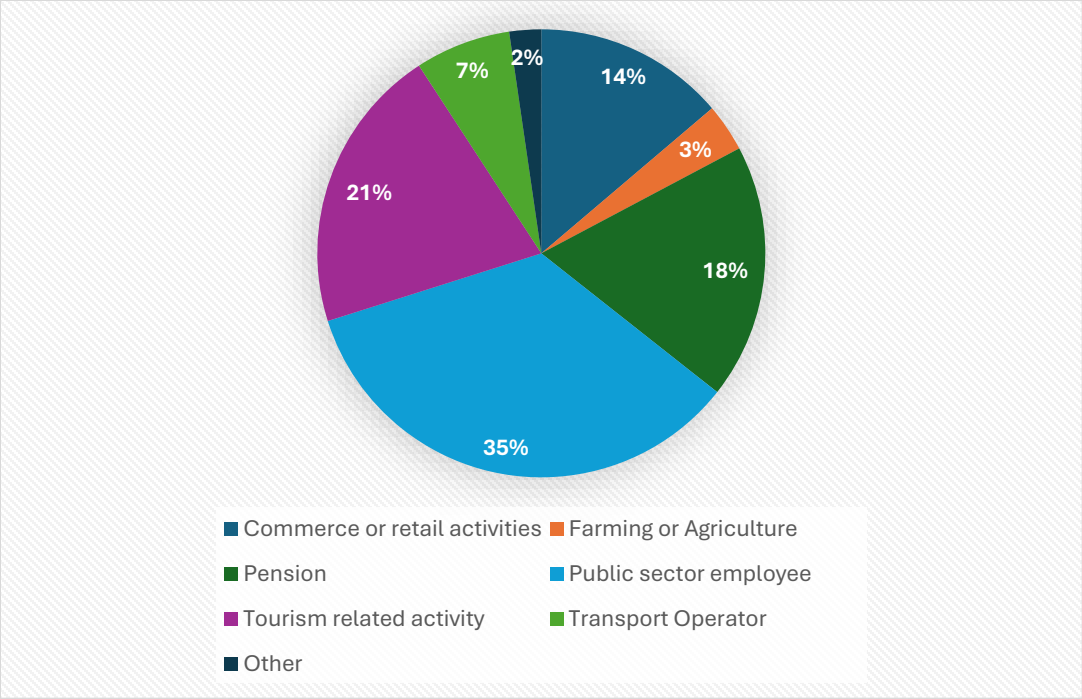


Figure 5-3: Respondents' Main Income Source

Levels of educational attainment are relatively high, with 77% of respondents sharing they had attained tertiary or vocational qualifications (Figure 54). For heads of households, educational attainment was also high, with 62.8% reporting they had completed secondary, tertiary, or vocational training (Figure 55).

Just over 37% of respondents indicated that their household had individuals enrolled in an early childhood, primary, secondary, tertiary, or vocational institution. Thirty five percent of households said they have children under 18 residing in their households. The total number of children reported is 49.

Eight percent of households have an individual aged 65 or older living there. The total number of senior citizens reported is 8.

Ten respondents, or 8.6% indicated that they or someone in their household had a disability. Low / no vision, hearing loss / deafness and physical disabilities were the reported forms of disability.

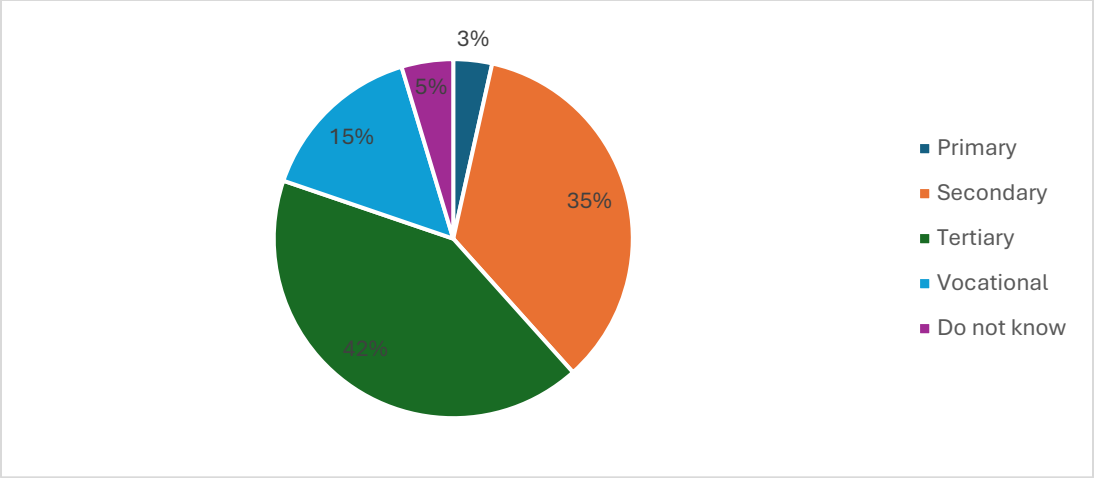


Figure 5-4: Educational Level of Respondents

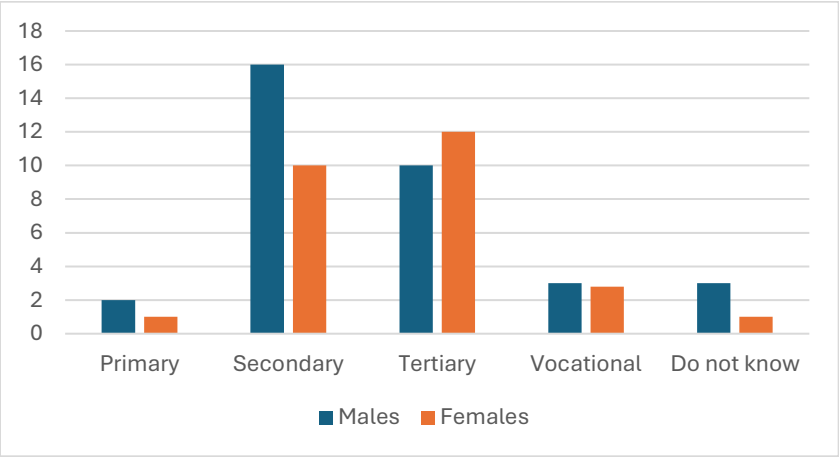


Figure 5-5: Educational Attainment of Household Heads by Sex

5.3 Description of Existing Infrastructure

5.3.1 Water

Most households – 74.4% - surveyed throughout the SIA are connected to the National Water Commission main and utilise indoor piped water as their main source of drinking water. Challenges with water lock offs or poor water quality were the reasons provided for 24.4% or respondents opting for bottled water as their main source of drinking water. One respondent shared that an outdoor pipe was their primary source, while another said a rainwater tank provided their household with potable water.

Roughly 92% of respondents were satisfied with the adequacy of their water supply. Of those who were not fully satisfied, low water pressure and the presence of sediments in the water coming through the pipes were the reasons for discontent. Most respondents– 57%- reported that they did

not experience water lock offs. Only 3% said they had weekly lock offs. This may be the reason that 64% of residents surveyed do not store water in tanks or containers.

5.3.2 Sewage Disposal

Coral Springs Village has a its own sewage plant. Consultations with the local Ministry of Health indicated periodic checks on the functionality of the system. It should be noted that the Sewage Treatment Plant has been turned over to the National Water Commission since November 2015.

The community survey indicates that 66% of respondents believe their sewage goes to a pit, while a further 16% say their sewage goes to a septic tank. Only 18% of respondents said they were connected to the central sewer network.

5.3.3 Solid Waste Management

Western Parks and Markets shared during their consultation that the area was serviced by their team on a periodic basis. Local government needs to facilitate the collection of garbage considering this proposed development, as well as the need for periodic maintenance affect the frequency of collection, which is scheduled for once weekly. Data from the community survey showed that 66% of respondents had regular public collection while a further 23% reported irregular public collection. Less than 5% of respondents indicated that they burned or dumped waste in their backyard when collection was irregular.

Observations during site visits noted that garbage was being disposed on the proposed site. While there were garbage receptacles located along the roadway, these were full. Consultation with H10 Hotel revealed that the resort has facilitated the collection of garbage from the public receptacles.

There is no specific guideline for recycling, however it is encouraged.

5.3.4 Transportation

Households in the SIA use a range of transportation modalities. From the community survey, 52% of respondents said their primary mode of transportation was their personal motor vehicle. A further 42% relied on public transportation, including route taxis, while 5% were primarily pedestrians. During community visits the team observed a steady number of route taxis traversing the community; however, there is no designated bus stop or taxi stand.

5.3.5 Telecommunications

5.3.5.1 Internet Access

Most respondents to the community survey – 44% - indicated that there was no public internet access, while 36% said they had public internet access. The research team did not note any community hotspots during the site visits.

5.3.5.2 Phones

There is good penetration of telephone service in the community. All respondents shared that their household had a telephone, with 98% indicating they had smart phones able to access the internet. Twenty six percent of those surveyed stated that they also had landlines.

5.3.6 Road and Drainage Network

The access road for the proposed project site is adjacent to the North Coast Highway, which is consistently maintained and slated for further improvement works. The entrance road is heavily utilised by both residents of Coral Springs as well as operators and staff of the Ocean Hotels. Consultations with the Jamaica Constabulary Force revealed that the junction is a crash hot spot. Accessing the Coral Springs Road from the westbound North Coast Highway is particularly precarious. All stakeholders interviewed shared concerns accessing the North Coast Highway from the Coral Spring Road, deeming it dangerous, as east bound traffic is often accelerating to go uphill, and westbound traffic is descending the slope. There are no traffic signals in place, and frequent accidents are reported at the intersection.

Roads within the community were observed to be in good condition, with appropriate drainage. Flooding does not appear to be a critical concern. There is a natural gully which runs parallel to the highway.

5.3.7 Community Services and Facilities

There are no direct community services or facilities located within the sphere of influence. The team observed a community centre and recreational facility for the Coral Spring Village. Consultations with stakeholders revealed that residents would be expected to access required public services, namely:

Healthcare: Falmouth Clinic (Type IV); Falmouth General Hospital (Type C hospital providing primary care and basic secondary services.

Security: Falmouth Police Station

Fire: Falmouth Fire Station

Schools: Duncans Infant and All Age; Hague Primary and Infant; William Knibb Memorial High; Falmouth All Age

5.4 Perception of the Proposed Development

Respondents of the community survey were generally in favour of the project concept (Figure 56). Those who disapproved shared that they believed there were already enough houses or were concerned at an increase in dust or noise pollution.

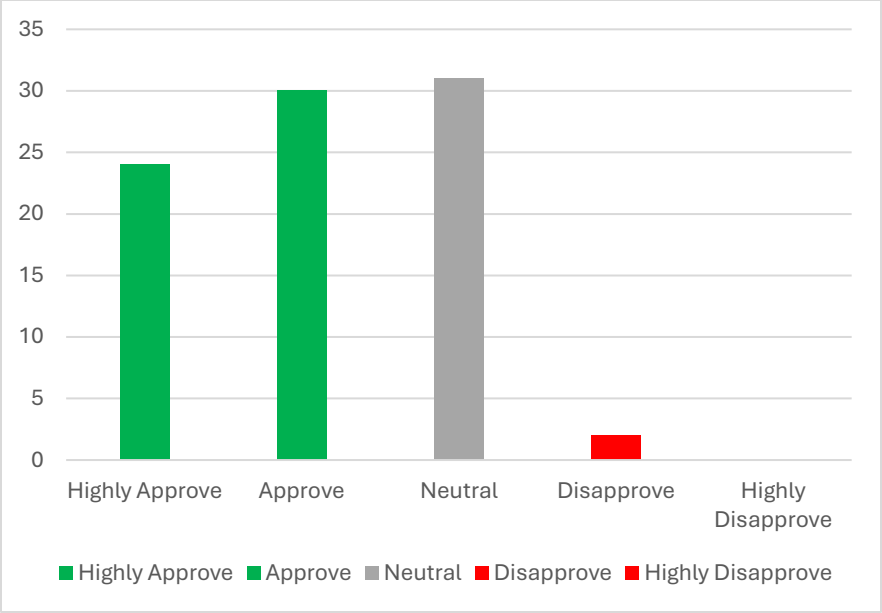


Figure 5-6: Respondents' Perception of the Development

When asked how they believed the community would perceive the project, respondents were generally positive, with 63% declaring that it would be highly approved, or approved (Figure 57).

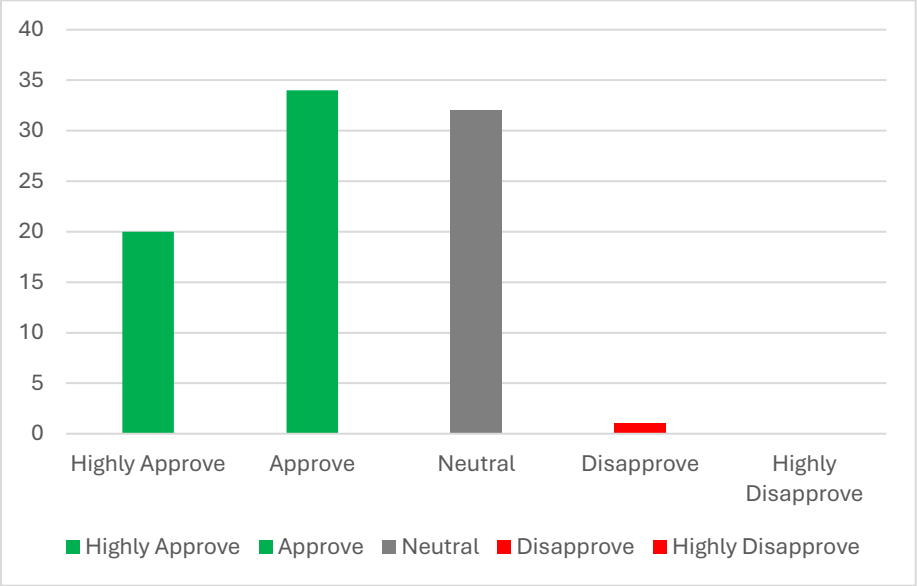


Figure 5-7: How Respondents' Believe the Community Perceives the Project

Just over 50% of respondents thought the project was 'necessary' or 'very necessary. Their views were driven by the need for more housing solutions (48%), improving the local infrastructure (20%) and belief that the project would be good for the economic development of the parish (18%) improve their property values (14%). Concerns for the potential negative impact on the environment and

confidence in the adequacy of the existing housing stock were the reasons provided for deeming the project unnecessary.

Most respondents – 91% - were not concerned about how much the proposed development will impact the Coral Spring - Mountain Spring Protected Area. Those who were concerned stated the potential impact on wildlife, particularly the birds (33%), impact on water sources (44%), as well as an increase in dust and noise pollution (23%).

5.5 Current Environmental Concerns

When asked to share their views on current environmental concerns, 89% of respondents shared that they had no experience of flooding. However, 9% of those surveyed in the wider project area said they experienced flooding every time during heavy rainfall. Thirty three percent of those affected by flooding considered it 'bad' or 'very bad' with one respondent indicating that the water would enter their house (Figure 58). Most respondents had concerns about likely natural hazards, with 64% believing that their community was vulnerable to earthquakes, flash floods or droughts.

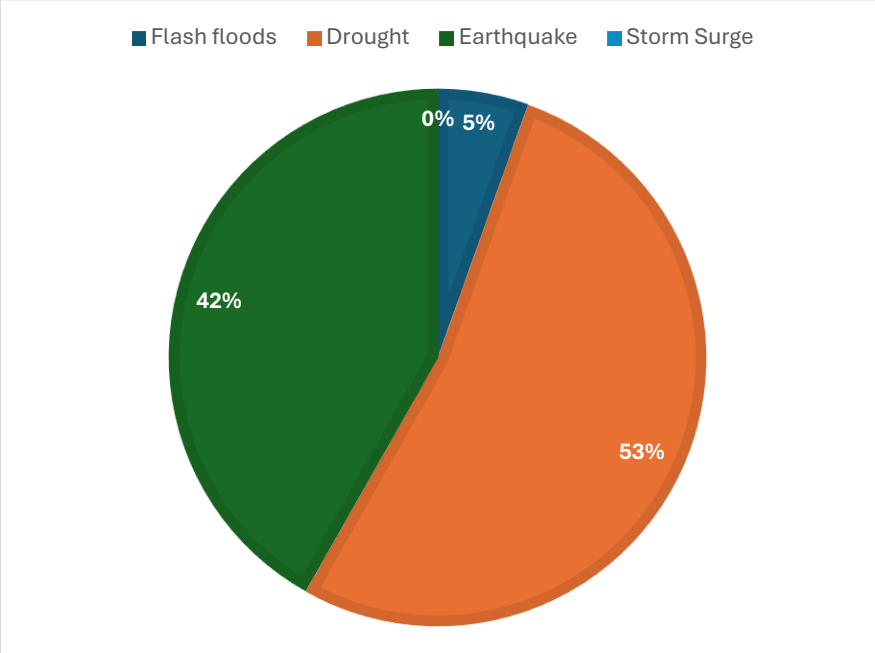


Figure 5-8: Likely Natural Hazards Affecting Community

When specifically asked about environmental concerns related to the proposed development, 92% of respondents had none. The remaining 8% stated concerns about the impact on the existing water supply (29%), increase in traffic congestion (29%), noise nuisance (14%), soil erosion (14%) and negative impact on plant and wildlife habitats (14%). Despite concerns for the environment, there is strong approval for the project to proceed as designed (Figure 59).

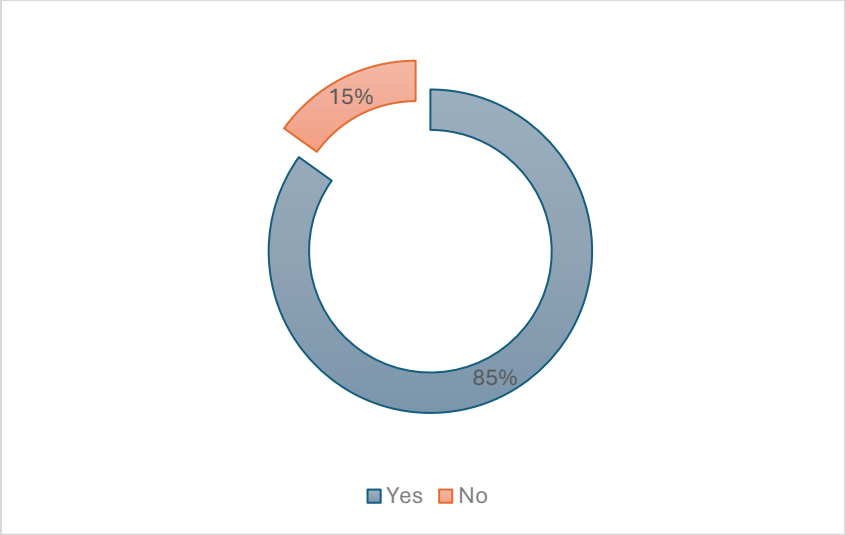


Figure 5-9: Should the Project Proceed as Designed?

5.6 Findings from Key Stakeholder Consultations

The research team undertook consultations with key stakeholders to understand better the impacts and opportunities presented by the proposed development. Entities consulted include:

- H10 Hotels – operators of Ocean Coral Spring and Ocean Eden Bay Hotels
- Jamaica Constabulary Force - Falmouth
- Jamaica National Heritage Trust
- Trelawny Health Department
- Western Parks and Markets
- Social Development Commission (SDC)
- Tourism Product Development Company

5.6.1 Ocean Coral Spring and Ocean Eden Bay H10 Hotels

The hotel will share its western boundary with the proposed site. The entity currently enjoys good relationship with the community and anticipates that this will obtain with the expansion of the Coral Spring Village. No objection was made to the proposed development, but some concerns were raised, namely:

1. The proposed development site is a wildlife habitat for various species of birds and insects. With habitat disruption, the birds, and insects (particularly crane flies and bees) may migrate to the resort and create a disruption to their operations.
2. There is informal economic activity taking place on the strip of beach adjacent to the hotel property. It is to be clarified who has ownership of the property, however access is obtained via the proposed development site. The informal economic activities have public health

implications and are considered a threat to the safety and security of the hotel's guests and needs to be formally addressed.

3. The installation of appropriate drainage to prevent water flowing down towards the hotel property is required.
4. The potential impact on the water table must be known, as the hotel sources all its water via wells connected to the local aquifer.
5. Maintenance of brisk security presence on the boundary wall, as the hotel's children's club and several suites are in that area.
6. Good site practices to be maintained to minimise disruption of its operations and damage to the natural environment. This includes advanced sharing of construction schedules, minimising potential run off to the beach, appropriate disposal of any hazardous waste.

5.6.2 Jamaica Constabulary Force (JCF)

Consultations with the Jamaica Constabulary Force revealed traffic safety and management as the primary concern. Numerous vehicular accidents take place with motorists seeking to enter and exit the Coral Spring main road as this is a non-signalised junction positioned at the foot of an incline. Measures will need to be taken to install appropriate traffic management signals to prevent loss of life and property considering the likely increase in traffic.

Worker influx may contribute to an increase in interpersonal conflict and opportunistic petty crimes. Periodic patrols are conducted throughout the community, and early engagement with the local police department is encouraged.

5.6.3 Jamaica National Heritage Trust (JNHT)

The proposed development is in an area of historical significance, with known Taino and colonial artefacts and sites being present in the area. These include the remnants of a Wharf and the Stewart Castle historical ruins. The Trust states that an archaeological assessment is required prior to construction.

5.6.4 Trelawny Health Department

The health department conducts periodic checks during the construction phase to ensure adherence to the public health regulations and maintenance of appropriate occupational health and safety practices. Plans for the disposal of sewage must include the building of an appropriate treatment facility, which is to come under the management of the National Water Commission.

This consultation highlighted the road safety concerns, stating that the local hospital had very limited capacity to treat the current numbers of motor vehicle accident victims. Additionally, it was shared that the public healthcare centres in Falmouth and Duncans were already stretched, and that an increase in the local population will put further pressure on child health, maternity, and routine health services.

5.6.5 Western Park and Markets (National Solid Waste Management Agency)

Waste disposal services are provided to residential communities by Western Parks and Markets that serves western parishes. While there are challenges maintaining a weekly collection schedule due to inadequate trucks, efforts are made to provide regular collection. Appropriate management of

construction waste was highlighted during the consultation, with the entity advising that a site visit be conducted to plan for waste management services.

5.6.6 Social Development Commission

The Social Development Commission shared the existence of active community groups in the Coral Spring area. In assessing the project concept, they were approving of the inclusion of green spaces and recreational areas to support health, engagement, and cohesion. It was noted that the expansion in residences would drive employment of persons from nearby communities, such as Duncans, during and post Construction. Opportunities for exercising good corporate citizenship were encouraged, such as investment in a recreational facility for the Duncans Community, or provision of resources to the Duncans Primary and Infant School to support students with special needs.

5.6.7 Tourism Product Development Company (TPDCo)

Consultations with the Tourism Product Development Company, TPDCo., revealed that the proposed site falls within the Trelawny tourism corridor. Their current concern relates to informal economic activities which take place on the beach front beside the Ocean Coral Spring Hotel. They note that activities include a restaurant (Jason's Lobster), craft shops, and horseback riding. The entity has worked with the Jamaica Constabulary Force to manage the informal activities, which pose a security and public health risks. They advised that extensive discussions were had with the previous property owners regarding the matter and highlighted that failure to address the situation will impact on the safety and security of the proposed development.

5.7 Culture and Heritage

Historical Background

The Mountain Spring-Coral Spring area has been inhabited by various ethnic groups over the centuries. An indigenous Taíno site has been identified in the vicinity (refer to Maps A & B, features 4, 5), with another site nearby (refer to Maps A & B, feature 7). During colonial times, the area fell within the parish of St. James, as the parish of Trelawny was not established until 1771. A review of historical maps dating from 1684 to 1991 reveals insights into the area's evolution. These maps depict several ponds, although the number and names varied across different maps. The Bochart and Knollis map of 1684 illustrates an area called Flemingo, featuring a large pond named Jarmu, with a stream called Little River flowing from it towards the south (refer to Map C). Activity areas are depicted near the pond (refer to Map C). Along the seacoast, the area was referred to as Platform Bay and Brittons Bay.

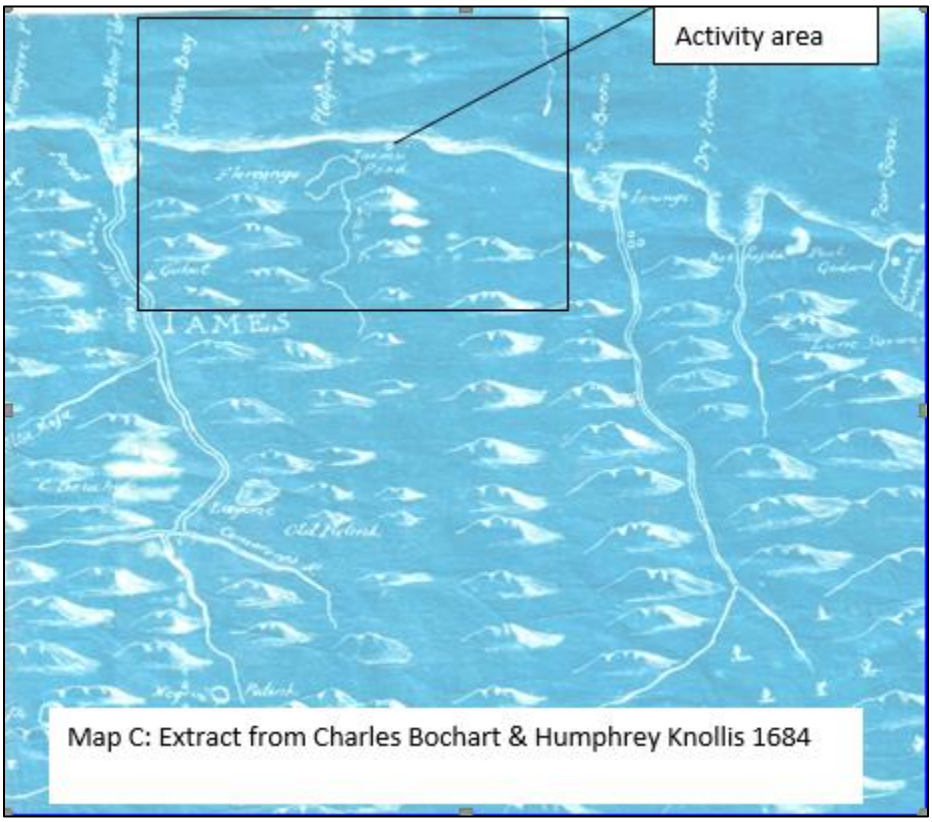


Figure 5-10: Map C Extract from Charles Bochart & Humphrey Knollis 1684

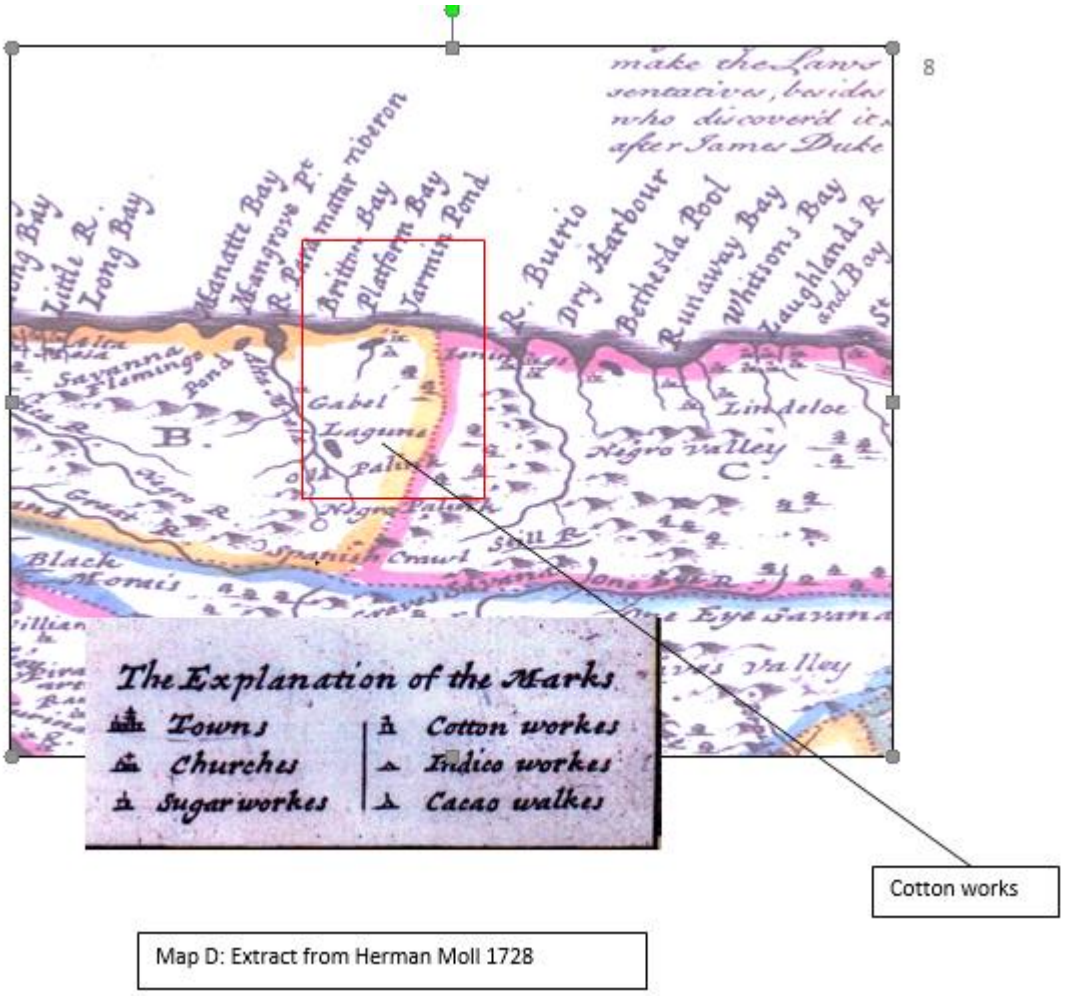


Figure 5-11: Map D Extract from Herman Moll 1728

Herman Moll's 1728 map indicates the presence of cotton works near Jarmin Pond. By 1763, settlements had expanded, and a road extended to Mountain Spring Bay. The term Mountain Spring Bay had replaced Brittons Bay (refer to Map E).

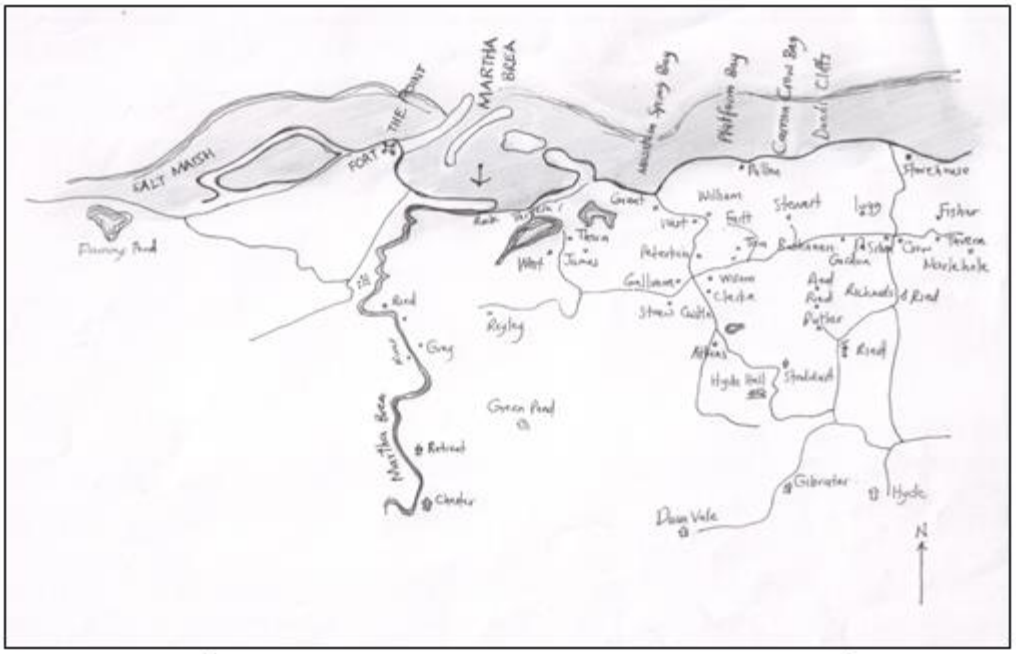
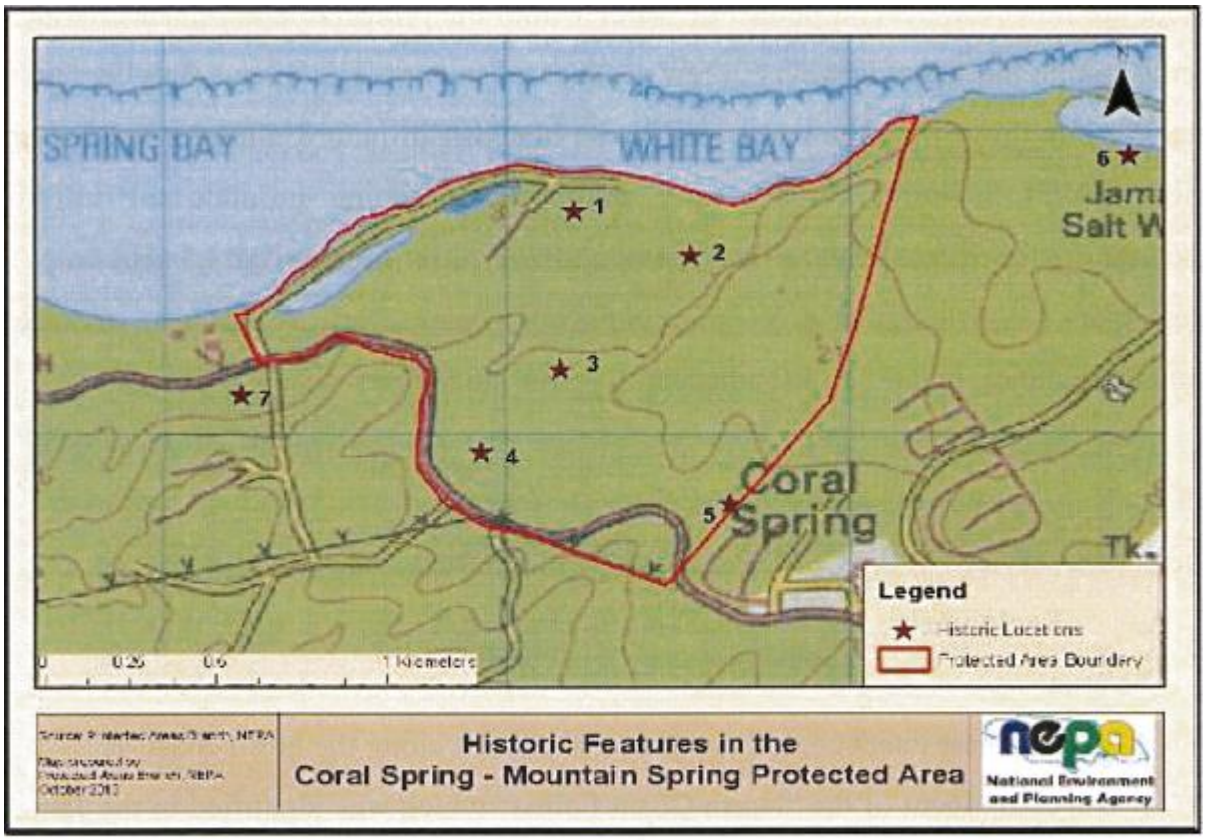


Figure 5-12: Map E Extract from Thomas Craskell & James Simpson 1763

Based on the examination of the project site, no evidence has been found of historical importance.

5.7.1.1 Cultural Assets

Cultural heritage assets have been previously observed in the proposed zoning area at Coral Spring-Mountain Spring and the immediate vicinity (see Figure 5-3). Numerous artifacts were discovered along the shore, particularly near the ruins. These include pieces of light olive-green glass, fragments of dark olive-green wine bottles, slipware, pearlware, creamware, stoneware, and porcelain sherds. An almost complete white clay smoking pipe was found among the debris of Ruin 4 (see Plate 9). Another assemblage, comprising large *Aliger gigas* (queen conch shells), a whole olive-green wine bottle, and several fragments of olive-green wine bottles, was found near the coastal limestone platform west of the pond (see Plate 10).



1 Historic foundations and remnant of wharf 2 Assemblage of historic artefacts
3 Historic foundation 4 Taino site 5 Historic stone wall
6 Historic salt works 7 Historic stone foundations and Taino site

Figure 5-13: Historic Features in the Coral Spring Area

The artefacts recovered from the site were all dated to the historical period late 17th century to early 20th century. The artefacts generated from the White Bay project are European in origin. Based on the artefacts and the type of ruins seen and those depicted on the historic maps, the area was used for residential and commercial purposes. The area closest to the bay most likely served as port facilities with a wharf where produce from the area was shipped and imports landed. A historic road which ran along the coast is now partly eroded by wave action (See Plate 14).

Plate 14: Historic road

Two areas noted on maps A and B fall outside the proposed protected zone; areas 6 and 7. Events in these areas in the past would have impacted on activities in the proposed zone, especially with regard to port facilities. In the 19th century, lands comprising the Spring estate encompassed the entire area thus the cultivation of sugar cane, harvesting of wood and cattle rearing would have occurred in sections of the proposed zone.

Based on the examination of the project site, no evidence has been found of historical importance.

6 Impact Identification, Analysis, and Mitigation

This section details the potential impacts on the natural, built and social environments identified that could occur during the pre-construction, construction and operational phases of the project. These impacts could be either positive or negative and were informed by the environmental assessment as well as stakeholder consultations. The Pre-Construction phase can be defined as the phase where the preliminary works, i.e. all the activities that are involved in a construction site before the actual work commences. This includes the site preparation which includes demolition, site clearance and enabling works (not including the transport of materials); site surveys such as geotechnical and soil surveys and ecological surveys; planning, designing, and cost estimation.[5] The Construction Phase refers to all construction and construction-related activities on site, until the contractor leaves the site.[6] The Operational Phase refers to all activities after construction, including the operation and maintenance of the proposed development.

6.1 Physical Impacts

The physical impacts of various activities associated with the project are outlined below, focusing on geotechnical risks, natural hazards, and operational phase concerns.

[5] Modified from https://theconstructor.org/building/preliminary-works-construction/39777/

[6] Taken from https://sahris.sahra.org.za/sites/default/files/additionaldocs/Appendix%20E%20-%20Impact%20Assessment%20Methodology_0.pdf

6.1.1 Geological and Geotechnical

Construction

1. Geotechnical risks include the presence of depressions, cavities, and voids, which pose threats to road infrastructure, equipment, and the safety of construction workers during construction activities.
2. Rockfalls from developing areas on the Bluff could cause damage to the area below and pose risks to workers.
3. Natural hazards such as flooding from excessive rainfall and storm events could lead to stormwater runoff, debris flow, and sediment deposition downstream, affecting marine and freshwater environments. Construction, site clearance, improper disposal of solid waste may also generate sediment that may be washed down into the coastal wetland and the marine environment.

Operation

1. Geological changes over time result in geotechnical risks, which can be aggravated during seismic activities. This risk can result in damage to housing, infrastructures and injury to people. The design of the housing development is crucial in reducing this risk and the potential impacts.
2. Cavities which currently exist on site based on geology can cause damage to buildings and other infrastructure from geotechnical risks within the area or those that appear over time either during construction or operations.
3. Sedimentation from loose material and transported material, material used could negatively impact the water quality at the coast if not monitored and controlled. This sedimentation could negatively impact the ecology of the coastal and marine environment.
4. The Sedimentation and loose material may also negatively impact the function of drains and could influence flooding in the immediate and surrounding areas.

6.1.1.1 Recommended Mitigation Measures

Mitigation measures are proposed to address these impacts, including site assessments by qualified professionals, proper construction practices, compliance with environmental regulations, and implementation of erosion and sediment control measures. It is crucial to ensure that activities are conducted in a manner that minimizes adverse effects on the environment and surrounding communities.

Construction

The following mitigation measures are recommended for implementation to minimize the potentially negative impacts in the construction phase of the development.

1. For an engineering geologist, geotechnical engineer or geologist to assess the site during site clearance and foundation excavation and determine the best approach and have appropriate measures taken for the safety and security of all people and assets.
2. There should be minimal disturbance of the immediate area around the sinkhole if discovered during site clearance. The use of mechanized equipment near the sinkhole should be controlled as the underground system of cavities and streams is dynamic.

3. Blasting is not recommended as explosions in the vicinity can alter or block underground drainage passages changing the output efficiency beyond current understanding of the system.
4. Plan and design Management Plans for the control of rockfalls and cliff excavation and include information on signage, communication with workers and protective barriers.
5. Construction practices, such as blasting is not recommended as it can change the geometry of the sinkhole throats and underground cavities, blocking outflow pathways and influence rockfalls.
6. Compliance with environmental permit conditions.
7. Sediment traps in any drains entering the sea/ implement sediment control measures.
8. Do not store construction material/debris in natural drainage pathways.
8. Practice good housekeeping to avoid spreading litter and waste from human/construction activities.
9. Ensure there is an emergency response plan in place during construction.

Operation

The following mitigation measures are recommended for implementation to minimize the potentially negative impacts in the operational phase of the development.

1. Ensure all buildings and supporting infrastructure are designed according to proper building and seismic codes.
2. To be further assessed after site clearance. It is recommended that a geotechnical engineer/ engineering geologist be available to advise on best practice based on what is observed.
3. Comply with permit requirement conditions granted by NEPA.
4. Concessionaires should abide by Erosion and Sediment Control Plans, Stormwater Management Plan, and Emergency Spill Response Plan, particularly near sensitive habitats such as mangrove areas adjacent to the road.
5. Inspect nearshore road sections and bridges intermittently for effects of coastal or riverine erosions.
6. Voids within the footprint of the development that are over 2 meters will be individually evaluated and an on-site decision taken for no buildings or infrastructure to be erected in that location.
7. Minimize bare areas and replant with vegetation, using native vegetation to the extent practicable to minimize sediment runoff from soils.

6.1.2 Water Quality, Air Quality and Noise

Construction

Water Quality:

Construction activities may impact coastal water quality due to the area's extensive groundwater network leading to the sea. Potential sources of contamination include sediment runoff, construction debris, and chemical spills.

Air Quality:

Air quality is expected to be impacted as a result of construction activities, including the operation of the batching plant during the construction phase of the development.

Noise:

Construction activities will generate noise from trucks, excavators, and heavy-duty equipment, which may disturb nearby communities.

Operation

Water Quality:

Changes in water flow could lead to freshwater influx into hypersaline ponds (mangroves), reducing salinity levels and potentially affecting associated species.

Air Quality:

An increase in particulate matter is expected especially during construction and operation of the batching plant.

Noise:

Increased traffic during the operation phase could lead to unwanted noise in the area.

6.1.2.1 Recommended Mitigation Measures

Construction

Water Quality Management:

1. Implement sediment control measures such as silt fences and sediment basins to prevent runoff into coastal waters.
2. Ensure proper storage and handling of chemicals to prevent spills.
3. Regularly inspect and maintain construction equipment to prevent leaks.

Air Quality Management

1. Regularly wet the batching plant site and access roads to reduce dust emissions.
2. Install dust enclosures or barriers around batching operations and stockpiles to contain dust, where possible.
3. Ensure that batching equipment is well-maintained and serviced to minimize emissions.
4. Restrict batching plant operations to specific hours to minimize impact during peak times.

Noise Control:

1. Develop and adhere to a maintenance and transportation schedule to ensure that trucks and other machinery are well-maintained, preventing additional noise from poorly maintained vehicles.
2. Restrict construction operations to specified time frames, particularly avoiding nighttime work to minimize noise disturbance to neighboring communities.

Operation

Water Quality Management:

1. Monitor and manage changes in water flow to maintain appropriate salinity levels in hypersaline ponds.
2. Implement water quality monitoring programs to detect and address any issues promptly.

Air Quality Management:

1. Plant trees, shrubs, and other vegetation around the development site to act as natural barriers that trap dust and particulates, improving local air quality.
2. Ensure that all roads, parking areas, and other frequently trafficked areas within the development are properly paved or grassed to minimize dust generation from vehicular movement.
3. Conduct regular air quality audits to assess emissions from the development and ensure that mitigation measures are working effectively.

Noise Control:

1. Install noise barriers to mitigate noise from increased traffic and operational activities.
2. Implement speed bumps or other traffic calming measures to reduce vehicle speed and associated noise.
3. Preserve existing trees and consider planting additional tree barriers to reduce noise pollution. Trees can act as natural sound buffers, minimizing noise impacts from the hotel and other sources.

6.1.3 Natural Hazards

There are several hazard risks that the existing environment poses for the development. The main hazards issues include:

1. Hurricanes can result in damage to the housing infrastructure as a result of high wind speeds.
2. Earthquakes and Fires The site is of relatively low risk to earthquakes, but this does not mean an earthquake cannot occur. Should this be experienced foundational risks can occur to housing units. Earthquakes can also result in secondary hazards such as fires.
3. Heavy rainfall events may influence flooding of surrounding properties and the road, especially as the ground will mainly be covered by concrete. This will result in an increase in storm water runoff.
4. Jamaica has a bimodal Rainy season. Early rainfall season is from April to June and the late rainfall season from September to November. It is usually split by a midsummer drought that falls in July. The RCP 8.5 emissions scenarios projected that there will be an abnormal drying across the Caribbean dry season (December to January) from as early as the 2020s, by up to 4% in the 2050s and 12% by the end of century. This drought period can potentially result in shortages to the water supply and climate change intensifies overtime.

6.1.3.1 Recommended Mitigation Measures

Based on the issues outlined the following mitigation measures are recommended to address these potential issues:

1. Ensure that roofing can sustain Category 5 hurricane storm winds.
2. Develop Emergency Response Plan and train on-site workers to ensure users are aware of the procedures.
3. Adherence to building codes for earthquakes and fire risks

4. Conduct Geotechnical investigations to guide engineering details of buildings to be constructed.
5. Ensure the relevant signage (evacuation routes, assembly points, etc.) are appropriate and displayed.
6. Ensure fire extinguishers and sprinkler systems are serviced and designated persons are trained on how to use and operate the equipment.
7. Conduct Hydraulic Assessment and develop a drainage plan, which includes mitigation measures in place to reduce the potential for the flooding of adjacent properties.
8. Ensure drains on the housing development are cleaned and maintained.
9. Engage Engineers to design sewage treatment plant can accommodated the increased volume of flood waters.
10. Innovative water conservation technologies will be implemented which reduces raw water consumption through water reuse and recycling.

6.2 Biological Impacts

The proposed development will have significant impacts on the site's biodiversity, extending beyond the site into adjacent areas. The site borders the Coral Spring Mountain Spring Protected Area (CSMSPA), leading to shared ecological processes and genetic exchange between species across boundaries. The planned development will result in the removal of a majority of existing species and the conversion of the area into a housing development, drastically modifying the habitat.

Presently, clearances for roadways have already fragmented the dry forest, and further development will remove most of what remains. This loss of biodiversity will diminish the positive impacts the ecosystem has had, including carbon sequestration, coastline protection, water filtration, and habitat provisioning. Additionally, the intrinsic value of biodiversity will be lost, regardless of the conservation status of each species.

The development will remove the buffering role played by the dry limestone forest, potentially exposing the CSMSPA to new impacts. Temporary impacts during development phases include dust and noise generation, affecting ecosystems at the site boundary.

Post-development impacts are expected from anthropogenic activities within the development and surrounding ecosystems. Road and housing construction will alter the area's hydrology, while runoff and artificial lighting will affect surrounding fauna. Increased pollution will further impact nearby ecosystems.

Preliminary impacts observed include pervasive solid waste dumping, mangrove cutting, evidence of firearm use, moderate levels of horse tours impacting mangrove and shoreline vegetation, and high salinities in salina ponds, among others. The Quadrat 3 area represents an ecotone with a mixture of limestone and mangrove species.

6.2.1 Recommended Mitigation Measures

The following mitigation measures are recommended to minimize the negative ecological impacts posed by the proposed housing development.

Habitat Preservation and Restoration

1. Implement measures to preserve existing biodiversity-rich areas within the development site.

2. Undertake habitat restoration initiatives to compensate for habitat loss, focusing on native vegetation replanting.
3. Special attention should be given to tank bromeliads to determine if there are populations of different taxa utilizing these as habitat. If this is the case, then these should be removed with extreme care especially if the taxa identified in these plants are endemic.

Buffer Zone Protection

1. Implement strict zoning regulations and land-use planning to protect critical habitats and ecological corridors.
2. Remove trees only where necessary and incorporation of the larger trees of a particular DBH into the landscaping and design of the CSV 2.

Construction Practices

1. Implement best construction practices to minimize disturbance to surrounding ecosystems during development phases.
2. Employ erosion control measures to prevent sedimentation in water bodies and nearby habitats.

Noise and Dust Management

1. Implement noise and dust control measures during construction to minimize disturbance to wildlife and nearby residents.
2. Schedule construction activities to minimize noise impacts on sensitive species during breeding seasons.
3. Dust suppression exercises should be carried out to reduce this impact on the surrounding vegetation. This also shows the importance of a green buffer at the edge of the development property in tandem with a wall is necessary.

Lighting Management

1. Use wildlife-friendly lighting designs to reduce impacts on nocturnal fauna.
2. Install shields or directional lighting to minimize light pollution and its effects on surrounding ecosystems.

Stormwater Management

1. Develop and implement a comprehensive stormwater management plan to mitigate runoff impacts on surrounding ecosystems.
2. Incorporate green infrastructure and permeable surfaces to reduce runoff volume and improve water quality.

Community Engagement and Education

1. Engage with residents and stakeholders to raise awareness about the importance of biodiversity conservation.
2. Establish community programs for responsible waste management and habitat protection.

Monitoring and Adaptive Management

1. Implement regular monitoring programs to assess the effectiveness of mitigation measures and adjust as needed.

2. Develop an adaptive management plan to address unforeseen impacts and ensure ongoing biodiversity conservation.

6.3 Social and Cultural Impacts

There are several potential social issues that can arise as a result of the planned housing development, these are outlined below:

1. **Security Issues**- the possibility of theft and illegal activities occurring on site from persons inside and outside of the area. This can occur due to the influx of workers into the area.
2. **Squatting**- The emergence of squatter/informal settlements populated by opportunistic migrants seeking work on the project site, who will most likely stay in the community long after the project has ended. This may lead to possible incidence of theft and petty crime in the neighbouring community.
3. **Parking Issues** - Construction related vehicles parking in places that exacerbate traffic issues.
4. **Traffic congestion and Safety concerns** - Increased traffic caused by construction vehicles departing and entering the proposed site
5. **Potential to uncover and destroy items of cultural** – The potential for damage or loss of cultural heritage items especially as it relates to it being a Taino site and in proximity to an Old Wharf and Stuart Castle Ruins.
6. **Biodiversity Disruption** - The development may lead to the possible disruption of biodiversity i.e. bees, crane flies, and threaten the migration patterns of birds. These species can become a nuisance to homeowners. The proposed housing development may be affected by the seasonal emergence of crane flies and bees which are in the area during the Early Rainfall (May) and Late (October)Rainfall season.
7. **Poor Air Quality** - Fugitive Dust from construction activity can affect the health of on-site workers, pedestrians, guests from the hotel and nearby residents.
8. **Noise Nuisance** - Excavation and earth works, frequent movement of trucks can impact site workers and nearest community and business complex. Sustained exposure to noise can result in damage to the hearing and so this should be appropriately managed for workers and neighbours.

6.3.1 Recommended Mitigation Measures

To minimize the potential impacts identified, the following mitigation measures have been identified:

1. Hire a security company to secure the work site.
2. Establish working protocols and code of conduct for workers to follow.
3. During the hiring process, developers need to ensure that all prospective site workers can provide proof of address within the immediate or surrounding community.
4. Designate an area on the site for parking; In the event there is a spillover develop a short-term arrangement with a neighbouring entity for parking spaces.
5. Develop a traffic plan to minimize impacts.
6. Implement the proper use of flag men, construction signs, detours as appropriate.
7. Coordinate scheduling with other road users of within proximity of the proposed site and the NWA.
8. Sensitize the surrounding community about the traffic management
9. Signalise the entrance to Coral Springs Development; and install rumble strips
10. Install speed limits

11. Archaeologists from the Jamaica National Heritage Trust (JNHT) shall do a watching brief in proximity of the proposed housing development site to identify and catalogue any items of cultural significance
12. It is recommended that the contractor install window mesh on all the housing units to minimize the disturbance of insect species to homeowners.
13. Periodic wetting of unpaved areas will be necessary for dust control.
14. The covering of all stockpiled material during storage and construction is also necessary to control dust.
15. Workers should be provided with and wear the appropriate PPE to prevent respiratory illnesses due to working in dusty conditions.
16. Monitor Air Quality during the construction period.
17. NEPA's noise standards are to be monitored and followed over a 24-hour period.
18. Advisories should be issued to nearest the communities and entities of planned elevated noise activities.
19. It was recommended that work be done before 6:00p.m. to protect the children of guests who go to bed at that time.
20. Workers should be provided with and wear appropriate PPE to protect their hearing during noisy activities.

6.4 Summary Impacts and Mitigation Measures

Table 6-1: Summary of Impacts and Proposed Mitigation Measures

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
PRECONSTRUCTION PHASE						
Poor Air Quality	Preconstruction activities include vegetation clearance and the construction or roads- and installation of utilities. This will include the clearing of land to facilitate these activities, which can result in an increase in dust/ particulate matter, which can affect human health and key ecological species.	Negative	Short-Term	Minor	Reversible	Intermittent wetting of excavated earth and exposed surfaces. Phasing of vegetation clearance activities. Clearing only as necessary. Ensure workers wear the appropriate PPE
Noise Naissance	Preconstruction activities include vegetation clearance and the construction or roads and installing of utilities. This will include the clearing of land to facilitate these activities, which can result in an increase in noise. Exposure to sustained high noise levels can impact human hearing and also disturb some types of fauna.	Negative	Short-Term	Minor	Reversible	Phasing of vegetation clearance activities.
CONSTRUCTION PHASE						
Traffic congestion and Safety concerns	Increased traffic caused by construction vehicles departing and entering the proposed site	Negative	Lifetime of the Project	Significant	Reversible	Develop a traffic plan to minimize impacts Implement the proper use of flag men, construction signs, detours as appropriate

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
						Coordinate scheduling with other road users of within proximity of the proposed site and the NWA Sensitize the surrounding community about the traffic management Signalize the entrance to Coral Springs Development; and install rumble strips Install speed limits
Potential to uncover and destroy items of cultural; heritage value	Damage or loss of cultural heritage items especially as it relates to it being a Taino site and in proximity to an Old Wharf and Stuart Castle Ruins.	Negative	Short-Term	Significant	Irreversible	Where cultural assets are discovered in the proximity of the proposed housing development, archaeologists from the Jamaica National Heritage Trust (JNHT) shall do a watching brief to identify and catalogue any items of cultural significance
Biodiversity Disruption	The development may lead to the possible disruption of biodiversity i.e. bees, crane flies, and threaten the migration patterns of birds. The proposed housing development may be affected by the seasonal emergence of crane flies and bees which are in the area during the Early Rainfall (May) and Late (October) Rainfall season.	Negative	Long-Term	Significant	Reversible	Designate specific areas within the development as conservation zones to protect the habitats of bees, crane flies, and other local wildlife. Incorporate native plants and trees into the landscaping design to provide natural habitats and food sources for local wildlife, including bees and birds. This will help maintain the local ecosystem and support biodiversity.

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
Storm Water Runoff/ Flooding	During heavy rainfall events, construction may generate sediment that cause ponding on the property based on the gradient and the soil properties. Depending on the time of year for construction, (May, September to October are the historically wettest months for the area) there is a possibility of flooding due to the changes in the existing waterways.	Negative	Long-Term	Significant	Reversible	Install sediment traps near the rear of the property. Avoid and prevent the storage of construction material/debris in natural drainage pathways. This is important to avoid disturbing the water table because the Ocean Coral Spring Hotel takes water from the well for its own operations. Develop an emergency response/evacuation plan for the site Install drainage pathways on the site Bore holes in any water storage containers on the site to prevent mosquito breeding The contractor should abide by Erosion and Sediment Control Plans, Stormwater Management Plan, and Emergency Spill Response Plan, particularly near sensitive habitats such as mangrove areas adjacent to the road. The contractor should liaise with the Parish Development Coordinator (ODPEM) to keep informed about local disaster management plans.

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
Drainage Issues	Changing land use may lead to disrupting preexisting drainage infrastructure. This has potential implications for sewerage to leak into the water table and may also affect water pressure for the nearby hotel. This contamination can have a negative impact on public health as well as ecological life within and outside the development.	Negative	Short-Term	Moderate	Reversible	Conduct a comprehensive hydraulic assessment. Construct a sewage treatment plant to ensure that sewerage is properly treated.
Poor Air Quality	Fugitive Dust from construction activity can affect the health of on-site workers, pedestrians, guests from the hotel and nearby residents. Excessive particulate matter can also smother wildlife.	Negative	Short-Term	Moderate	Reversible	Periodic wetting of unpaved areas. The covering of all stockpiled material during storage and construction Ensure workers wear the appropriate PPE Monitor Air Quality during the construction period.
Noise Nuisance	Excavation and earth works, frequent movement of trucks can impact the hearing of site workers and nearest community and business complex. Wildlife can also be negatively impacted by noisy activities.	Negative	Short-Term	Moderate	Reversible	NEPA's noise standards are to be followed over a 24-hour period. Advisories to nearest communities of planned elevated noise activities. It was recommended that work be done before 6:00p.m. to protect the children of guests who go to bed at that time.

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
						Workers should wear appropriate PPE. Schedule construction activities to minimize noise impacts on sensitive species during breeding seasons.
Solid Waste pollution	Improper storage or disposal of solid waste generated	Negative	Medium Term	Significant	Reversible	Waste should be removed by an approved waste management contractor and taken to an approved waste disposal site.
Earthquake risk	Site is of relatively low risk to earthquakes. Earthquakes can result in fires on-site and accidents that can result in injury or death.	Negative	Short-Term	Significant	Irreversible	Adhere to building codes and guidelines from geotechnical investigations. Develop and implement Emergency Response Plan. Execute training on the plan to ensure users are aware of the procedures. Ensure the relevant signage (evacuation routes, assembly points, etc.) are appropriate and displayed.
Fires	Potential damage from fires as a secondary risk to other hazards or from an accident on the construction site. This can result in injuries or death.	Negative	Short-Term to Medium Term	Moderate	Irreversible	Ensure fire extinguishers and water trucks are on site, serviced and designated persons are trained on how to use and operate these equipment.
Hurricanes and Wind Damage	Flooding of the site; injuries to the workers during the passage of a hurricane is a possibility	Negative	Lifetime of the Project	Significant	Reversible	Develop an emergency response/evacuation plan for the site

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
						Install drainage pathways on the site Bore holes in any water storage containers on the site to prevent mosquito breeding The contractor should liaise with the Parish Development Coordinator (ODPEM) to keep informed about local disaster management plans.
Security Issues	Possibility of theft and illegal activities occurring on site from persons inside and outside of the area. This can occur due to the influx of workers into the area.	Negative	Short-Term to Long Term	Major	Irreversible	Hire a security company to secure the work site. Establish working protocols and code of conduct for workers to follow.
Squatting	Emergence of squatter settlements: Possibility of informal settlements populated by opportunistic migrants seeking work on the project site, who will most likely stay in the community long after the project has ended, which may lead to possible incidence of theft and petty crime in the neighbouring community.	Negative	Long-Term	Significant	Irreversible	During the hiring process, developers need to ensure that all prospective site workers can provide proof of address within the immediate or surrounding community.
Parking Issues	Construction related vehicles parking in places that exacerbate traffic issues	Negative	Short-Term	Significant	Reversible	Designate an area on the site for parking; In the event there is a spillover develop a short-term

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
						arrangement with a neighbouring entity for parking spaces
OPERATION PHASE						
Air Quality	Poor Air Quality/ Odor related to operation of the Sewage Treatment Plant	Negative	Short-Long Term	Significant	Reversible	The aerated ponds use technology that eliminates spray and reduces the odour potential and as such the setbacks proposed (19-45m) will not adversely affect the neighbouring properties. The boundary line will have either a concrete wall or chain link fence with trees/tall shrubs to act as a visual barriers.
Increase in housing solutions	The development provides housing to meet the great demand that exists for housing needs in the parish of Trelawny.	Positive	Long-Term	Significant	Reversible	N/A
Employment opportunities	Provides opportunities for potential employment on the site throughout the life cycle of the project, utilizing skillsets from residents within the surrounding community of the project site.	Positive	Long-Term	Significant	Reversible	N/A
Loss in ecological life in the area	The removal of vegetation will lead to the death of flora and fauna in the project area.	Negative	Long-term	Significant	Reversible	Undertake habitat restoration initiatives in the design of green spaces to compensate for habitat loss, focusing on native vegetation replanting.

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
						Special attention should be given to the tank bromeliads to determine if there are populations of different taxa utilizing these as habitat. If this is the case, then these should be removed with extreme care especially if the taxa identified in these plants are endemic. Where not possible, implement nature-based solutions such as vertical gardening utilizing native species on the proposed concrete wall. Implement strict zoning regulations and land-use planning to protect critical habitats and ecological corridors. Remove trees only where necessary and incorporation of the larger trees of a particular DBH into the landscaping and design of the CSV 2. Use wildlife-friendly lighting designs to reduce impacts on nocturnal fauna.

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
						Install shields or directional lighting to minimize light pollution and its effects on surrounding ecosystems, which will remain. Consider green infrastructure such permeable surfaces to reduce runoff volume and improve water quality if/where necessary. Community Engagement and Education with residents and stakeholders to raise awareness about the importance of biodiversity conservation Monitoring and Adaptive Management to address unforeseen impacts and ensure ongoing biodiversity conservation.
Hurricanes and wind damage	Damage to the housing development and infrastructure during hurricanes	Negative	Long term	Significant	Reversible	Ensure that roofing can sustain Category 5 hurricane storm winds. Adherence to building codes.
Earthquake risk	The site is relatively at low risk to earthquakes. Foundational risks to housing units and injury to people if earthquake occurs	Negative	Short-Term to Medium Term	Moderate	Irreversible	Conduct Geotechnical investigations to guide engineering details of buildings to be constructed. Construction to building meet code requirements for seismic risk.

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
Fire risk	Potential for damage from fires	Negative	Short-Term to Medium Term	Moderate	Irreversible	Fire Hydrant System Installed in the community. Adhere to building codes with respect to fire safety.
Increased Stormwater runoff/ Flooding	Heavy rainfall events may influence flooding of surrounding properties and the road, especially as the ground will mainly be covered by concrete. Runoff can contain high sediment loads which can smother flora and fauna in coastal ecosystem and the marine environment.	Negative	Long-Term	Significant	Reversible	Conduct Hydraulic Assessment and develop a drainage plan, which includes mitigation measures in place to reduce the potential for the flooding of adjacent properties and sediment loading in the coastal ecosystem and marine environment. Ensure drains on the housing development are cleaned and maintained. Engage Engineers to design sewage treatment plant to accommodate the increased volume of flood waters.
Drought	Jamaica has a bimodal Rainy season. Early rainfall season is from April to June and the late rainfall season from September to November. It is usually split by a midsummer drought that falls in July. The RCP 8.5 emissions scenarios projected that there will be an abnormal drying	Negative	Long-Term	Significant	Reversible	Innovative water conservation technologies will be implemented which reduces raw water consumption through water reuse and recycling.

Risk Identified	Possible Impacts	Possible Impacts				Mitigation Measures
		Direction	Duration	Magnitude	Permanence	
	across the Caribbean dry season (December to January) from as early as the 2020s, by up to 4% in the 2050s and 12% by the end of century.					
Infrastructure damage due to cavities	Damage to building and other infrastructure from geotechnical risks within the area or those that appear over time either during construction or operations.	Negative	Long-term	Significant	Reversible	To be further assessed after site clearance. It is recommended that a geotechnical engineer/ engineering geologist be on standby to advise on best practice based on what is observed. Voids within the footprint of the development that are over 2 meters will be individually evaluated and an on-site decision taken for no buildings or infrastructure to be erected in that location.
Sedimentation in coastal waters	Sedimentation and loose material may negatively impact the function of drains and could influence flooding in the immediate and surrounding areas. Sedimentation could also cause smothering of ecological life in the coastal wetland and the marine environment.	Negative	Long-term	Significant	Reversible	Inspect nearshore road sections and bridges intermittently for effects of coastal or riverine erosions. Minimize bare areas and replant with vegetation, using native vegetation to the extent practicable to minimize sediment runoff from soils.

6.5 Cumulative Impacts

Potential cumulative impacts include flooding, contamination of the water table, sediment runoff, and increased traffic. These issues are all associated with changes in hydrology from filling cavities, and the leaching of treated wastewater into the water table through the proposed earthen ponds. Other critical concerns include proximity and encroachment to the protected area, the migration of species, and to a lesser extent, the impact on the wetland area (i.e., salt ponds and mangroves).

The construction's potential impact on water resources (both during and after construction) coupled with the hotel's reliance on its wells raises questions about resource overexploitation and potential contamination of the water table in the area. At least three known springs in the area require an understanding of interconnectedness and flow directions to the sea. These springs are a result of fault lines cutting the water table; however, they remain difficult to understand until land clearing occurs. Furthermore, the presence of sinkholes and cavities on the property poses potential negative impacts on construction and water flow, which may necessitate assessing additional data points and engineering solutions. Field observations thus far suggest that larger cavities appear closer to the sea, raising concerns about structural stability (i.e., the potential collapse of cavities/sinkholes) particularly in those areas. Section 7 elaborates on alternative design solutions that were considered based on these cumulative factors.

The project may also contribute to flooding and erosion in other areas outside the project site, such as the wetland area and the (dirt) access road to the beach. The anticipated 50% increase in runoff post-development was, however, deemed manageable, especially considering the natural slope of the land towards the wetland area. Changes in hydrology caused by filling cavities or blocking natural drainage flows may increase freshwater influx into the mangrove/wetland area. While this might have a net positive impact on mangrove plants due to the existing hypersaline environment, it could be less beneficial in the short-term for some microhabitats and associated species, such as barophilic species with high saline tolerance, which provide food for the numerous bird species observed. As conditions change, these species could eventually be replaced by others, such as fish and crustaceans.

Water quality and ecological impacts were also prominent cumulative concerns. For example, sediment loading in the marine environment, particularly near seagrass beds and coral reefs, due to changes in hydrology and increased runoff. Additionally, air and noise pollution from construction combined with the anticipated increase in traffic combined are concerns; based on wind direction, these could have negative impacts on the existing Coral Springs community.

6.5.1 Mitigating Measures

To address these cumulative impacts, the project will incorporate robust mitigation measures:

- **Water Quality**: Further investigation into fault lines and potential contamination sources.
- **Runoff Management**: Enhanced design and monitoring of detention ponds and overflow systems.
- **Ecological Protection**: Strategies to mitigate sewage discharge, protect coastal vegetation, and prevent disruption of species migration.
- **Pollution Control**: Implementation of measures such as phased construction schedules to reduce air and noise pollution during both construction and operation.
- **Water Management**: Incorporate berms in the design of detention ponds.

- **Construction Considerations**: During construction, the team will observe for cavities, and lots may be abandoned if large cavities of over 2 metres are observed. Voids of this size will be evaluated on-site, and a decision taken. Where possible engineering solutions to fill small to moderately sized cavities may be considered as outlined below:

Construction on Voids/ Cavities

Where the area is to be developed the void will be opened up to a sufficient extent to allow for work to take place in the void as shown in the figures below:

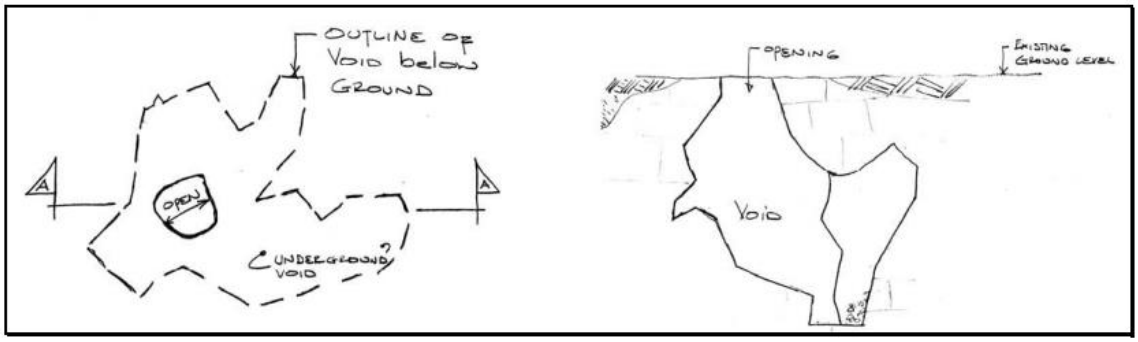


Figure 6-1: Left: Possible plan of void; Right: Assumed cross-section of void

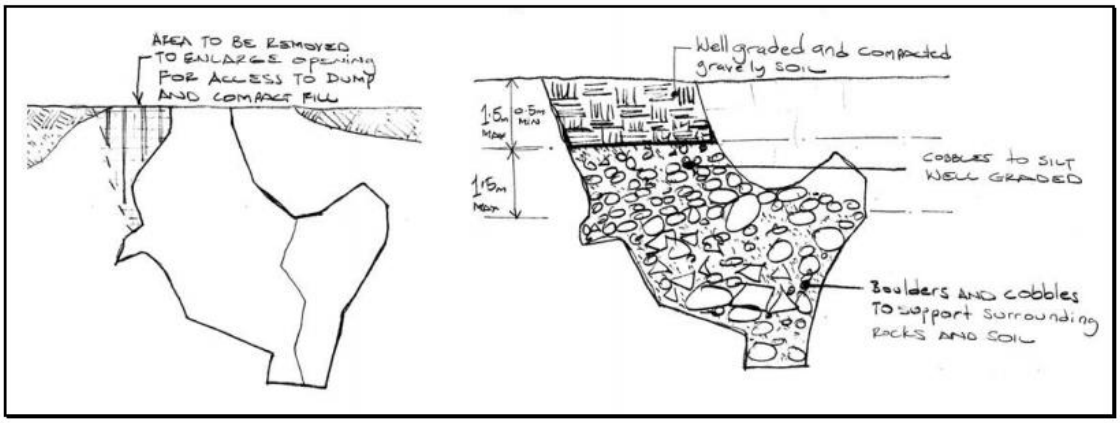


Figure 6-2: Left: Possible Plan of void; Right: Void filled with granular material

As shown in Figure 6-1 and Figure 6-2 above different fill materials are proposed for the various elevations in the voids so as to achieve free drainage through that part of the stratum, thereby satisfying the recommendation from the geological report to maintain the movement of groundwater through the areas of the voids. Boulders and cobbles will be the predominant particle size placed at the lowest levels in the void while more densely compacted granular materials are proposed for the upper levels of the fill. This will allow for free flow of groundwater through the filled void. Closer to the surface, well graded soil from cobbles to sizes that will be retained on the No 200 sieve and will be used to fill the upper most parts to complete the filling of the void.

7 Analysis of Alternatives

7.1 No Action

In the No Action Alternative, the core dry limestone forest would remain intact, thereby protecting the endemic and threatened species within. This approach would also preserve the ecosystem services provided by the forest at the proposed site, including habitat provision for fauna, carbon sequestration, oxygen production, water filtration draining to the sea and reef systems, and protection of inland areas from storm surges and flooding. However, there is a significant need for housing in the area, and the site is zoned for resort development. Better housing options for Jamaicans could potentially benefit the community more than another internationally owned and operated hotel.

7.2 The Development as Proposed

As proposed, the development would provide affordable housing for approximately 700 residents. The plan incorporates sustainability measures, such as including over twice the recommended green space in the community design, utilizing treated water for irrigation of these green spaces, using native vegetation, and retaining larger ‘legacy’ trees in the design Additionally, the erection of concrete walls is to be erected between the development and the adjacent protected area. This approach aims to balance the need for housing with environmental sensitivity and sustainability.

7.3 The Development as Proposed with Modifications

Possible modifications to the proposed development include larger lot sizes with a slightly reduced number of housing units. This approach could provide several benefits:

- **Increased Green Space**: Lot sizes provided in the development proposed is larger than the minimum standard in the Development Guidelines allow for more green space within each property, enhancing the overall aesthetics and ecological value of the community. The green spaces are 55% more than the requirements in the Development Guidelines. This further improves the quality of life for residents by providing more recreational areas and natural landscapes. This modification would help preserve more of the native vegetation and larger 'legacy' trees, contributing to the conservation of local biodiversity.
- **Enhanced Water Management**: A reduced number of housing units decreases the overall demand on water resources. This could improve the efficiency of using treated water for irrigation and reduce the potential impact on the water table and surrounding aquatic ecosystems.
- **Lower Density and Reduced Traffic**: Only 35% of lots are a minimum standard lot sizes of 4,000 square feet as per Guidelines for Development and 65% are above the minimum standard. This lower density that the Development Guidelines lowers the population density, potentially reducing the development’s contribution to traffic congestion within the development and surrounding areas. This could also lessen the impact on local infrastructure and decrease noise and air pollution.
- **Maintained Community Character**: Larger lots and fewer homes could help maintain a more open, less crowded community character, which might be more in keeping with the

surrounding natural environment and more appealing to potential residents seeking a balance between development and nature.

While these modifications aim to enhance the sustainability and environmental sensitivity of the development, they are generally not feasible for the developer.

7.3.1 Development in Phases

The proposed development will be executed in approximately six (6) phases. The development is likely to start in the northeastern area of the property, which will house the Sewage Treatment Plant (STP), batching plant, and storage area. From there, the construction will progress in the north and gradually uphill, with each phase corresponding to a specific roadway aligned along the contour of the land. This phased approach offers several advantages:

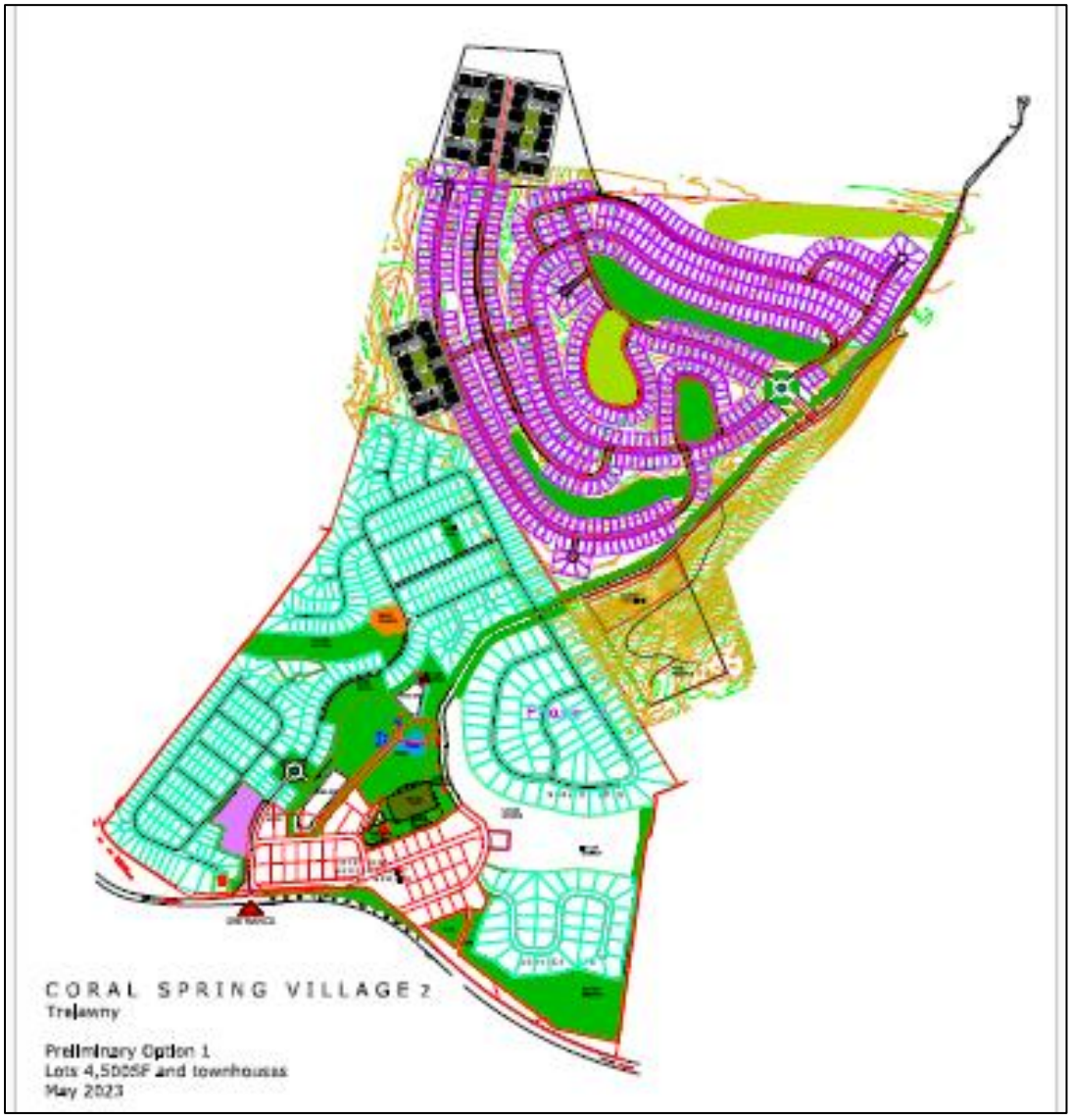
- **Efficient Resource Management**: Starting with the northern area allows for the immediate establishment of essential infrastructure such as the STP and batching plant, ensuring that these facilities are operational early in the project timeline.
- **Minimized Environmental Impact**: Developing in phases reduces the overall disruption to the site at any given time, allowing for better management of construction impacts such as erosion, sediment runoff, and habitat disturbance.
- **Gradual Infrastructure Development**: Phased development facilitates the systematic installation of utilities and services, ensuring that each phase is fully supported before moving on to the next.
- **Responsive to Market Demand**: By progressing in phases, the development can adapt to market conditions and demand for housing, allowing for adjustments in the scale or nature of future phases based on initial outcomes.
- **Community Integration**: Gradual development allows for better integration of new residents into the community, avoiding the sudden influx of a large population and the associated strain on local services and infrastructure.

This phased approach not only enhances project manageability but also ensures that each stage of the development aligns with sustainable practices and community needs.

7.3.2 Layout Alternatives

The following three (3) layout alternatives are proposed for the property assessed. Each alternative considers variations in lot sizes, road alignments, green spaces, and community amenities to optimize the balance between housing needs and environmental preservation. These included the extension of high-end housing on the Bluff. Based on the results of the assessment, these alternatives were abandoned for the preferred designed illustrated in Section 3.2.1 which optimized on the housing opportunities and greenspaces.

Alternative A



Alternative B

Alternative C

7.3.3 Retention of the Forested Slopes

The development plan includes the retention of some forested slopes and the construction of detention ponds and other water management features. Additionally, berms will be constructed around the detention ponds to manage stormwater runoff and prevent erosion. These measures aim to enhance the site's natural beauty while supporting environmental sustainability by preserving crucial ecological areas and maintaining natural hydrological processes.

7.3.4 Reduce Size of the Development

One modification that must be considered is to reduce the size of the development by decreasing the number of housing units, thereby lowering housing density. This approach could provide several potential benefits, including increased green space, enhanced privacy for residents, and reduced environmental impact due to lower population density. However, it is important to note that this reduction would significantly compromise the affordability of individual lots and homes.

7.3.5 Locate Development in Another Location

Relocating the development to another area within Trelawny is not feasible as GDL does not own or have agreements to purchase land in any other location within the parish. Therefore, the proposed site remains the most viable option for the project.

8 Environmental Management Plan and Monitoring Programme

8.1 Introduction

This Environmental Management and Monitoring Plan (EMMP) provides the framework for management and mitigation of potential environmental and social impacts associated with the Construction and Operation of the Coral Spring Village II Housing Development in Coral Spring, Trelawny by Gore Developments Ltd. (GDL). The EMMP has been prepared in compliance with environmental permit conditions typically set out by the National Environment and Planning Agency, as well as international environmental and social best practices.

8.2 Project Overview

Gore Developments Limited (GDL) intends to develop additional lands in Coral Springs, Trelawny for housing. This parcel is adjacent to the existing Coral Springs Village, and west of the Ocean Coral Spring Hotel. The property is contained within VOL.1399 FOL.832, covers approximately 160 Acres (65 hectares) and will be developed into approximately 632 lots for single family homes and one large lot for approximately 60 townhouses. A lot at the southern end of the project will be utilized for sewage treatment. The total footprint of the development will be subdivided as follows illustrated in the table below.

Table 8-1: Coral Springs Village II Subdivision Breakdown

	m2	ha	acre
Overall property area:			
Lot 2 (parent title)	40,571.749	4.057	10.025
Lot 3 (parent title)	607,376.648	60.738	150.086
Lot 4 (parent title)	44,538.282	4.454	11.006
Total:	**692,486.679**	**69.249**	**171.117**
Residential Lot Area:			
Lots 1 - 640 (Single Family)	340,725.002	34.073	84.195
Lot A01 (Multi-Family)	67,301.659	6.730	16.631
Total:	**408,026.661**	**40.803**	**100.825**

Non Residential Lot Areas:			
OPEN SPACES	21,511.585	2.151	5.316
PARKS	32,293.338	3.229	7.980
NATURE RESERVE	50,554.20	5.055	12.492
UTILITIES	53,118.990	5.312	13.126
Total:	**157,478.112**	**15.748**	**38.914**
Roadways, Reservations and Easements:			
	126,981.91	**12.698**	**31.378**

The site is located approximately 7 km due east of the town of Falmouth and 7.5 km due west of Duncans, Trelawny. It is bordered by the Coral Spring-Mountain Spring Protected Area (CSMSPA). The proposed development site spans approximately 0.7 km^2 with a perimeter of about 3.22 kilometres, and encompasses distinct habitat zones, characterized by its vegetation types. To the north, disturbed limestone woodlands transition into coastal limestone forests to the south. These habitats gradually shift to more pristine forested areas at higher elevations in the northeast and southwest, where human disturbance diminishes (see Figure 8-1 below).

Figure 8-1: Subdivision Layout Plan

8.3 Objectives of the EMMP

An EMMP outlines the relevant measures that all contractors and subcontractors are expected to comply with during the construction and operation phases of the project. The overall objectives of this EMMP are to:

- Describe the measures required to implement construction and operation related management and mitigation measures in line with international environmental best practice and approval conditions stipulated by NEPA and other regulatory agencies (NWA, Trelawny Municipal Corporation, etc.)
- Identify the roles and responsibilities of the environmental management and monitoring organization(s) of the project; and
- Communicate environmental expectations and requirements throughout the project team.

8.4 Scope of the EMMP

The Construction and the Operational Phases of the Project are presented as separate sections, as each of the phases has its particular receptors and stressors. Responsibilities for development, implementation and monitoring are clearly defined.

The **Construction Phase** includes attention to the site operations and overall responsibility of GDL; and standards for other contractors under the responsibility of GDL. The aspects of the site operation that are governed by the environmental permit include but are not limited to sewage treatment and disposal, drainage, water supply, fauna and flora, open space/other uses, dust control, noise abatement, solid waste disposal, rainwater harvesting, archaeological and artifacts protection.

The EMMP for **Operations** addresses issues related to the post-construction phase. However, as GDL's involvement post-construction is limited, this aspect of the EMMP will focus on decommissioning and handover activities. It is typical that housing units will start to be occupied once completed, even though there is ongoing construction in other areas of the development. The EMMP will as a result also address operational issues related to sewage treatment and disposal during operation.

The potential impacts and associated mitigation measures and management procedures presented in this EMMP are based on the baseline information and assessments provided in the Environmental and Social Assessment Report for Housing Development- Coral Spring Village 2 (ESL, 2024), as well as on the general and specific conditions outlined in the following permits and licences, once granted:

Table 8-2: List of Required Permits and Licences

Permit Type	**Issuing Authority**
Construction of housing projects of 51 or more houses	National Environment and Planning Agency (NEPA)
Construction and operation of Batching and crushing plants (mobile and fixed)	National Environment and Planning Agency (NEPA)
Construction and operation of facilities for hydrocarbon production, refining, storage, and stockpiling	National Environment and Planning Agency (NEPA)
Construct a Wastewater Treatment Plant	National Environment and Planning Agency (NEPA)
Operate a Wastewater Treatment Plant	National Environment and Planning Agency (NEPA)
Licence to discharge sewage effluent	National Environment and Planning Agency (NEPA)
Subdivision Approval	Trelawny Municipal Corporation

8.5 Summary Impacts and Mitigation Measures

Key potential impacts and the recommended mitigation measures are summarized by parameters of risk. Environmental Monitoring is critical for the implementation of this project, and the principle of continuous improvement through monitoring and corrective actions will be followed.

Table 8-3: Summary Impacts and Mitigation measures for the Pre-Construction, Construction and Operation Phases

RISKS	POTENTIAL IMPACTS	PROPOSED MITIGATION MEASURES	RESPONSIBLE PARTY
PRE-CONSTRUCTION PHASE			
Clearing of vegetation	Loss of habitat and potential food for wildlife Fragmentation of the coastal limestone forest in this part of Jamaica's north coast	Retain areas of the site as Forest reserves. Proposed areas include sections of the property with large trees greater than 30cm DBH. Limit clear cutting only to essential areas. Limit the duration of the disturbance as best as possible. Limit the creation of roads or paths near the CSMSPA No burning of vegetation or other solid waste. All waste should be disposed of in an approved location	GDL and subcontractors
CONSTRUCTION PHASE			
Increased Erosion	Increased erosion of exposed soils by wind and surface run-off Increased sedimentation in groundwater as well as surface water sources	Utilise vegetative buffers where possible to reduce erosion. A phased approach to vegetation clearance should be undertaken during construction to limit the exposure of soils. Proper disposal of cleared vegetation to include mulching The use of sediment traps where necessary to reduce sediment run off. Proper storage of construction material e.g. cover stockpiles, locate stockpiles away from natural drainage paths.	GDL
Changes in hydrologic regime	Filling of cavities resulting in flooding	Voids within the footprint of the development that are over 2 meters will be individually evaluated and an on-site decision taken for no buildings or infrastructure to be erected in that location.	GDL

RISKS	POTENTIAL IMPACTS	PROPOSED MITIGATION MEASURES	RESPONSIBLE PARTY
		Ensure areas with cavities are properly engineered and constructed as per drainage plan Ensure that the existing natural drainage is not impeded in any way	
Construction activities resulting in poor air quality (AQ)	Poor air quality impacting workers and residents of nearby communities Airborne dust can smother vegetation	Fugitive dust can be reduced by phasing clearing activities, frequent wetting where this is unavoidable, as well as covering stock-piled material Wetting of exposed surfaces during dry periods should be implemented as part of the site activities during construction. Covering of stockpiled material. PM_{10} should be monitored in $\mu g/m^3$ using the WHO's and NEPA's ambient air quality guidelines during the construction period. Ensure equipment and vehicles are well maintained to reduce emissions	GDL
Noise nuisance from construction activities	Nuisance and potential hearing damage to nearby residents and workers. Other health risks triggered from sustained high noise levels.	Monitor noise during construction to ensure that decibel levels are restricted to 70dBA or below of sustained noise which is detrimental to human hearing. Advise neighbouring properties at least 24 hours in advance of planned noisy activities. Limit the hours of noisy activities between 7am and 6pm Ensure equipment and vehicles are well maintained	GDL and subcontractors
Worker safety	Accidents and adverse health effects on workers may occur on construction sites	Construction crews should be provided with the appropriate safety gears such as hard hats, gloves, safety shoes, reflector vests where appropriate, etc. Wearing of the appropriate protective gear on site should be stipulated and mandatory.	GDL and subcontractors

RISKS	POTENTIAL IMPACTS	PROPOSED MITIGATION MEASURES	RESPONSIBLE PARTY
		Sanitary practices in regard to providing potable water and the disposal of human waste should be enforced to safeguard worker health. Appropriate signage on site to prevent persons being put at risk. A Logbook should be kept to record any health and safety incidents A plan should be in place and known by all in case of an injury or an emergency. A first aid kit should be readily available. Training or sensitization to necessary health and safety requirements should be done for all workers.	
Traffic congestions and increases in traffic such as heavy-duty trucks with material – sand and gravel etc. and equipment	Changes in traffic type and volume are expected to negatively affect traffic flow when heavy vehicles are entering and leaving the construction site to deliver materials and equipment. Potential dust nuisance arising from transporting material (AQ mitigation measures already outlined above) Damage to roads and associated infrastructure from heavy vehicles Potential for Personnel accidents and other human vulnerabilities arising from heavy duty vehicles on roads	Appropriate temporary road signs, including: slow signals, caution signals about construction Flag persons to guide trucks on and offsite Police presence at intervals Public awareness of construction activities – can be achieved through notices and signage Ensure trucks do not travel overloaded and are covered Ensure truck drivers obey road codes and are qualified Ensure trucks are appropriately marked and serviced Trucking material on site during off-peak periods as much as possible	GDL and subcontractors
Water Quality impacts	Pollution of groundwater and nearby marine environment from leaching of construction spoils and unsafe chemical usage	Inspect (daily) all vehicles and equipment for potential leakage of fuel, oil, hydraulic fluid or coolant. Any machinery found to be leaking will be repaired or replaced immediately.	GDL and subcontractors

RISKS	POTENTIAL IMPACTS	PROPOSED MITIGATION MEASURES	RESPONSIBLE PARTY
		Proper storage of hazardous materials. These should be locked away when not in use as instructed by material safety data sheet (MSDS). Provide appropriate signage and security for all storage of dangerous goods. Provide Material Safety Datasheets (MSDS) for dangerous goods used or stored on-site. Personnel should be made aware of the environmental and safety requirements for these hazardous materials. Monitoring of effluent and discharge points during construction Hazardous materials such as fuels and oils should not be stored near storm water drains.	
Solid waste disposal	Poor solid waste management can result in blocked drains and flooding during rainy periods. Improper disposal of solid waste resulting in infestation of rodents and other vectors	Construction waste material, and other domestic waste that would be generated on site are to be appropriately disposed of in approved locations. Refuse bins should be placed on site to meet the needs of the workforce Arrange for the collection of solid waste by certified contractors and disposal at an approved site Any hazardous waste should be separated and stored in areas clearly designated and labelled Open burning of solid wastes should not be conducted as these generate polluting emissions which cannot be controlled effectively. Garbage storage areas should always be kept clean. If a bin is damaged, the contents will be transferred to another container in good condition. The waste container should be of waterproof material to prevent the escape of fluids.	GDL

RISKS	POTENTIAL IMPACTS	PROPOSED MITIGATION MEASURES	RESPONSIBLE PARTY
		The stored waste should be covered to prevent rainwater from flooding the waste and overflow and to prevent pest infestation Proper disposal of cleared vegetation and other waste material in an approved dumpsite Ensuring proper waste storage onsite in covered containers	
Sewage treatment	Improper sanitary facilities pose a health risk. Disposal of improperly treated or untreated sewage resulting in contamination of water with pathogenic organisms and spread of water borne disease odours causing a nuisance to neighbouring properties Eutrophication of receiving water bodies resulting in damage to aquatic ecology	Portable chemical toilets must be provided, maintained and removed by a certified contractor to mitigate inappropriate disposal. Portable toilets must be sited away from natural drainage paths or surface water sources to avoid contamination	GDL
OPERATION PHASE			
Poor water quality	• Quality of receiving waters negatively impacted by poorly treated sewage effluent	• Proper infrastructure and facilities would be required to handle waste generation including sewage generated during operations. Should meet the requirements of NEPA and NWC.	GDL
Soil Contamination	• Leached oils, fuels and accidental spills from fuel storage and dispensing facilities	• Frequent monitoring and inspections for fuel leaks • Tank integrity tests • Soil remediation if necessary	GDL

8.6 Construction Phase – Management and Monitoring Procedures

The Construction Phase primarily involves operations related to land clearing and civil works. The proposed mitigation measures pay particular attention to pollution prevention, resource efficiency and environmental health and safety guidelines. The potential impacts identified for the construction phase relate to:

- Air quality (dust control) and noise
- Changes in drainage
- Alteration to the current habitat zones (site clearance)
- Worker health and safety
- Solid waste and hazardous disposal
- Sewage Treatment and disposal
- Traffic Management
- Archaeological and artifacts protection

The NEPA Environmental Permit typically indicates that the EMMP should also include energy and water conservation measures. Emphasis should be placed on substantially incorporating environmentally sustainable design practices such as energy conservation, the use of renewable energy, water reuse, rainwater harvesting & recycling, the collection and use of rainwater for irrigating the landscaped areas, the use of low impact materials, lighting and landscaping and the use of construction materials and techniques to eliminate or reduce urban heat island (for e.g. the use of vegetative roofs, use of grass-crete, etc.).

8.7 Monitoring Framework

The following sub-sections are discussed below:

- Monitoring Standards
- Monitoring Equipment and Stations
- Monitoring Frequency
- Management and Mitigation measures
- Key Performance Indicators
- Roles and Responsibilities
- Data analysis and Reporting

8.7.1 Monitoring Standards

8.7.1.1 Air Quality

Table 8-4: Air quality monitoring standards and timing

Description		Standard		
		Average Timing	NRCA (NEPA) (Max Concentration in μgm^{-3})	Average Timing
Particulate Matter	PM_{10}	Annual 24 hours	50 150	1-year 24-hour

8.7.1.2 Noise

Table 8-5: Noise Standard

Description	Standard	
	Average Timing	NRCA (NEPA)
Noise	7:00am-6:00pm Mondays to Fridays	70dBa at the boundary of the site
	8:00am-6:00pm on Saturdays	

8.7.1.3 Water Quality

Table 8-6: Final Sewage Effluent Standard

Parameter	NRCA Standards
Biochemical Oxygen Demand (BOD)	20mg/L
Chemical Oxygen Demand (COD)	100 mg/L
Total Suspended Solids (TSS)	20 mg/L
Total Nitrogen	10 mg/L
Phosphates(PO_4-P)	4 mg/L
Faecal Coliform	200MPN/100mL.
Residual Chlorine	1.5mg/L
pH	6-9

8.7.2 Monitoring Equipment and Stations

Parameter	Equipment	Station
Air quality	Samples for particulate matter will be collected using calibrated pumps. The pumps will be placed at the approximate respiratory height of the individual(s) for a 24-hour period. The data obtained from the analyses of the filter will be expressed as the exposure levels of particulate matter (PM10) using a Time Weighted Average (TWA). The results at the end of the sampling period will be compared to the NEPA standards.	These monitoring stations will be established based on the prevailing winds and most sensitive human receptors. As construction progresses, changes may be made to monitoring locations.
Noise	A calibrated sound level meter will be used to measure noise. The model of the equipment will be clearly stated, and the meter will be calibrated before each survey.	Same as above. Monitors will be located approximately 1.5m above the ground and no closer than 3m to any reflecting surface (e.g. wall).
Water Quality	Combination of grab sampling and in-situ measurements using a YSI ProPlus Model Multi-parameter system (MPS) or similar multi-meter. All sample containers will be properly labelled, individually packaged, stored and transported in a cooler maintained at the appropriate temperature. All samples will be kept between 0 – 4°C and transported to an accredited Laboratory for analysis bearing in mind the analysis hold time for each test parameter.	Effluent discharge point

8.7.3 Monitoring Frequency

Table 8-7: Proposed Monitoring Frequency

Parameter	Monitoring Frequency
Air quality	Once per month during construction. Monitoring frequencies are proposed and will be finalized by NEPA
Noise	Once per month during construction. Monitoring frequencies are proposed and will be finalized by NEPA
Water Quality (sewage effluent)	At least twice per month upon commissioning and to continue monthly or quarterly during the operational phase. Monitoring frequencies are proposed and will be finalized by NEPA
Flora and Fauna Assessment	• Tree flagging activities prior to phased vegetation clearing

Parameter	Monitoring Frequency
	• Assessment during day-to-day activities for any endemic, endangered, rare, threatened or ecologically valuable species • Monitoring of plant nursery daily/weekly (depending on species maintenance needs) • Once per month monitoring activities of construction site
Worker health and safety	• Daily by site manager • Once per month monitoring activities of construction site
Solid waste disposal	• Daily by site manager • Once per month monitoring activities of construction site
Traffic Management	• Daily by site manager • Once per month monitoring activities of construction site
Archaeological and artifacts protection	• Assessment during day-to-day activities for any discovered artifacts • Once per month monitoring activities of construction site
Energy Conservation	Once per month
Water Conservation	Once per month

**Note: Monitoring frequencies are proposed and will be finalized by NEPA.

8.7.4 Management and Mitigation measures

The key management and mitigation measures are outlined above in Section 8.5 above.

8.7.5 Key Performance Indicators

The following key performance indicators (KPIs) have been selected in order to evaluate the effectiveness of the environmental management and monitoring plan:

Table 8-8: Key Performance Indicators

No.	Key Performance Indicators	Monitoring and Measuring Methods
	Air Quality Management	
1	Equipment maintenance log and schedule	Review and inspection of documentation
2	Notices to stakeholders	Review and inspection of documentation
3	Air quality parameters within NEPA standards	Results certificates
4	Log of wetting frequency	Review and inspection of documentation
5	Use of personal protective equipment	Review and inspection of documentation
	Noise Management	
7	Noise parameters within NEPA standards	Results certificates
8	Log of complaints	Review and inspection of documentation

No.	Key Performance Indicators	Monitoring and Measuring Methods
	Water Quality Management	
9	Sediment traps	Site Inspection
10	Logs indicating when work was halted	Review and inspection of documentation
11	Water Quality Results from a certified lab.	Review and inspection of documentation-certificate results
	Health and Safety Management	
12	Health and Safety Policy	Review and inspection of documentation
13	Health and Safety Signs	Inspection of the site
14	Training log and schedule	Review and inspection of documentation
	Emergency Response Management	
15	Register of all EHS related incidents	Review and inspection of documentation
16	Equipment maintenance log and schedule	Review and inspection of documentation
17	Emergency Kit	Inspection of site office
	Flora and Fauna Management	
18	No major losses of priority flora and fauna species	Review and inspection of documentation
19	Signage (related to sighting of key species)	Inspection of the site
20	Number of Training and Awareness sessions on key species	Review and inspection of documentation
	Waste Management	
21	No construction waste deposited in the active roadway, drains or in the rivers	Location of a temporary storage site away from road, rivers and drains for construction waste
22	No leakages or spills	Monitor possible spills Inspection of the site by the Contractor (in Construction) and PEU (in Operation)
23	Limited sediment laden runoff during heavy rain	Monitor runoff of the construction period during rainfall events. Monitor areas immediately downstream for significant sediment deposits after rainfall event.
24	Reuse of construction waste where possible	Less construction waste being delivered to the dump
25	Approved Contractors	Inspection of licences and documentation
26	No burning of waste/ proper disposal of waste in approved locations.	Inspection and documentation
	Resource Management	
27	Number of energy conservation efforts implemented	Inspection and documentation
28	Number of water conservation methods employed	Inspection and documentation

8.7.6 Roles and Responsibilities

It is the responsibility of GDL to ensure that all mitigation measures are carried out and that monitoring reports are prepared. GDL should ensure that an appropriate Manager is employed to oversee the specific requirements of this plan. GDL is responsible for monitoring all subcontractors to ensure that the mitigation measures are being enforced.

8.7.7 Data Analysis and Reporting

During construction, monthly reports will be produced. The sampled data will be compared to the relevant monitoring standards outlined in Section 8.7.1 and will be included in the environmental monitoring report prepared and submitted to NEPA. NEPA typically requests that quarterly monitoring reports be submitted during the construction phase.

If there are any non-conformities, these will be reported immediately to the Manager to allow for the implementation of corrective measures or adjustment in management strategies based on the results, and where practicable to the operations.

The Monitoring Report should include the following headings:

- Introduction (Purpose)
- Project Background
- Approach/ Methods
- Results
- Discussion (Trend analysis)
- Monitoring Summary

8.8 Operation Phase - Management and Monitoring Procedures

During the operational phase of the development, the areas of concern relate to the decommissioning and handover activities as well as sewage treatment and disposal during operation (which may also still fall within the construction phase as described above).

Requirements of the various necessary permits and licences for this phase typically include:

1. **Closure Plans-** the Project should develop a plan for the decommissioning of the Batching plant and diesel storage facilities.

   The plans should include details on how the Project will manage the responsibilities, final destination of the equipment, waste and scraps management, etc. during the decommissioning phase. This includes the remediation of the site should any contamination be identified upon closure.

2. **Water Quality Management**- The Monitoring Standards, Monitoring Equipment and Stations, Monitoring Frequency, and Management and Mitigation measures related to Sewage Treatment and Disposal (Water Quality) have been addressed during the Construction Phase above, but these activities need to continue into the operational phase of the development. The supporting Key Performance Indicators for water quality, Roles and Responsibilities and Data analysis and Reporting requirements have also been described above.

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10Appendices

10.1 Appendix 8.1 – The EIA Professional Team

Team	Role
Eleanor Jones	Team Lead
Dr. Dexter-Dean Colquhoun	Project Manager and Marine Ecologist
Annmarie Goulbourne	Environmental Management Specialist
Keron Campbell	Terrestrial Ecologist
Dr. Camilo Trench	Wetland Ecology Specialist
Brandon Hay	Terrestrial Ecologist
Rashidah Khan-Haqq	Environmental Chemist
Jaidene Webster-Jones	Senior Chemical Analyst
Herona Thompson	Engineering Geologist
Dr. Arpita Mandal	Geologist and Hydrologist
Melissa Johnson	Social Specialist
Pietra Brown	Stakeholder Engagement Specialist

10.2 Appendix 8.2 - Photos of Foral Species at Coral Springs

PLATE 6-13

From top left down – *Melochia tomentosa*, *Phytolacca icosandra*, *Solanum erianthum*, *Bromelia pinguin*

From top right down – *Heliotropium angiospermum*, *Solanum havanense*,*Thespesia populnea*, *Tecoma stans*

PLATE 14-21

Images showing areas cleared throughout the proposed development site.

10.3 Appendix 8.3 – Plant Species Checklist for Coral Springs

CORAL SPRING PLANT SPECIES CHECKLIST

	Family	Species	Common Name	Habit Type	Distribution Status	IUCN Status	DAFOR Rating
1	Acanthaceae	Avicennia germinans (L.) L.	Black mangrove	Tree	Native	Least concern	F
2	Amaranthaceae	Achyranthes aspera L. var. aspera	Devil's horsewhip	Herb	Exotic	Not listed	R
3		Amaranthus viridis L.	Wild calalu	Herb	Native	Not listed	R
4	Anacardiaceae	Comocladia sp.	Maiden plum	Tree	Native	Unknown	O
5		Comocladia pinnatifolia L.	Maiden plum	Tree	Native	Not listed	O
6		Metopium brownei (Jacq.) Urb.	Hog octor	Tree	Native	Least concern	F
7	Apocynaceae	Echites umbellatus Jacq.	Rubber vine	Vine	Native	Not listed	O
8		Nerium oleander L.	Oleander	Shrub	Exotic	Least concern	R
9		Plumeria obtusa L.	Wild frangipani	Tree	Native	Least concern	O
10		Tabernaemontana laurifolia L.	Wild jasmine	Shrub	Native	Near threatened	O
11	Araceae	Philodendron lacerum (Jacq.) Schott	Wicker	Herb	Native	Not listed	R
12	Arecaceae	Cocos nucifera L.	Coconut	Tree	Exotic	Not listed	R
13		Thrinax parviflora Sw. subsp. parviflora **	Thatch pole	Tree	Endemic	Not listed	A
14	Asparagaceae	Agave morrisii Baker	Agave, Maypole	Herb	Native	Not listed	A
15	Asteraceae	Acmella uliginosa (Sw.) Cass.	Not Listed	Herb	Native	Least concern	R
16		Parthenium hysterophorus L.	Wild wormwood	Herb	Native	Not listed	R
17		Tridax procumbens L.	Tridax daisy	Herb	Native	Not listed	O
18	Bataceae	Batis maritima L.	Jamaican samphire	Herb	Native	Not listed	A
19	Bignoniaceae	Tabebuia heterophylla (DC.) Britton	White cedar	Tree	Native	Least concern	A
20		Tecoma stans (L.) Kunth	Yellow elder	Shrub	Native	Least concern	R
21	Boraginaceae	Cordia gerescanthus	Spanish Elm	Tree	Native	Least concern	O
22		Bourreria succulenta Jacq.	Not listed	Tree	Native	Least concern	O
23		Heliotropium angiospermum Murray	Dog's tail	Herb	Native	Not listed	O
24		Heliotropium astrotricha (A. DC.) Govaerts	Not listed	Shrub	Native	Not listed	R
25	Bromeliaceae	Bromelia pinguin L.	Pinguin	Herb	Native	Not listed	O

	Family	Species	Common Name	Habit Type	Distribution Status	IUCN Status	DAFOR Rating
26		Tillandsia compressa Bertero ex Schult. & Schult. f.	Wild pine	Herb	Native	Not listed	F
27		Wittmackia penduliflora (A. Rich.) Aguirre-Santoro	Tank bromeliad	Herb	Native	Not listed	R
28		Wittmackia polycephala (Baker) Aguirre-Santoro	Tank bromeliad	Herb	Endemic	Not listed	A
29	Burseraceae	Bursera simaruba (L.) Sarg.	Red Birch	Tree	Native	Least concern	F
30	Cactaceae	Selenicereus grandiflorus (L.) Britton & Rose	Queen-of-the-night	Vine	Native	Least concern	F
31		Selenicereus triangularis (L.) D.R. Hunt *	God okra	Vine	Native	Least concern	F
32		Stenocereus heptagonus (L.) Mottram	Dildo pear	Tree	Native	Not listed	O
33	Cannabaceae	Celtis trinervia Lam.	Bastard fustic	Tree	Native	Data deficient	R
34	Capparaceae	Cynophalla flexuosa (L.) L.J. Presl	Bottle-cod root	Shrub	Native	Least concern	O
35		Quadrella cynophallophora (L.) Hutch.	Black willow	Tree	Native	Least concern	F
36	Celastraceae	Colubrina asiatica (L.) Brongn.	Hoop with	Shrub	Exotic	Least concern	O
37		Crossopetalum rhacoma Crantz	Poison cherry	Shrub	Native	Least concern	O
38		Schaefferia frutescens Jacq.	Not listed	Shrub	Native	Least concern	O
39	Clusiaceae	Clusia rosea	Autograph tree	Tree	Native	Least concern	F
40	Combretaceae	Conocarpus erectus L.	Button mangrove	Tree	Native	Least concern	A
41		Laguncularia racemosa (L.) C.F. Gaertn.	White mangrove	Tree	Native	Least concern	A
42		Terminalia catappa L.	Almond	Tree	Exotic	Least concern	R
43	Commelinaceae	Commelia erecta L.	Water grass	Herb	Native	Least concern	A
44		Tradescantia spathacea Sw.	Moses-in-the-bulrushes	Herb	Exotic	Not listed	F
45	Convolvulaceae	Camonea umbellata (L.) A.R. Simoes & Staples	Hog vine	Vine	Native	Not listed	O
46		Distimake dissectus (Jacq.) A. R. Simoes & Staples	Know you	Vine	Native	Not listed	O
47		Ipomoea pes-caprae (L.) R.BR.	Beach morning glory	Vine	Native	Least concern	A
48		Ipomoea tiliacea (Willd.) Choisy	Wild slip	Vine	Native	Least concern	F
49	Cucurbitaceae	Cucumis anguria L.	Wild cucumber	Vine	Exotic	Not listed	R
50	Cyperaceae	Cyperus sp.	Sedge	Herb	Unsure	Unknown	O
51	Euphorbiaceae	Acalypha alopecuroidea Jacq.	Not listed	Herb	Native	Least concern	R
52		Acalypha scabrosa Sw.	Not Listed	Herb	Endemic	Not listed	R

	Family	Species	Common Name	Habit Type	Distribution Status	IUCN Status	DAFOR Rating
53		Adelia ricinella L.	Wild lime	Shrub	Native	Least concern	O
54		Croton nitens Sw.	Not listed	Tree	Native	Least concern	A
55		Euphorbia lasiocarpa Klotzsch	Not Listed	Herb	Native	Not listed	O
56		Ricinus communis L.	Castor oil tree	Shrub	Exotic	Not listed	F
57	Fabaceae	Abrus precatorius L.	John crow bead	Vine	Exotic	Not listed	R
58		Bauhinia divaricata L. var. divaricata	Bull Hoof	Tree	Native	Least concern	O
59		Cajanus cajan (L.) Huth	Gungo peas	Shrub	Exotic	Not listed	R
60		Clitoria ternatea L.	Blue pea	Vine	Exotic	Not listed	O
61		Desmodium incanum	Sweetheart	Herb	Native	Not listed	O
62		Haematoxylum campechianum L.	Logwood	Tree	Exotic	Least concern	R
63		Leucaena leucocephala (Lam.) De Wit subsp. leucocephala	Lead tree	Tree	Exotic	Not listed	O
64		Macroptilium lathyroides (L.) Urb.	Not listed	Herb	Native	Not listed	R
65		Piscidia piscipula (L.) Sarg.	Dogwood	Tree	Native	Least concern	O
66	Goodeniaceae	Scaevola taccada (Gaertn.) Roxb.	Beach cabbage	Shrub	Exotic	Not listed	R
67	Lauraceae	Nectandra sp.	Sweetwood	Tree	Native	Unknown	O
68	Malpighiaceae	Malpighia glabra L.	Wild cherry	Shrub	Native	Least concern	R
69		Stigmaphyllon emarginatum (Cav.) A. Juss.	Not listed	Shrub	Native	Not listed	F
70	Malvaceae	Abutilon permolle (Willd.) Sweet	Velvety abutilon	Shrub	Native	Not listed	O
71		Gossypium barbadense L.	Sea island cotton	Shrub	Exotic	Least concern	R
72		Guazuma ulmifolia Lam.	Bastard cedar	Tree	Native	Least concern	O
73		Hibiscus poeppigii (Spreng.) Garcke	Fairy hibiscus	Shrub	Native	Not listed	O
74		Melochia tomentosa L.	Raichie, Tea bush	Shrub	Native	Not listed	F
75		Sida acuta Burm.f.	Broomweed	Herb	Native	Not listed	O
76		Thespesia populnea (L.) Sol. ex Correa	Seaside mahoe	Tree	Exotic	Least concern	A
77		Waltheria indica L.	Raichie	Herb	Native	Least concern	F
78	Moraceae	Brosimum alicastrum Sw.	Breadnut	Tree	Native	Least concern	O
79		Ficus citrifolia Mill.	Fig	Tree	Native	Least concern	O

	Family	Species	Common Name	Habit Type	Distribution Status	IUCN Status	DAFOR Rating
80	Myrtaceae	Calyptranthes sp.		Tree	Native	Unknown	O
81		Eugenia sp.	Rodwood	Tree	Native	Unknown	O
82	Nyctaginaceae	Bougainvillea glabra Choisy	Bougainvillea	Shrub	Exotic	Least concern	R
83		Pisonia aculeata L.	Cockspur	Tree	Native	Least concern	O
84	Orchidaceae	Brassavola subulifoliaLindl.**	Orchid	Herb	Endemic	Not listed	R
85		Broughtonia sanguinea (Sw.) R. Br.**	Blood Red Broughtonia	Herb	Endemic	Not listed	F
86		Oeceoclades maculata (Lindl.) Lindl.	Monk orchid	Herb	Exotic	Least concern	F
87	Petiveriaceae	Rivina humilis L.	Bloodberry	Herb	Native	Not listed	O
88	Phyllanthaceae	Phyllanthus angustifolius (Sw.) Sw.	Seaside laurel	Shrub	Native	Not listed	A
89	Phytolaccaceae	Phytolacca icosandra L.	Not listed	Herb	Native	Not listed	F
90	Poaceae	Cynodon dactylon (L.) Pers	Bermuda grass	Herb	Exotic	Not listed	O
91		Eleusine indica (L.) Gaertn.	Yard grass	Herb	Exotic	Least concern	F
92		Pennisetum sp.	Fountain grass	Herb	Exotic	Unknown	R
93		Sporobolus virginicus (L.) Kunth	Not listed	Herb	Native	Least concern	F
94	Polygonaceae	Coccoloba tenuifolia L.	Mountain grape	Tree	Native	Not listed	F
95		Coccoloba uvifera (L.) L.	Sea grape	Tree	Native	Least concern	O
96	Rhamnaceae	Krugiodendron ferreum (Vahl) Urb.	Black ironwood	Tree	Native	Least concern	O
97	Rhizophoraceae	Rhiziphora mangle L.	Red mangrove	Tree	Native	Least concern	A
98	Rubiaceae	Guettarda elliptica Sw.	Velvet seed	Shrub	Native	Least concern	R
99		Morinda royoc L.	Red gal	Shrub	Native	Least concern	O
100		Portlandia grandiflora L.**	Bell flower	Tree	Endemic	Near threatened	O
101	Sapindaceae	Melicoccus bijugatus Jacq.	Genip	Tree	Exotic	Least concern	O
102	Scruphulariaceae	Capraria biflora L.	Goatweed	Herb	Native	Not listed	R
103	Smilacaceae	Smilax domingensis Willd.	Chainy root	Vine	Native	Not listed	O
104	Solanaceae	Solanum bahamense L.	Canker berry	Herb	Native	Least concern	A
105		Solanum erianthum D. Don	Wild susumber	Shrub	Native	Least concern	F
106		Solanum havanense Jacq.	Not listed	Shrub	Native	Not listed	O

	Family	Species	Common Name	Habit Type	Distribution Status	IUCN Status	DAFOR Rating
107	Verbenaceae	Lantana camara L.	Wild sage	Shrub	Native	Not listed	R
108	Zygophyllaceae	Guaiacum officinale L.	Lignum vitae	Tree	Native	Endangered	R

10.4 Appendix 8.4 – Bird Species List and Butterfly Species List

Bird Data Overview

	Family	Common Name	Scientific Name	Status	DAFOR
1	**Pelecanidae**	Brown Pelican	*Pelecanus occidentalis*	**R**	**R**
1	**Fregtidae**	Magnificent Frigatebird	*Fregata magnificens*	**R**	**R**
1	**Ardeidae**	Cattle Egret	*Bulbicus ibis*	**I**	**O**
1	**Ardeidae**	Great Egret	*Ardea alba*	**R**	**R**
1	**Ardeidae**	Black-crowned Night Heron	*Nycticorax violacea*	**R**	**R**
1	**Ardeidae**	Yellow-crowned Night Heron	*Nycticorax nycticorax*	**R**	**O**
1	**Ardeidae**	Little Blue Heron	*Egrette caerulea*	**R**	**R**
1	**Ardeidae**	Snowy Egret	*Egretta thula*	**R**	**R**
1	**Anatidae**	West Indian Whistling Duck	*Dendrocygna arborea*	**R**	**R**
1	**Anatidae**	Blue-winged Teal	*Anas discors*	**W**	**O**
1	**Cathartidae**	Turkey Vulture	*Cathartes aura*	**R**	**O**
1	**Pandionidae**	Osprey	*Pandion halieatus*	**M**	**R**
1	**Accipitridae**	Red-tailed Hawk	*Buteo Jamaicensis*	**R**	**R**
1	**Falconidae**	American Kestrel	*Falco sparverius*	**R**	**R**
1	**Falconidae**	Merlin	*Falco columbarius*	**R**	**R**
1	**Rallidae**	Clapper Rail	*Rallus longirostris*	**R**	**R**
1	**Charadriidae**	Black-bellied Plover	*Pluvialis squatarola*	**W**	**R**
1	**Charadriidae**	Killdeer	*Charadrius vociferus*	**R**	**R**
1	**Recurvirostridae**	Black-necked Stilt	*Himantopus mexicanus*	**R**	**O**
1	**Scolopacidae**	Greater Yellowlegs	*Tringa melanoleuca*	**R**	**R**
1	**Scolopacidae**	Lesser Yellowlegs	*Tringa flavipes*	**R**	**R**
1	**Scolopacidae**	Willet	*Catoptrophorus semipalmatus*	**R**	**R**
1	**Scolopacidae**	Spotted Sandpiper	*Actitis macularia*	**W**	**R**
1	**Scolopacidae**	Ruddy Turnstone	*Arenaria interpes*	**W**	**O**
1	**Laridae**	Laughing Gull	*Larus atricilla*	**R**	**R**
1	**Laridae**	Royal Tern	*Sterna maxima*	**R**	**R**

	Family	Common Name	Scientific Name	Status	DAFOR
1	**Columbidae**	White-crowned Pigeon	*Patagioenas leucocephala*	**R**	**O**
1	**Columbidae**	Zenaida Dove	*Zenaida aurita*	**R**	**O**
1	**Columbidae**	White-winged Dove	*Zenaida asiatica*	**R**	**O**
1	**Columbidae**	Caribbean Dove	*Leptotila jamaicensis*	**R**	**F**
1	**Columbidae**	Common Ground-Dove	*Columbina passerina jamaicensis*	**R**	**F**
1	**Psittacidae**	Jamaican Parakeet	*Aratinga nana*	**E**	**F**
1	**Psittacidae**	Green-rumped Parrotlet	*Forpus paserinus*	**I**	**F**
1	**Tytonidae**	Barn Owl	*Tyto alba*	**R**	**R**
1	**Strigidae**	Jamaican Owl	*Pseudoscops grammicus*	**E**	**O**
1	**Cuculidae**	Smooth-billed Ani	*Crotophaga ani*	**R**	**R**
1	**Cuculidae**	Jamaican Lizard Cuckoo	*Saurothera vetulatus*	**E**	**R**
1	**Caprimulgidae**	Antillean Nighthawk	*Chordeiles gundlachii*	**S**	**R**
1	**Nyctibiidae**	Northern Potoo	*Nyctibius jamaicensis*	**ES**	**R**
1	**Apodidae**	White-collared Swift	*Streptoprocne zonaris*	**W**	**O**
1	**Apodidae**	Antillean Palm Swift	*Tachornis phoenicobia*	**R**	**O**
1	**Trochilidae**	Red-billed Streamertail	*Trocholus polytmus*	**E**	**O**
1	**Trochilidae**	Jamaican Mango	*Anthracothorax mango*	**E**	**R**
1	**Trochilidae**	Vervain hummingbird	*Mellisuga minima*	**ES**	**R**
1	**Todidae**	Jamaican Tody	*Todus todus*	**E**	**R**
1	**Alcenidae**	Belted Kingfisher	*Ceryle alcyon*	**W**	**R**
1	**Picidae**	Jamaican Woodpecker	*Melanerpes radiolatus*	**E**	**A**
1	**Tyrannidae**	Gray Kingbird	*Tyrannus dominicensis*	**S**	**R**
1	**Tyrannidae**	Stolid Flycatcher	*Myiarchus stolidus*	**ES**	**O**
1	**Tyrannidae**	Rufous-tailed Flycatcher	*Myiarchus validus*	**E**	**R**
1	**Tyrannidae**	Sad Flycatcher	*Myarchus barbirostris*	**E**	**R**
1	**Tyrannidae**	Loggerhead Kingbird	*Tyrannus caudifasciatus jamaicensis*	**ES**	**A**
1	**Hirundinidae**	Cave Swallow	*Pterochelidon fulva*	**R**	**O**
1	**Hirundinidae**	Barn Swallow	*Hirundo rustica*	**W**	**R**
1	**Muscicapids**	White Chinned Thrush	*Turdus aurantius*	**E**	**R**
1	**Mimidae**	Northern Mockingbird	*Mimus polyglottos*	**R**	**A**
1	**Vireonidae**	Jamaican Vireo	*Vireo modestus*	**E**	**F**
1	**Vireonidae**	Black-whiskered Vireo	*Vireo altiloquus*	**S**	**A**
1	**Spindalidae**	Jamaican Spindalis	*Spindalis nigricephalus*	**E**	**R**
1	**Icteridae**	Greater Antillean Grackle	*Quiscalus niger*	**R**	**R**
1	**Icteridae**	Jamaican Oriole	*Icterus leucopteryx leucopteryx*	**ES**	**O**
1	**Emberizidae**	Yellow Warbler	*Dendroica petechia*	**R**	**R**
1	**Emberizidae**	Northern Parula	*Parula americana*	**W**	**R**
1	**Emberizidae**	Black and White Warbler	*Mniotilta varia*	**W**	**R**
1	**Emberizidae**	American Redstart	*Setophaga ruticilla*	**W**	**R**
1	**Emberizidae**	Ovenbird	*Seiurus aurocapillus*	**W**	**R**

	Family	Common Name	Scientific Name	Status	DAFOR
1	**Emberizidae**	Northern Waterthrush	*Parkesia noveboracensis*	**W**	**R**
1	**Emberizidae**	Palm Warbler	*Dendroica palmarum*	**W**	**R**
1	**Thraupidae**	Orangequit	*Euneornis campestris*	**E**	**R**
1	**Thraupidae**	Greater Antillean Bullfinch	*Loxigilla violacea*	**R**	**R**
1	**Thraupidae**	Black-faced Grassquit	*Tiaris bicolor*	**R**	**R**
1	**Thraupidae**	Yellow-faced Grassquit	*Tiaris olivacea*	**R**	**R**
1	**Thraupidae**	Yellow-shouldered Grassquit	*Loxipasser anoxanthus*	**E**	**R**
1	**Thraupidae**	Bananaquit	*Coereba flaveola faveola*	**R**	**O**
1	**Fringillidae**	Jamaican Euphonia	*Euphonia jamaica*	**E**	**R**
75					

	Assignments	
D	**Dominant**	Present at 8 or more points or more than 50 individuals
A	**Abundant**	Present at 6 to 7 points or between 20 and 49 indivuduals
F	**Frequent**	Present at 4 to 5 points
O	**Occasional**	Present at 2 to 3 points
R	**Rare**	Present at one point (or not detected during Counts)

Butterfly Data Overview

No.	Family Name	Common Name	Scientific Name	Status	DAFOR
1	Hesperiidae	Fiery Skipper	*Hylephila phyleus phyleus*	*Native*	O
1	Hesperiidae	Checkered Skipper	*Pyrgus oileus*	*Native*	O
1	Lycaenidae	Miss Perkins Blue	*Leptotes perkinsae*	*Endemic Sub-species*	R
1	Lycaenidae	Cassius Blue	*Leptotes cassius theonus*	*Native*	R
1	Lycaenidae	Hairstreak (unknown)	*Strymon sp*	*Species undetermined*	R
1	Nymphalidae	Jamaican White Peacock	*Anartia jatrophae saturata*	*Native*	O
1	Nymphalidae	Jamaican Zebra	*Heliconius simulator*	*Endemic*	R
1	Nymphalidae	Julia Longwing	*Dryas iulia delila*	*Endemic Sub-species*	O
1	Nymphalidae	Rusty Fritillary	*Euptoieta hegesia hegesia*	*Native*	R
1	Nymphalidae	Gulf Fritillary	*Agraulis vanillae insularis*	*Native*	R
1	Nymphalidae	Jamaican Mestra	*Mestra dorcas*	*Endemic*	A
1	Nymphalidae	Jamaican Calisto	*Calisto zangis*	*Endemic*	F
1	Nymphalidae	Mangrove Buckeye	*Junonia evarete*	*Native*	R
1	Papilionidae	Bahamian/Citrus Swallowtail	*Heraclides andraemon andraemon*	*Introduced*	F
1	Pieridae	Cloudless Sulphur	*Phoebis senae senae*	*Native*	O
1	Pieridae	Giant Antillean White	*Ganyra josephina paramaryllis*	*Esub*	R
1	Pieridae	Lyside (Lignum vitae) Skipper	*Kricogonia lyside*	*Native*	R
1	Pieridae	Apricot Sulphur	*Phoebis argante comstocki*	*Endemic Sub-species*	R

10.5 Appendix 8.5 – Species List for Fish

Functional Feeding Group	Scientific Name	Common name	DAFOR
Carnivore	*Thalassoma bifasciatum*	Bluehead Wrasse	Occasional
	Halichoeres bivittatus	Clown Wrasse	Occasional
	Halichoeres poeyi	Slippery Dick	Occasional
	Lutjanus mahogoni	Blackear Wrasse	Very Rare
	Dasyatis americana	Mahogany Snapper	Rare
	Sparisoma aurofrenatum	Southern sting ray	Rare
Herbivores	*Sparisoma viride*	Striped Parrotfish	Rare
	Sparisoma atomarium	Stoplight Parrotfish	Rare
	Acanthurus bahaianus	Greenblotch Parrotfish	Rare
	Acanthurus	Ocean Surgeon	Rare
	Acanthurus coeruleus	Doctorfish	Occasional
	Haemulon flavolineatum	Blue Tang	Rare
	Haemulon plumierii	French Grunt	Occasional
	Stegastes diencaeus	Blue-Striped Grunt	Rare
	Microspathodon chrysurus	Longfin Damselfish	Frequent
Algae Gardeners	*Aulostomus strigosus*	Yellowtail Damselfish	Frequent
	Chaetodon striatus	Atlantic trumpetfish	Rare
	Abudefduf saxatilis	Reef Butterflyfish	Rare
Omnivore		Sergeant Major	Frequent

10.6 Appendix 8.6- Seagrass Species

Seagrass Species, Density (#shoot/m^2), Blade Length, And Relative % Cover Of Seagrass Species Found Within The Project Area Location (T. tes = *Thalassia Testudinum*; S. Fil = *Syringodium Filiforme*).

Quadrat #	Seagrass Sp.	Shoot/25cm^2	Shoot/m^2	Blade length (cm)	% Cover
1	*T tes/ S. fil*	25-35	475	15-20	85
2	*T tes/S fil*	18	405	20-30	90
3	*T tes/S. fil*	24	370	20-30	100
4	*T tes/S fil*	18	250	15-20	50
5	*T tes*	22	365	10-20	70

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