# ENVIRONMENTAL IMPACT ASSESSMENT

## FOR ROZELLE ESTATES, ST. THOMAS

Ecosystems Quality Management Limited

# Environmental Impact Assessment for a Proposed Housing Development at Rozelle, White Horses, St. Thomas

Prepared for:

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ECOHYDROLOGY FOR ASSESSMENT OF WATER, WETLANDS AND WATERSHEDS

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| | |
|---|---|
| BOD | Biological Oxygen Demand |
| BSJ | Bureau of Standards Jamaica |
| CBD | Convention on Biological Diversity |
| DAC | Development Assistance Centre |
| EIA | Environmental Impact Assessment |
| EPA | Environmental Protection Agency |
| EQT | Equalization Tank |
| GLO | Get the Lead Out |
| GPA | Global Programme of Action |
| GIS | Geographic Information System |
| HURDAT | Hurricane Databases |
| IUCN | International Union for Conservation of Nature |
| IWRMC | Integrated Water Resources Management Council |
| JNHT | Jamaican National Heritage Trust |
| JPS | Jamaica Public Service |
| KSAMC | Kingston and St. Andrew Municipal Corporation |
| LCLU | Land Cover and Landuse |
| LDUC | Land Development and Utilisation Commission |
| LPS | Litres Per Second |
| MOE | Ministry of Education |
| MSL | Mean Sea Level |
| MTF | Medium-Term Socioeconomic Policy Framework |
| NbS | Nature-Based Solution |
| NEPA | National Development Plan |
| NOAA | National Oceanic and Atmospheric Administration |
| NPDP | National Physical Development Plan |
| NRCA | Natural Resources Conservation Authority |

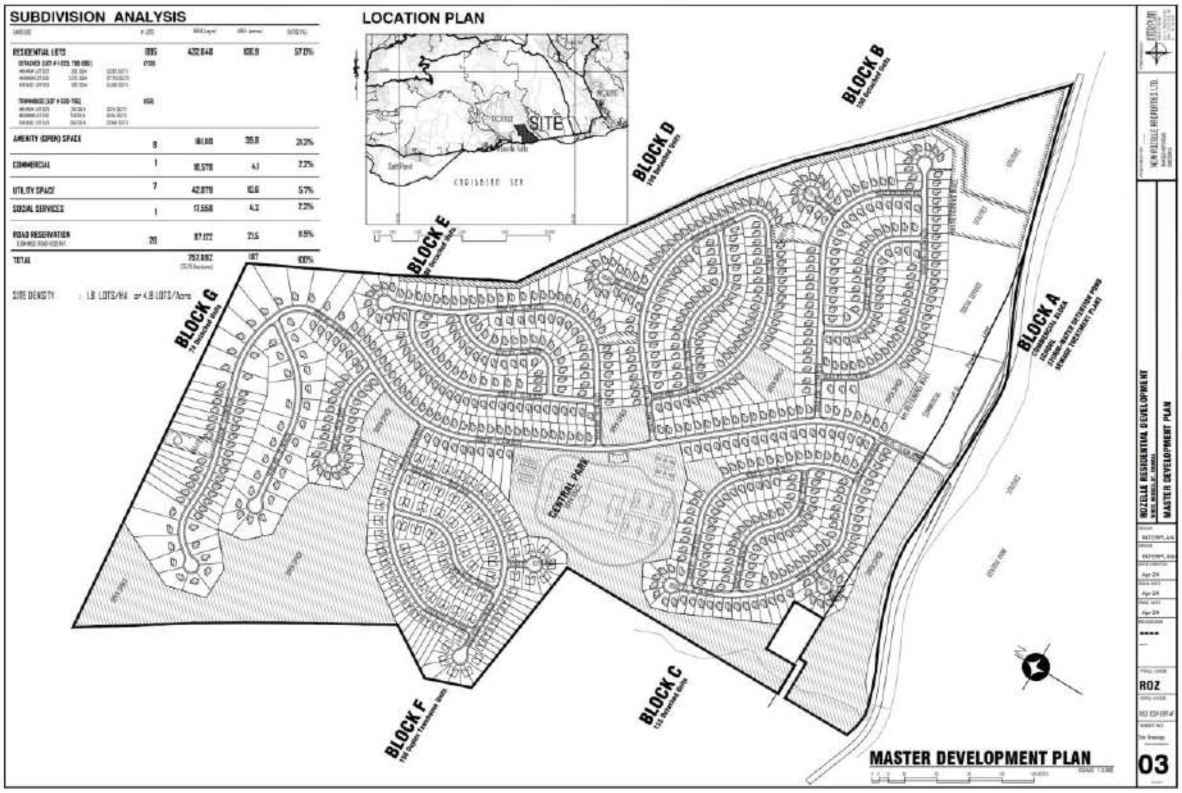
| | |
|---|---|
| NRPL | New Rozelle Properties Limited |
| NSWMA | National Solid Waste Management Authority |
| NWC | National Water Commission |
| OAS | Organization of American States |
| PLC | Programmable Logic Controller |
| RADA | Rural Agricultural Development Authority |
| RAS | Reliability, Availability, and Serviceability |
| SCS | Scientific Certification Systems |
| SCHIP | Southern Coastal Highway Improvement Project |
| SDGs | Sustainable Development Goals |
| SIA | Social Impact Assessment |
| STLSDP | St. Thomas Local Sustainable Development Plan |
| TIA | Traffic Impact Assessment |
| TOR | Terms of Reference |
| TPD | Town Planning Department |
| USBF | Up-flow Sludge Blanket Filtration |
| WHO | World Health Organization |
| WLPS | Wildlife Protection Act |
| WPA | Watershed Protection Act |
| WRA | Water Resources Authority |
| WMUs | Watershed Management Units |
| WWTP | Wastewater Treatment Plant |

# EXECUTIVE SUMMARY

New Rozelle Properties Limited (NRPL) (the Developer) intends to develop lands located at Rozelle, White Horses, St. Thomas, for the purpose of providing housing solutions. The development is to be called Rozelle Estates. Ecosystems Quality Management Limited (EQM) was contracted by the Developer to conduct an Environmental Impact Assessment (EIA) for the proposed development. The EIA was requested by the National Environment and Planning Agency (NEPA) to unearth the possible impacts of the project on the environment of the White Horses and neighbouring communities, where the project is to be executed. Herein submitted are the findings of the EIA study.

The relevant policy framework, legislation and standards governing environmental quality, the protection and management of sensitive ecosystems, endangered species, culture and heritage, and public health and safety is discussed. Also discussed are the relevant policy and institutional framework for the management of Jamaica's natural resources, landuse planning, and development control. These are presented at the national level and in relation to international standards that Jamaica is a party to that are relevant to the proposed project. The project is summarized below:

| Land Use | No. of Lots | Area (sq.m) | Area (acres) | Area (Ha.) | Ratio (Percentage) |
|---|---|---|---|---|---|
| Residential | 895 | 432, 648 | 106.9 | 43.3 | 57% |
| Commercial | 1 | 16,578 | 4.1 | 1.6 | 2.2% |
| Open Space | 8 | 163,505 | 40.4 | 16.3 | 21.3% |
| Road | 26 | 87,122 | 21.5 | 8.7 | 11.5% |
| Social Services | 1 | 18, 367 | 4.3 | 1.8 | 2.3% |
| Utilities | 7 | 42,879 | 10.6 | 4.3 | 5.7% |
| Total | 917 | 757,892 | 187 | 77 | 100% |




### *Zoned Landuse*

The zoned uses for the general area, as per the Town and Country Planning (Saint Thomas Parish) Provisional Development Order (2018) is agriculture in the flatter regions and forest reserves in the upper, steeper areas. The current landuse on the site is agricultural fields, mainly orchard farming, and beekeeping and animal grazing to a less extent. This occupies less than one-third of the property, with the majority being in ruinate. Other expressed planned uses for the general area include resort (coastal villas) for the property in general and "nature and adventure" for the Rozelle Falls, in particular, by the Ministry of Tourism.

### *Water Resources and Drainage*

The site falls within the White Horses sub-watershed of the Morant River Watershed Management Unit (WMU). The major rivers of the drainage basin are the White River, approximately 2km West of the site and the Morant River, which flows approximately 3.8km East of it.

The major drainage systems affecting the site are the Banfield's Gut River, a tributary of which traverses the north-western limits of the property, and the Chocolate Gully, which traverses the northernmost and mid-western sections of the property and continues south-easterly from the property's eastern boundary, before discharging into the Caribbean Sea.

Spring sources were identified both on and abutting the property. The "Rozelle Spring or Rozelle Falls" is a surface water feature on the south-western limit of the site. There are no historical studies on the development potential of the source, hence, an assessment of its discharge and water quality were incorporated under this study.

"Dam Head" emerges East of the site and is used by the residents of Rozelle District for domestic purposes.
"Shadey Spiring", which neighbours the site on the West, was assessed as well, to determine flow rates and water quality prior to the proposed project, given its proximity to the site.

### *Socioeconomic Situation*

A Social Impact Assessment (SIA) was done to evaluate the potential social and economic impacts of the proposed Rozelle Estates development. Drawing on data from a household socio-economic survey and business impact survey conducted between December 2024 and January 2025, the 2009 Social Development Commission White Horses Community Profile, and the 2011 STATIN Jamaica Census, the report examines changes over time, current community sentiments, and the potential outcomes of the proposed development.

- The findings indicate widespread support for the project, grounded in the community's desire for economic development, housing access, and modernized infrastructure. A large majority of both **residents (93%) and local businesses (85.7%) expressed approval of the project** and the belief that it should proceed as designed.
- *Demographic Trends*: The population of White Horses has aged significantly since 2009. The mean respondent age in 2025 is 50.45 years, compared to a previously youth-dominant population with 51% being below the age of 24 years. This shift indicates potential outmigration of younger adults and raises the need for community services that cater to older residents while fostering youth retention.
- *Education and Skills*: Educational attainment has improved. While in 2009 only 35% of household heads had completed secondary education, by 2025 that number has risen to 54%. Vocational training and tertiary education have also increased. Nonetheless, 27.6% of respondents proposed a skills training centre as a preferred landuse, demonstrating an ongoing need for accessible capacity-building initiatives.
- *Employment and Income*: Employment among heads of households increased from 9% in 2009 to 69% in 2025, with farming and informal sector work remaining dominant. However, income remains low; 55% of households earn under J$100,000 annually (approximately J$8,300/month), underscoring economic vulnerability and the need for job creation initiatives.

- *Infrastructure and Services:* Access to modern infrastructure has improved but remains insufficient. While internet access has risen dramatically (from 4% in 2009 to 81% in 2025), water security is still a concern. Nearly 40% of residents experience weekly lock-offs in piped water supply, and 6% depend on springs, predominantly the culturally significant **Rozelle Spring**. Sanitation infrastructure shows some progress, but pit latrines are still in use.

- *Rozelle Spring*: The spring is a critical natural and cultural resource, used for domestic purposes (48%). Nearly half (49.5%) of residents expressed concern that the housing project might negatively affect the spring's water quality or access to it. Given the spring's role in daily survival, any development must prioritize water resource protection and accessibility.

- *Community Sentiment*: 95% of respondents believe the project should proceed as designed. Reasons for support include community development (35.6%), housing access (15.9%), and increased economic activity (16.5%). While support is high, environmental concerns persists, including air quality, loss of flora and fauna, soil erosion, and potential reductions in water supply.

- *Business Community:* Businesses anticipate benefits including increased customer traffic and profits. Expressed preferred alternative uses of the site include entertainment, shopping, and tourism. This demonstrates local support for development and investment, even among those not directly tied to housing.

- *Environmental Vulnerability*: The area residents indicated the area remains at risk from hurricanes (50.8%), storm surge (30.8%), and flash flooding (21.8%). While 27.4% of respondents reported experiencing flooding, only 11.4% saw it as a barrier to development. This highlights the need for flood-resilient planning and infrastructure.

- The community of White Horses is ready for transformative development. Despite historical infrastructure deficits and continued economic fragility, there is strong optimism that the Rozelle Estates development will usher in a new era of opportunity. However, for this potential to be realized equitably and sustainably, the project must remain sensitive to environmental concerns, incorporate mechanisms for community feedback, and include tangible commitments to local hiring, skills development, and water resource preservation.

## *Ecological Status*

The site features ecosystems such as streams, riparian forest, terrestrial forests and coastal vegetation.

From the floral survey, 154 plant species from 62 families were recorded. Most of the plant species recorded in the survey can be classified as ornamentals, agricultural crops or plants associated with anthropogenic disturbances.

Those species considered endemic, rare, endangered or under protection included:

- Two (2) endemic flora: Broadleaf (*Terminalia latifolia*) and God Bush (*Oryctanthus occidentalis*). *T. latifolia* is listed as Near Threatened (NT) by the International Union for Conservation of Nature (IUCN).

- Eight (8) endemic bird species, including Jamaican Euphonia (*Euphonia Jamaica*), , Jamaican Mango *(Anthracothorax mango)*; Jamaican Parakeet (*Eupsittula nana*); Jamaican Tody *(Todus todus)*; Jamaican Woodpecker *(Melanerpes radiolatus)*; Jamaican Vireo *(Vireo modestus)*; Red-billed Streamertail (*Trochilus polytmus*); *and* Yellow-shouldered Grassquit (*Loxipasser anoxanthus*).

- One endemic butterfly species, the Jamaican Kite/ Blue Swallowtail Butterfly, and four (4) endemic sub-species: Polydamas Swallowtail (*Battus polydamas jamaicensis*); *Zebra Longeing (Heliconius charithonia simulator); Julia (Dryas iulia delilah); and* Jamaican tropical leafwing (*Anaea troglodyta portia*).

- The Black Lancewood (*Oxandra lanceolata*) plant, although not endemic or of special conservation needs, occurs throughout sections of the property and will be required in favourable quantities to sustain Blue Swallowtail Butterfly populations. Conservation of the species is proposed. Further details are provided in Chapter 6.

No arthropod of special conservation status was observed. Similarly, no amphibians of special conservation status were identified. Three amphibian species were identified, which are all introduced species.

The Jamaican Boa was not observed during the assessment, however, anecdotal information from residents indicate that it is present in the general area.

The project provides an otherwise far-fetched opportunity to protect a national endangered and IUCN-listed vulnerable species; the Jamaican Kite/Blue Swallowtail Butterfly (*Protographium marcellinus*). Where under normal circumstances the species would be at risk of its food source being completely eradicated due to land clearing for agriculture proposes, the study has lead to a detailed investigation geotagging its distribution and the extent of its habitation in the area. Resulting from this information, the Developer, in partnership with the local stakeholders and other partners, can take deliberate steps to conserve the species by enhancing its habitat situation in the locality.

Without this initiative, the local community could unknowingly clear the land of the plants serving as the Butterfly's larval food source, eliminating the chances for survival of an endemic species.

There is also widespread land degradation across the entire property. Several charcoal kilns have been detected and there is evidence of other fires. This amplifies the vulnerability of the butterfly species since Black Lancewood plants are being damaged or destroyed as a result of these activities. The proposed development would therefore help to curtail some of the fires being set and removal of native species such as the Black Lancewood.

### *Potential Environmental and Socio-economic Impacts*

The study unearthed a number of potential impacts, which are discussed in detail in Chapter 7. Primary amongst them is the longevity of the Rozelle Falls, the sustainability of the Blue Swallowtail Butterfly populations, and increased runoff causing flooding and impaired water quality, both in freshwater sources and the downgradient marine environment.

The table below provides a summary of the potential impacts identified and the recommended mitigation measures for the different phases of the project.

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| **Physical** | Hydrology & Drainage | Blocking of the Rozelle Falls source | Install alternative subsurface storage, staging this section first in construction during the dry season |
| | | Increased runoff causes flooding of lower regions of the property and the roadway | ▪ Design a temporary stormwater management system for runoff mitigation as well as grade construction zone as needed to direct water to the designated drainage areas.<br>▪ Regrade sections of development site and design stormwater system to NWA standards<br>▪ Phase construction to manage stormwater flows<br>▪ Phase removal of vegetation, during each phase of the development<br>▪ Select sustainable drainage system (SuDS) alternatives for major drainage infrastructure. Examples include water quality/vegetation swales and detention ponds where appropriate.<br>▪ Use grasscrete/grassblock, interlocking blocks or other permeable paving to facilitate percolation and biological |
| | Soil | Destabilized slopes resulting in soil erosion and reduced soil fertility, affecting re-vegetation efforts post-construction | ▪ Clear land of vegetation in stages<br>▪ Build silt fences<br>▪ Install temporary sedimentation forebays |
| | | Chemical spills cause soil contamination in the vicinity of the construction yard | ▪ Store chemicals in appropriate container<br>▪ Install bund around chemical storage housing |
| | Freshwater Quality | Siltation and increased turbidity of freshwater sources | ▪ Develop Environmental Management and Monitoring Plan, to include management of solid waste, and conduct periodic audits to ensure adherence.<br>▪ Install temporary sedimentation forebays<br>▪ Use sediment traps/turbidity barriers where necessary to avoid sedimentation of the nearby marine waters |

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | Marine Water Quality | | ▪ Cover or hoard all stockpiles of soil and other aggregate material with appropriate to prevent escape to waterways and exposure to rain<br>▪ Seal the footing of such hoarding to avoid seepage of surface run-off, or;<br>▪ Create entrenchment around mounds of materials to ensure stability of materials<br>▪ Establish and maintain vegetative cover along bare soils and steep erodible slopes<br>▪ Construct catchpits along drains running parallel to slopes to intercept surface run-off flowing out of the construction site.<br>▪ The detention ponds should capture the bulk of any runoff loads not previously intercepted up-gradient via the means described above |
| | Air Quality | Increased particulate emissions in and around the construction site | ▪ Develop and implement an Environmental Management and Monitoring Plan which should address air quality, to include regular vehicular servicing and maintenance<br>▪ Develop and implement an onsite Waste Management Plan to reduce the likelihood of workers resorting to burning to get rid of unwanted material.<br>▪ Ensure the site is monitored periodically to ensure compliance with the practices highlighted in this Plan. |
| | Noise | Elevated noise levels within the sphere of influence affecting residents, schools and churches, as well as construction workers | ▪ Conduct noise generating activities during regular working hours to minimize noise nuisance at night-time.<br>▪ Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area.<br>▪ All heavy-duty equipment and noise generating machinery should be equipped with mufflers to minimize noise emission levels and not be allowed to idle unnecessarily.<br>▪ All heavy machinery being used on site will be properly used and maintained to the manufacturer's specifications and possess current fitness certificates from the relevant authorities. |

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | | | ▪ Prioritize equipment with a low noise rating. If not possible, use noise dampeners. This equipment should be placed in areas downwind of sensitive receptors. |
| ***Human*** | Culture and Heritage | The general White Horses community does not have access to Rozelle Falls | Design dual entrance to the Falls so that both residents of the development and the general public have access to the Falls |
| | | The Falls is destroyed during site clearance and construction activities | ▪ Preserve riparian vegetation along the stream sourcing the Falls and fence the area to prevent equipment or workers from entering the area during construction phase in the vicinity.<br>▪ Erect appropriate signage in conspicuous areas |
| | | Taino sites and artefacts were uncovered during the JNHT's investigation which can be lost during site preparation activities. | Inform JNHT of the different phases and stages of the project and accommodate archaeological watching briefs. |
| | Socio-economic | Improved local economy from increase in employment and businesses | |
| | Worker and Community Health and Safety | Accidents, falls, and potential loss of life from operating machinery | ▪ Establish protocols for the necessary personal protective equipment, and the training of employees to ensure their correct usage, and ongoing monitoring of said usage<br>▪ Appoint Health and Safety personnel on the site |
| | | Increased Vehicular Traffic cause delays at intersection of site access road and the main road (based on increased traffic loading and increase in heavy machinery) leading to increased congestion in the area | ▪ Implement traffic management protocols to prevent congestion<br>▪ Laise with the local traffic authorities to assist with traffic management |
| | Habitat | Loss of habitat for species of flora and fauna, including endemics, as lands are | ▪ Tag endemic trees that are in close proximity to areas that will be cleared to ensure they are preserved. |

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| **Biological** | | cleared and topsoil removed prior to construction | ▪ The planting of native trees throughout the property as a part of landscaping when the development is completed, is encouraged where possible. This will bolster the habitat for fauna. |
| | Ecosystem | Edge Effects: Edges of fragmented land becomes exposed to a new microclimate which may cause stress to flora and fauna that are not adapted to the new conditions<br><br>Stream integrity is compromised from garbage, sedimentation and removal of riparian vegetation | ▪ Maintain a buffer zone of at least 10m from streams and gullies; no development should be allowed in this buffer area<br>▪ Where possible, some of the larger trees within the property should be retained. This will help to maintain some of the habitat for fauna within the areas.<br>▪ Distributing solid waste receptacles at designated areas across the site, erect warning and informational signs in conspicuous locations informing employees of garbage receptacle placements and warning of penalties for not complying with instruction |
| | Species | Blue Swallowtail Butterfly and Black Lancewood Tree | Develop a Swallowtail and Black Lancewood Conservation Plan, to include the following:<br>▪ Establishment of a Butterfly Sanctuary in a section of the land North of the project site boundary (Zone B)<br>▪ Establishment of a nursery for Black Lancewood seedling at a suitable location outside the development footprint, for transplanting later to the conservation site<br>▪ Prior to commencement of work, remove all individuals where feasible and relocate to predetermined conservation zone<br>▪ Monitoring of the species in the form of annual butterfly counts when there is a flight of adults |
| | | Other Species | ▪ Preserve large trees (≥ 30cm DBH) on the development property that are outside the development footprint and plant native trees throughout the housing development once construction is completed. |

| CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| **Physical** | Hydrology & Drainage | Blocking of the Rozelle Falls source | Same as per pre-construction |
| | | Flooding | ▪ Regrade sections of development site and design sustainable stormwater system to NWA standards<br>▪ Phase construction to manage stormwater flows<br>▪ Select sustainable drainage system (SuDS) alternatives for major drainage infrastructure, such as water quality/vegetation swales and detention ponds where appropriate.<br>▪ Design and construct rain gardens for common areas such as the nature park and recreational spaces<br>▪ Use permeable options such as grasscrete/grassblock or interlocking blocks for individual yard access<br>▪ Consider conducting a detailed investigation to locate sources for ponding area in catchment 2. |
| | Soil | Destabilized slopes resulting in soil erosion and reduced soil fertility, affecting re-vegetation efforts post-construction | Same as per pre-construction |
| | | Contaminated soil in the vicinity of the construction yard | Same as per pre-construction |
| | Freshwater Quality | Siltation and increased turbidity of freshwater and marine waters | Same as per pre-construction |
| | | Increase in nutrients and bacterial content causing eutrophication and contamination | ▪ Provide proper lavatory access to workers<br>▪ Develop Environmental Management and Monitoring Plan, to include monthly audits with water quality monitoring being a part of the monitoring regime<br>▪ Materials to be used during construction phase should not be stored near or riverbanks, or in the path of natural drainage |

| CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | | | ▪ Audit for compliance to Waste Management Plan (solid and chemical waste) |
| | Marine Water Quality | | Same as per pre-construction |
| | Air Quality | Fugitive dust emissions are generated in and around the construction site<br><br>Vehicle Emissions cause poor air quality<br><br>Burning of Solid Waste causes increased airborne particulates, affecting site personnel and the larger district | ▪ Develop and implement an Environmental Management and Monitoring Plan which addresses air quality, to include regular vehicular servicing and maintenance<br>▪ Develop and implement an onsite Waste Management Plan to reduce the likelihood of workers resorting to burning to get rid of unwanted material. Ensure the site is monitored periodically to ensure compliance with the practices highlighted in this Plan.<br>▪ Wet areas where applicable to reduce the generation of fugitive dust.<br>▪ Cover fine earth material with appropriately sized covers during transportation. |
| | Noise | Elevated noise levels within the sphere of influence affecting residents, schools and churches, as well as construction workers | ▪ Conduct noise generating activities during regular working hours to minimize noise nuisance at night-time.<br>▪ Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area.<br>▪ All heavy-duty equipment and noise generating machinery should be equipped with mufflers to minimize noise emission levels and not be allowed to idle unnecessarily.<br>▪ The contractor should ensure that all heavy machinery being used on site are properly used and maintained to the manufacturer's specifications and possess current fitness certificates from the relevant authorities.<br>▪ Prioritize equipment with a low noise rating. If not possible, use noise dampeners. This equipment should be placed in areas downwind of sensitive receptors. |

| CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| ***Human*** | Culture and Heritage | The general White Horses community don't have access to Rozelle Falls | Design dual entrance to the Falls so that both residents of the development and the general public have access to the Falls |
| | | The Falls is destroyed during site clearance and construction activities | Preserve riparian vegetation along the stream sourcing the Falls and fence the area to prevent equipment or workers from entering the area during construction phase in the vicinity. |
| | | Taino sites and artefacts were uncovered during the JNHT's investigation which can be lost during site preparation activities. | Inform JNHT of different phases of the project and accommodate archaeological watching briefs. |
| | Socio-economic | Improved local economy from increase in employment and businesses | |
| | Worker and Community Health and Safety | Accidents, falls, and potential loss of life from operating machinery | ▪ Establish protocol for the necessary personal protective equipment, and the training of their correct usage, and ongoing monitoring of said usage<br>▪ Appoint Health and Safety personnel on the site |
| | | Prolonged exposure to noise levels above recommended limits without the appropriate PPE resulting in adverse health impacts. | ▪ Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area.<br>▪ Erect noise barriers as needed.<br>▪ Implement soft-start procedures where possible when using construction equipment.<br>▪ Staff should be equipped and trained in the use of required personal protective equipment (PPE).<br>▪ Phase clearance activities. |
| | Ecosystem | Edge Effect: Edges of fragmented land becomes exposed to a new microclimate which may cause stress to flora and fauna that are not adapted to the new conditions | ▪ Maintain a vegetative buffer zone of at least 10m from streams and gullies; no development will be allowed within this buffer zone.<br>▪ Where possible, some of the larger trees within the property should be retained. This will help to maintain some habitat for fauna |

| CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | Species | Blue Swallowtail Butterfly and Black Lancewood Tree | ▪ Monitoring of the species in the form of annual butterfly counts when there is a flight of adults<br>▪ Establish nursery for Black Lancewood Tree and transplant when appropriate to the established conservation area (Zone B). |
| | | Other Species | ▪ Preserve large trees (≥30cm DBH) on the development property that are outside the development footprint<br>▪ Plant native trees throughout the housing development once construction is completed. |
| **Natural Hazards** | | Storm Surges/Flooding | ▪ Develop a Warning System for alerting all on-site personnel when strong weather alerts are issued<br>▪ Develop and Emergency Response Plan and sensitize staff |
| | | Earthquakes and Seismic Risk | ▪ Ensure building design adheres to the code for earthquake safety<br>▪ Develop an Emergency Response Plan and conduct regular drills<br>▪ Conduct post event inspections to ensure worker safety and structural integrity |
| | | Hurricanes | ▪ Develop an Emergency Response Plan<br>▪ Install a warning /public address system for alerting employees when strong weather alerts are issued<br>▪ Conduct site inspection after storm to ensure worker and structural safety |

| POST CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| **Physical** | Hydrology & Drainage | No Rozelle Falls- The stream dries up | Design underground storage to maintain flow to the Falls |
| | | Flooding | ▪ Enhance drainage systems to divert runoff to the detention ponds and Caribbean Sea to reduce flooding downstream.<br>▪ Install additional drainage structures along vulnerable areas, especially along the main road near to Duhaney Pen<br>▪ Realign the Chocolate gully's eastern stem so that the flow path is not directly impacting the site.<br>▪ Implement minor systems to divert runoff away from the edges of Catchment 1 (west-point) and Catchment 3 (east-point) and simultaneously contain and direct the runoff already onsite via the proposed drainage system to their respective outlets.<br>▪ Re-vegetate areas of bare soil as soon as is practical |
| | | Hydrological regime altered | ▪ Implement long term (3-year) Hydrological Monitoring Programme to monitor hydrological changes, assess the effectiveness of implemented measures, and make necessary adjustments overtime.<br>▪ Collaborate with relevant agencies to update criteria and mitigation strategies based on evolving climate and landuse conditions. |
| | | Groundwater recharge is reduced | ▪ Incorporate permeable pavements and infiltration basins in the development<br>▪ Encourage rain gardening to homeowners<br>▪ Consider incorporating additional subsurface storage areas in conjunction with subsurface gravel drainage systems, such as cut-off drains, additional detention pond to effectively manage runoff in the green areas (open spaces) along the north-western site boundary, directing flow towards Rozelle Falls. |
| ***Human*** | Culture and Heritage | The Rozelle Falls quality becomes degraded over time | Implement Long Term Protection /Maintenance<br>▪ Monitoring flow and stream water quality over the medium to long term to ensure there is no negative impact from the development |

| POST CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | | | ▪ Implement monitoring program in dialogue with the relevant authorities (WRA, EHU) to ensure sustainability of monitoring programme |
| **Biological** | Habitat | Reduced Biodiversity from construction activities | ▪ Restore habitats through replanting native species throughout the development during landscaping activities<br>▪ Preserve natural wildlife corridors. |
| | Ecosystem | Edge Effect: Edges of fragmented land becomes exposed to a new microclimate which may cause stress to flora and fauna that are not adapted to the new conditions | ▪ Maintain a buffer zone of at least 10m from streams and gullies; no development should be allowed in this buffer area to aid in preserving this natural feature. |
| | Species | Blue Swallowtail Butterfly and Black Lancewood Tree | Develop a Blue Swallowtail Butterfly and Black Lancewood plant Conservation Plan, to include the following:<br>▪ Monitoring of the species; perhaps annual butterfly counts when there is a flight of adults, in which other interested parties may<br>▪ Monitor Black Lancewood plant to ensure acclimatization in new environment<br>▪ The nature park being proposed provides a space where species of interest, including the Black Lancewood plant, can be planted between secondary forest patches and degraded areas. |

# 1. INTRODUCTION

## 1.1 PROJECT RATIONALE

New Rozelle Properties Limited (NRPL) (hereinafter referred to as the Developer), proposes to construct a residential development in Rozelle, St Thomas. The proposal is to create a cohesive and sustainable community of 895 residential units with a mixture of housing options along with supporting services and infrastructure, a nature park, social services and landscape reserve.

The design for the development is based on sustainable best practices which include facilities for storm water and waste management such as detention ponds, a tertiary sewage treatment facility and a solid waste transfer station. The affordable housing solutions proposed for the initial target market are for low to moderate income earners with lot sizes ranging from 305 sq. m to 2, 575 sq.m, providing adequate land space to allow for subsistence agriculture and/or unit expansion.

The proposed development will have a significant economic impact on the surrounding community by spurring development as well as providing employment for adjoining communities. The project is therefore in alignment with country's development plan, **Vision 2030 Jamaica**: "**Jamaica, the place of choice to live, work, raise families, and do business**".

After full build-out, the government can expect increased revenue from property taxes as well as income taxes from the employment generated.

### 1.1.1 STUDY AREA

Figure 4-5 shows the total area of the property (top right) and delineates the portion to be developed (bottom left). The portion of the property that will be developed amounts to less than half (46%) of the total acreage of the parent property. The Developer proposes to reserve the remainder of the land (the northern half) for low impact, eco-friendly activity such as zip lining, bird watching, e-biking, nature-walk, etc., whichever is most suitable. A portion of the northern section of the parent property is being proposed for use as a conservation area as well, for the Jamaican Blue Swallowtail butterfly and its host plant, the Black Lancewood. The area proposed is approximately 84 acres. This is further detailed in Chapter 6 (section 6.3) below.


*Figure 1-1: The Rozelle project development site showing a 2km radius used as the zone of impact for analysis of potential environmental impacts*

### 1.1.2 STUDY SCOPE

Environmental Permit and Licence Applications for the proposed housing development were lodged with the NEPA, under the prescribed category: *Subdivision and Housing Development 50 Lots and Over and Construction and Operation of Wastewater Treatment Plant.* The said application was lodged on 14 August 2023.

The construction of the housing development and the construction and operation of the wastewater treatment plant are anticipated to potentially generate environmental impacts on the natural environment, as well as affect residents (human environment) living adjacent to the site. It was therefore prudent to evaluate the plausible impacts, recommend feasible mitigation strategies and potentially viable alternatives to the proposed project. NEPA requested that an EIA be conducted for the development project and requested a Terms of Reference (TOR) outlining the elements of the EIA (Appendix 1). The TOR for the EIA was developed and accepted by the NEPA and the EIA subsequently executed by Ecosystems Quality Management Limited and is submitted here within.

### 1.1.3 GENERAL APPROACH

The approach for conducting the study involved several different scientific techniques. The assessment of baseline conditions for describing the natural environment involved fields inspections, GIS mapping and use of various measuring devices and modelling software.

The initial data gathering process involved a number of site visits by a team of consultants and experts to firstly carry out site reconnaissance and determine factors for consideration in planning field designs to collect baseline data and execute field surveys. Desktop studies were also done to research lierature and historical maps of the site, develop initial basleine maps and determine data gaps, obtain additional data and conduct geospatial analyses where applicable.

A mixture of quantitative and qualitative studies have been done to undertake the assessments, which lead to understanding the potential and existing environmental issues concerning the development. Details on the methodology and approach are provided in Chapter 3.

# 2. POLICY, LEGISLATIVE AND REGULATORY FRAMEWORK

## 2.1 NATIONAL POLICY FRAMEWORK

Development in Jamaica is guided by a suite of policies, legislation and guidelines that are designed to provide environmental protection and ensure sustainability of its natural resources, ensure buildings of sound integrity and safeguard biodiversity, human health and safety, and culture and heritage. Discussed below are the national, regional and international policies, legislation, and guidelines relevant to the project.

### 2.1.1 VISION 2030 JAMAICA: NATIONAL DEVELOPMENT PLAN 2009-2030

Vision 2030 Jamaica is Jamaica's National Development Plan (NDP), which is a strategic road map by which the country will progress to be a developed country over a 21 year period and by which our people here and in the Diaspora will make Jamaica the place of choice to live, work, raise families, and do business (PIOJ).

Vision 2030 Jamaica can only be realised by targeted plans and programmes that are closely monitored. There are four such long term goals and associated outcomes.

4 Jamaicans are empowered to achieve their fullest potential through,
  - A healthy and stable population
  - World class training and education,
  - Effective social protection,
  - Authentic and innovative culture,

4 The Jamaican Society is Secure, Cohesive and Just, through
  - Security and safety,
  - Effective governance,

4 Jamaica's Economy is Prosperous, with
  - A stable macro economy,
  - An enabling business environment,
  - Strong economic infrastructure,
  - Energy security and efficiency,
  - A technology driven society,
  - Internationally competitive industry structures,

4 Jamaica's development is in harmony with its natural environment,
  - Sustainable use and management of environmental and natural resources,
  - Hazard risk reduction and adaptation to climate change,
  - Sustainable urban and rural development

### 2.1.2 NATURAL RESOURCES AND WATERSHED MANAGEMENT

#### 2.1.2.1 WATERSHEDS POLICY FOR JAMAICA (GREEN PAPER) (2024)

A watershed is that total area of land from which all the water collected in a particular area drains to a single outlet; usually a stream. The landscape covering a watershed is all the natural elements such as slopes, hills, mountains, valleys, rivers, etc., and includes all the built environment including all industrial and housing developments. Jamaica's hydrologic network is divided into ten (10) drainage basins, which are divided into twenty-six (26) watershed management units (WMUs), identified via their major rivers. The WMUs are further subdivided into sub-WMUs.

The Watersheds Protection Act (WPA), 1963, gives the responsibility of the protection of watersheds and adjoining areas and promoting the conservation of water resources, to the Natural Resources Conservation Authority (NRCA). Watershed management is the purview of the National Environment and Planning Agency (NEPA), and the Water Resources Authority (WRA) is responsible for the protection of the water resources within these watersheds. In fact, the delineation of the WMUs was a joint effort between the two agencies. Both NEPA and the WRA conducts water quality monitoring, to characterize our watersheds, however, NEPA routinely collects brackish and marine water samples (coastal water quality monitoring), while the WRA collects freshwater samples only, from both surface (rivers, streams and springs) and groundwater sources (wells). The WRA conducts flow measurements also, while NEPA doesn't.

The last State of the Environment Report published by the NEPA (2017), showed, "…all 26 WMUs have been assessed as degraded to some extent…" More than a third of the total watershed area in Jamaica were classified as either degraded (22%) or severely degraded (14%); these (degraded and severely degraded) watersheds are generally located on the eastern side of the island. The most severely degraded WMUs included Rio Minho, Wagwater, Hope River and Yallahs".

The policy document provides a rationale for the legislative and institutional frameworks for watershed management, an overview of the policy's nine guiding principles, issues affecting Jamaican watersheds, status of watersheds, past initiatives and interventions, and current international trends in watershed management. The Policy document also details some of the implementation strategies for meeting the Policy objectives (Water Policy for Jamaica, 2024). Lastly, the policy document sets out the essential elements of the institutional framework required for the attainment of policy objectives.

Monitoring and evaluation of the Policy is via the Medium-Term Socioeconomic Policy Framework (MTF) of Vision 2030 and in the corporate and operational plans of the relevant agencies. The targets for the relevant SDGs such as SDG6, will also be monitored through the Vision 2030 Secretariat. Reports on other commitments in relation to global and regional agreements to which Jamaica is a Party will be done through the respective national focal points. However, watershed management issues are the responsibility of the Natural Resources Conservation Authority (NRCA) and the Integrated Water Resources Management Council (IWRMC). The NEPA's State of the Environment Reports include information on the state of Jamaica's watersheds.

The proposed development site is located within the Blue Mountain South Hydrologic Basin and the Morant River WMU, deemed "degraded." See Figure 2-1 below.

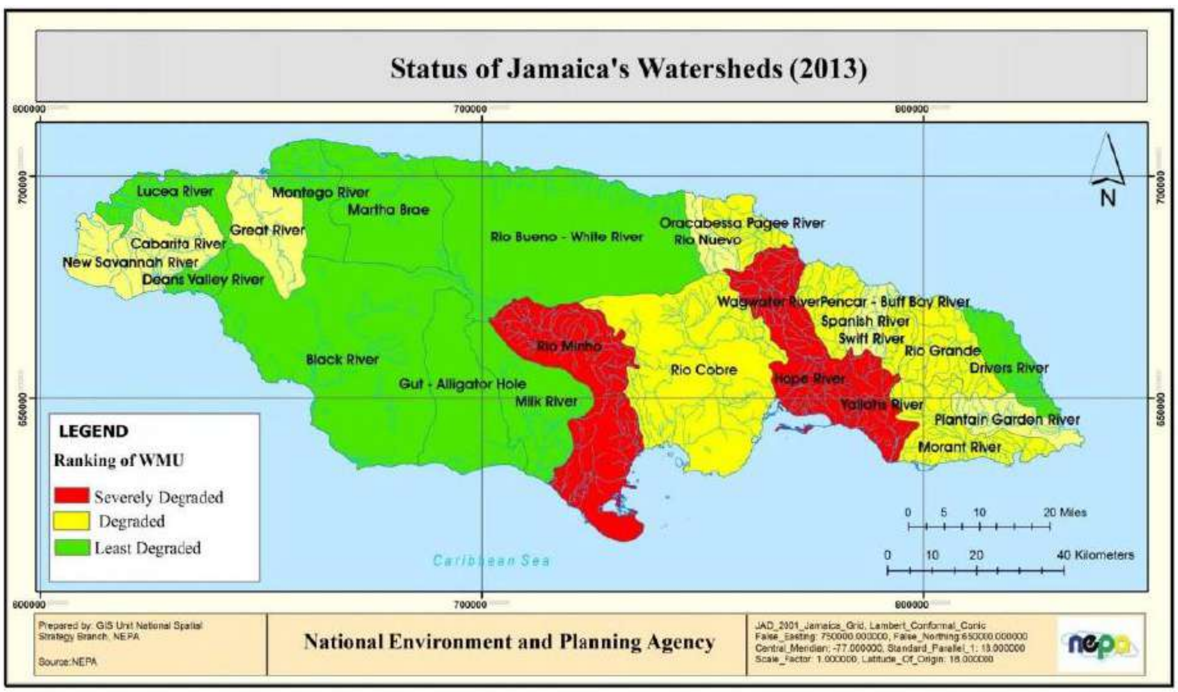



*Figure 2-1 A representation of Jamaica's watersheds (WMUs) showing their state in 2013. Source: NEPA*

#### 2.1.2.2 NATIONAL WATER SECTOR POLICY AND IMPLEMENTATION PLAN (2018)

The National Water Sector Policy and Implementation Plan details the vision for Jamaica's water policy, what the guiding principles of the Policy are, the goals and objectives of the Policy and the institutional arrangements in place for realization of the objectives. The Water Sector Policy and Implementation Plan is aligned with Vision 2030 Jamaica, towards universal access to potable water by 2030. There are six (6) guiding principles. These include:

- sustainability and intergenerational equity;
- efficiency;
- Integrated Water Resources Management (IWRM);
- universal access;
- responsiveness to gender and vulnerable groups; and
- stakeholder participation

Following these principles, the goal of the Policy is to ensure sustainable management of Jamaica's water resources.

### 2.1.3 LANDUSE, PLANNING AND DEVELOPMENT CONTROL

#### 2.1.3.1 National Physical Development Plan

The National Physical Development Plan (NPDP) is the major planning policy used to guide landuse planning and development in Jamaica. It focuses on physical planning, settlement, conservation, income generators (i.e. forestry and fisheries, agriculture, mineral industries, tourism and manufacturing) and public utilities. To support modern planning objectives the NPDP has been used to inform the preparation of Development Orders, which are development control mechanisms used in the development control process.

The proposed development is located in the parish of St. Thomas and as such any proposed development must be in accordance with the zoned landuses promulgated by the Saint Thomas Development Order; the Town and Country Planning (Saint Thomas Parish) Provisional Development Order, 2018.

#### 2.1.3.2 Development and Investment Manual (2006)

The Development and Investment Manual is a development guide that outlines the policies, regulations and procedures to see a project through the stages of planning through to implementation. The guide was developed via collaborative effort between the government and private sector, with support from external partners. The manual outlines the criteria for the design and implementation of different infrastructure and amenities.

The Manual consists of seven (7) volumes:

- Volume 1: Planning and Development Matters
- Volume 2: Environment
- Volume 3: Infrastructure, Utilities and Communications
- Volume 4: Hospitality Industry and Security
- Volume 5: Social Infrastructure and Waste Disposal
- Volume 6: Business Facilitation
- Volume 7: Finance

#### 2.1.3.3 THE TOWN AND COUNTRY PLANNING (SAINT THOMAS PARISH) PROVISIONAL DEVELOPMENT ORDER, 2018

The Town and Country Planning (Saint Thomas Parish) Provisional Development Order, 2018, is used to guide land development in the parish of St. Thomas. Rozelle falls within the boundaries the development order area, which extends from Bull Bay River in the West, northerly along the boundaries of St. Andrew, Portland and South-westerly to Prospect.

The proposed project area is not zoned for any particular landuse in the St Thomas Development Order. There are four (4) Local Planning Area Landuse Proposals; namely the Marant Bay; Yallahs; Seaforth and Bath Landuse proposals. However, the community of Rozelle does not fall within the boundaries of any of the above. The use of the proposed land is therefore guided by the Certificate of Title under the Registration of Titles Act. The Morant Bay Local Planning Area is the closest local planning area in proximity to the proposed development site.

#### 2.1.3.4 DRAFT ST. THOMAS LOCAL SUSTAINABLE DEVELOPMENT PLAN (STLSDP)

The Draft St. Thomas Local Sustainable Development Plan (STLSDP) is a framework for achieving sustainable development within the parish. The STLSDP will also be a tool for the Local Authority to manage the orderly growth and development of the parish by identifying areas for improvements and opportunities. The Plan also identifies the strategies to achieve the goals and objectives of the locality.

#### 2.1.3.5 THE LOCAL IMPROVEMENTS ACT, 1991

The Local Improvements Act, 1991, governs the subdivision of lands islandwide, the requirements for the subdivision of land, specifications for the submission of drawings/maps, sanctioning of a subdivision, and the appeal process. The Act constitutes an amendment of the Local Improvements Law.

#### 2.1.3.6 BUILDING ACT (NO. 3) 2018

The Building Act, 2018, repeals the Kingston and St. Andrew Building Act and the Parish Councils Building Act and make new provisions for the regulation of the building industry. It aims to facilitate the adoption and efficient application of national building standards; the National Building Code of Jamaica, for ensuring safety in the built environment, enhancing amenities, and promoting sustainable development. In the Act, a "building" is described as a domestic building, a public building, a building of the warehouse class and any other physical structure, whether a temporary structure or not, any part of the structure, and any architectural or engineering product or work erected or constructed on, over or under land or the sea or other body of water.

The objectives of the Act, include, but are not limited to:

- Regulating building work and change of building use by requiring the obtaining of building permits in connection with building works and change of building use, to protect public safety and public health and other relevant public interest considerations;
- Give effect to the National Building Code;
- Require the construction of environmentally friendly and energy efficient buildings;
- Establish an efficient and effective system for issuing building permits and certificates of occupancy;
- Regulate the standard of training and certification and provide for the licensing of building practitioners and the establishment of a procedure for the recognition of building professionals.

For the purposes of this Act, the Kingston and St. Andrew Municipal Corporation (KSAMC) (for the parishes of Kingston and St. Andrew), the Parish Municipal Corporations (all other parishes) are designated as the Local Building Authority for the respective parish. A person who proposes to carry out building work must apply to the relevant Local Building Authority for the appropriate building permit. For the particular site, the St. Thomas Municipal Corporation is the local planning authority. A person shall not carry out any building work unless the respective building permit has been issued; where applicable, a planning permit has been issued under the Town and Country Planning Act; and the work is carried out in accordance with the building permit, the provisions of this Act, the National Building Code, or of any other regulations made under this Act.

### 2.1.4 ENVIRONMENTAL CONSERVATION AND MANAGEMENT

#### 2.1.4.1 NATURAL RESOURCES CONSERVATION AUTHORITY ACT (1991)

This is Jamaica's over-arching environmental law governing environmental management in Jamaica. The NRCA Act *provides for the management, conservation and protection of the natural resources of Jamaica, to establish a Natural Resources Conservation Authority, to make consequential amendments to certain enactments and to provide for matters incidental thereto or connected therewith.*

The Act binds the Crown and therefore supersedes the authority of other agencies with related mandates. Pursuant to this piece of legislation, the Natural Resources Conservation Authority (NRCA) was formed with the mandate to manage, conserve and protect the natural environment. In 1991 the NRCA, the Town Planning Department (TPD) and the Land Development and Utilisation Commission (LDUC) were merged to create the National Environmental and Planning Agency (NEPA).

NEPA' s role is then to administer the NRCA Act by requiring new developments that fall within prescribed categories to apply to the Authority for an Environmental Permit to build or an Environmental License to discharge effluent and thus, evaluate the potential impact of any development. In instances where there is a potential for significant adverse impact to the environment as a result of the implementation of a project under review by the Authority, the NRCA may subject the project to an Environmental Impact Assessment (EIA).

Volume 2 of the Investment Manual entails is the guidelines for conducting environmental impact assessments. The guidelines require that public notices be issued informing that the EIA has been requested by NEPA, give the public time to access and review the EIA report and provide comments and a public presentation of the EIA study be done. There is a preliminary review period of ten (10) days to determine whether additional information is needed. After the initial review the process can take up to ninety (90) days for approval. If upon review and evaluation of the EIA the required criteria are met, a permit is granted.

Sections of the NRCA Act that are important to this project include:

1. 9 (2): Subject to the provisions of this section and section 31, no person shall undertake in a prescribed area any enterprise, construction or development of a prescribed description or category except under and in accordance with a permit issued by the Authority.

2. 10 (1) (b): Where it is of the opinion that the activities of such enterprise, construction or development are having or are likely to have an adverse effect on the environment, to submit to the Authority in respect of the enterprise, construction or development, an environmental impact assessment containing such information as may be prescribed, and the applicant or, as the case may be, the person responsible shall comply with the requirement.

3. 17 (1) : The Authority may by notice in writing require the owner or operator of any sewage treatment plant, industrial waste treatment facility or any facility for the disposal of solid waste or for the abatement of air pollution or any other facility for controlling pollution, to submit to the Authority at such intervals as the Authority may specify in the notice, information relating to all or any of the following:
    a. The performance of the facility;
    b. The quantity and condition of effluent discharged;
    c. The area affected by the discharge of effluents, and such owner or operator as foresaid shall comply with the requirements of the notice.

#### 2.1.4.2 WATER RESOURCES ACT (1995)

The Water Resources Act, 1995 is implemented by the Water Resources Authority (WRA) and aims to manage, protect and control the allocation and use of Jamaica's water resources and to provide for water quality control. The Act also provides for the establishment and functions of the Water Resources Authority and address issues such as water quality, availability, and sustainable use. This legislation is crucial in the context of Jamaica's hydrological challenges, including contamination and salinity issues in various basins. Some key highlights of the Act include:

##### 2.1.4.2.1 Water Quality Management

- The Act emphasizes the need for monitoring and regulating water quality to prevent contamination from urban runoff and agricultural practices.

- Studies indicate significant nitrate and chloride contamination in the Kingston Hydrologic Basin, primarily due to urbanization and inadequate sewage treatment (Arpita Mandal 2020). Under the Act, the WRA may exercise coordinated efforts for the protection of the quality of water resources in any area necessary for the purpose of safeguarding public health via Water Quality Control Plans.

#### 2.1.4.2.2 Groundwater Resources

The Act supports the sustainable management of groundwater resources, which are increasingly threatened by saline intrusion, from over-extraction.

#### 2.1.4.2.3 Integrated Watershed Management

The Act promotes integrated watershed management (IWRM),

While the Water Resources Act provides a framework for addressing these challenges, ongoing issues such as climate variability and urbanization continue to threaten Jamaica's water security. Further research and policy adjustments may be necessary to enhance the effectiveness of the Act in safeguarding water resources.

### 2.1.4.3 WILD LIFE PROTECTION ACT 1945 AND WILDLIFE PROTECTION (AMENDMENT OF SECOND AND THIRD SCHEDULES) REGULATIONS 2016

The Wild Life Protection Act (WLPA), 1945 (amendment, 1991) governs the protection of certain faunal species including animals, birds and fish. This Act protects several rare and endangered faunal species, and the Wildlife Protection (Amendment of Second and Third Schedules) Regulations, 2016, provides substitutions for the Second and Third Schedules of the principal Act which lists these species. The WLPA represents the most important legislation affecting wildlife management in Jamaica and is the only statute in Jamaica specifically designated to protect species of animals and birds and regulates hunting in Jamaica. The Act provides a list of protected species (which includes all birds).

The establishment of two types of protected areas, namely Game Sanctuaries (crown lands) and Game Reserves (private lands) are authorized under this Act. A Game Sanctuary/Game Reserve is a parcel of land, body of water or area comprising both land and water within which, the hunting of animals, removal of eggs or the nest of any bird and the use or possession of any dog, gun, catapult, or any other weapon which could be used to hunt any animals or birds is prohibited. In addition, all Forest Reserves are also designated as Game Reserves and form part of the Protected Areas System of Jamaica.

This Act has undergone review particularly around increased fines and the number of animals having a protected status. Further amendments are being undertaken to address a variety of issues relating to the management and conservation of these natural resources, and the inclusion of flora.

The Act prohibits the removal, sale or possession of protected animals, the use of dynamite, poisons, or other noxious material to kill or injure fish, and it prohibits discharge of trade effluent or industrial waste into harbours, lagoons, estuaries, and streams.

#### 2.1.4.4 ENDANGERED SPECIES (PROTECTION, CONSERVATION AND REGULATION OF TRADE) ACT 2000 AND (AMENDMENT OF FIRST, SECOND AND THIRD SCHEDULES) ORDER 2021

The Endangered Species (Protection, Conservation and Regulation of Trade) Act was created in 2000 to ensure the codification of Jamaica's obligations under the Convention for the International Trade in Endangered Species of Wild Fauna and Flora. This Act governs international and domestic trade of endangered species in and from Jamaica and generally provides for the conservation and management of endangered fauna and flora.

The regulations associated with Endangered Species (Protection, Conservation and Regulation of Trade) Act were most recently amended in 2021. This included revised listings of a) endangered species threatened with extinction, b) species that could become extinct, or which have to be effectively controlled, and c) species that any contracting Party regulates within its own jurisdiction for the purpose of preventing or restricting over-exploitation and require the cooperation of other Parties for the control of trade in such species.

#### 2.1.4.5 GUIDELINES FOR PREPARING HYDROLOGIC AND HYDRAULIC DESIGN REPORTS FOR DRAINAGE SYSTEMS OF PROPOSED DEVELOPMENTS, 2015

This Guideline for Preparing Hydrologic and Hydraulic Design Reports for Drainage Systems of Proposed Developments, 2015, was prepared via a partnership through the Ministry of Transport, Works and Housing, the National Works Agency (NWA) and the Ministry of Local Government and Community Development.

The guide outlines a set of procedures and refers to a number of standards and/or requirements that are relevant and applicable to subdivision and development of land across the country. The guidelines aim to highlight the necessity for designers to consider a) the entire watershed in which their site is located, and b) climate change projections (increased frequency and intensity of meteorological weather systems), when designing and calculating drainage systems for hydraulic reports.

The guidelines establish the minimum information to be included in the preparation of hydrologic and hydraulic design reports on drainage systems for proposed sub-divisions. The document also "*advances the mainstreaming of Disaster Risk Reduction considerations into the project planning phase to reduce future impacts from hazards and economic losses from disasters, contributing to the achievement of goals under the Vision 2030 National Development Plan*".

## 2.1.5 PUBLIC HEALTH

### 2.1.5.1 PUBLIC HEALTH ACT 1985

The Public Health Act is administered by the Ministry of Health through Local Boards, namely the Municipal Corporations. The Public Health (Nuisance) Regulations 1995 aims to, control reduce or prevent air, soil, and water pollution in all forms. Under the regulations:

- No individual or organisation is allowed to emit, deposit, issue or discharge into the environment from any source;
- Whoever is responsible for the accidental presence in the environment of any contaminant must advise the Environmental Control Division of the Ministry of Health and Environmental Control, without delay.
- Any person or organisation that conducts activities which release air contaminants such as dust and other particulates is required to institute measures to reduce or eliminate the presence of such contaminants; and
- No industrial waste should be discharged into any water body, which will result in the deterioration of the quality of the water.

### 2.1.5.2 DRAFT NATIONAL WATER QUALITY STANDARDS

The NRCA has primary responsibility for control of water pollution in Jamaica. National standards for ambient freshwater and marine water quality are presented in Table 2-1 and Table 2-2. For drinking water, World Health Organisation (WHO) standards are utilized, and these are regulated by the National Water Commission (NWC).

*Table 2-1: Draft National Ambient (Freshwater) Quality Standard for Jamaica, 2009*

| Parameter Group | Parameters | Measured as | Standard Range and Unit |
|---|---|---|---|
| Ambient Freshwater | pH | | 7-8.40 |
| | Nitrate | $(NO_3^-)$ | 0.1-7.5 mg/L |
| | Phosphates | $(PO_4^{3-})$ | 0.01-0.8 mg/L |
| | Sodium | $(Na^+)$ | 4.5-12.0 mg/L |
| | Chloride | $(Cl^-)$ | 5.0-20.0 mg/L |
| | Calcium | (Ca) | 40.0-101.0 mg/L |
| | Magnesium | $(Mg^{2+})$ | 3.6- 27.0 |
| | Sulfate | $(SO_4^{2-})$ | 3.0-10.0 mg/L |

| | | | |
|---|---|---|---|
| | Potassium | ($K^+$ ) | ($K^+$ ) 0.74- 5.0 mg/L |
| | Hardness | ($CaCO_3$) | 127.0-381.0 mg/L (as $CaCO_3$ |
| | Silica | ($SiO_2$) | 5.0- 39.0 mg/L |
| | Conductivity | | 150.0-600 µS/cm |
| | Biological Oxygen Demand (BOD) | (O) | 0.8- 1.7 mg/L |
| | Total Dissolved Solids | | 120.0-300 mg/L |

*Table 2-2: Draft National Ambient (Marine) Water Quality Standards for Jamaica, 2009*

| Parameter Group | Parameters | Measured as | Standard Range and Unit |
|---|---|---|---|
| Ambient Marine | pH | | 7-8.40 |
| | Nitrate | ($NO_3^-$ ) | 0.007-0.014 mg/L |
| | Phosphates | ($PO_4^{3-}$) | 0.001-0.003 mg/L |
| | Biological Oxygen Demand (BOD) | (O) | 0.0- 1.16 mg/L |
| | Total Coliform | | 2-256 mg/L |
| | Faecal Coliform | | <2-13 mg/L |

A National Water Quality Technical Committee was formed to develop a national standard describing the requirements for selected parameters for ambient (raw) fresh and marine waters in and around Jamaica, with minimal anthropogenic influence. The WRA and the Bureau of Standards Jamaica (BSJ) are spearheading the initiative. The committee was established in 2022 and comprises twenty-eight (28) members from various agencies, academic institutions and private entities, such as the BSJ, WRA, NEPA, NWC, Department of Government Chemist, University of the West Indies (UWI-Mona), to name a few.

The scope of the National Water Quality Technical Committee entails:

I. Review and revise the existing Jamaican standards for applicability

II. Developing/adopting/adapting relevant CARICOM Regional standards as appropriate
III. Development of relevant Jamaican standards
IV. Serve as a technical advice team for related standardization activities and other related matters, (e.g. from regional or international sources) specific to the sector, that may arise during the tenure of the Committee.

#### 2.1.5.3 THE CLEAN AIR ACT, 1964

The Clean Air Act, 1964, makes provisions for abating the pollution of the ambient air. It refers to premises on which there are industrial works, the operation of which is, in the opinion of an inspector, likely to result in the discharge of smoke, fumes, gases or dust in the air. An inspector may enter any affected premises to examine, make enquiries, conduct tests, and take samples of any substance, smoke, fumes, gas or dust that may be considered necessary or proper for the performance of his/her duties.

The second schedule list the noxious or offensive gases, and includes:

- Fumes and dust emanating from any works for the production of alumina
- Fumes or dust from any cement works
- Fumes or dust from any limes works
- Gas containing any sulphur compound emanating from any petroleum works
- Fumes, vapour, or gas from any electrical generating station
- Fumes or dust from any gypsum works
- Ash, dust or soot from any sugar factory

#### 2.1.5.4 THE NATURAL RESOURCES CONSERVATION AUTHORITY (AIR QUALITY) REGULATIONS, 2006

The Natural Resources Conservation Authority (Air Quality) Regulations, 2006 were created. These regulations were gazetted on July 12, 2006. The regulations stipulate the requirements of ambient air quality assessment and continuous emissions (gases and particulate matter) monitoring and provides emission standards for testing and monitoring of air pollution within an operator’s air shed.

Part 1 outlines the requirements for obtaining an Air Pollutant Discharge Licence. Part 2 prescribes targets, standards and guidelines, relating to stack emissions, fugitive particulate emission, odours, and testing, monitoring and reporting protocols. Table 2-3 outlines the ambient air quality standards as issued by NEPA.

The environmental impact from any air emissions (gases or particulate matter) will be influenced by the ambient meteorological conditions within the area, such as wind (speed and direction), and rain.

*Table 2-3: The NRCA ambient air quality standards*

| Pollutant | Avg. Period | Significant Impact Concentration (µg/m3) | Jamaican NAAQS or GC (µg/m3) |
|---|---|---|---|
| PM10 | 24-hr | 80 | 150 |
| Annual | 20 | 50 | |
| TSP | 24-hr | 80 | 150 |
| Annual | 20 | 60 | |
| NO2 | 1-hr | N/A | 400 |
| **Pollutant** | **Avg. Period** | **Significant Impact Concentration (µg/m3)** | **Jamaican NAAQS or GC (µg/m3)** |
| 24-hr | 80 | N/A | |
| Annual | 20 | 100 | |
| SO2 | 1-hr | N/A | 700 |
| 24-hr | 80 | 280 | |
| Annual | 20 | 60 | |
| CO | 1-hr | 2000 | 40000 |
| 8-hr | 500 | 10000 | |
| 1,3 Butadiene | 1-hr | N/A | 0.04 |
| Acetaldehyde | 1-hr | N/A | 1250 |
| 24-hr | N/A | 500 | |
| Acrolein | 1-hr | N/A | 58.75 |
| 24-hr | N/A | 23.5 | |
| Benzene | Annual | N/A | 1 |
| Benzo (a) pyrene | 1-hr | N/A | 0.00275 |
| 24-hr | N/A | 0.0011 | |
| Carbon Tetrachloride | 1-hr | N/A | 6 |
| 24-hr | N/A | 2.4 | |
| Chloroform | 1-hr | N/A | 1250 |
| 24-hr | N/A | 500 | |
| Ethylene Dibromide | 1-hr | N/A | 7.5 |
| 24-hr | N/A | 3 | |
| Formaldehyde | 1-hr | N/A | 162.5 |
| 24-hr | N/A | 65 | |
| Methylene Chloride | 1-hr | N/A | 550 |
| 24-hr | N/A | 220 | |
| Styrene | 1-hr | N/A | 2500 |
| 24-hr | N/A | 1000 | |
| Xylenes | 1-hr | N/A | 5750 |
| 24-hr | N/A | 2300 | |
| Vinyl Chloride | 24-hr | N/A | 1 |
| Annual | N/A | 0.2 | |
| Arsenic | 1-hr | N/A | 0.75 |
| 24-hr | N/A | 0.3 | |

| | | | |
|---|---|---|---|
| Beryllium | Annual | N/A | 0.0013 |
| Cadmium | 1-hr | N/A | 5 |
| 24-hr | N/A | 2 | |
| Chromium | 1-hr | N/A | 3.75 |
| 24-hr | N/A | 1.5 | |
| Cobalt | 24-hr | N/A | 0.12 |
| Copper | 1-hr | N/A | 125 |
| 24-hr | N/A | 50 | |
| Lead | 1-month | N/A | N/A |
| 3-month | N/A | 2 | |
| Manganese | Annual | N/A | 119 |
| Mercury | 1-hr | N/A | 5 |
| 24-hr | N/A | 2 | |
| Nickel | 1-hr | N/A | 5 |
| 24-hr | N/A | 2 | |
| Selenium | 24-hr | N/A | 25 |
| Annual | N/A | 10 | |
| Zinc | 24-hr | N/A | 12 |

#### 2.1.5.5 NOISE ABATEMENT ACT 1997

The Noise Abatement Act, 1997, is a legislation aimed at regulating noise pollution by controlling noise caused by amplified sound and other specified equipment. This is particularly relevant in urban areas like Kingston, which is known for its vibrant and loud entertainment culture. The act is part of a broader effort to balance the thriving entertainment sector with the need for public peace and safety. This regulation is crucial in a country where the sound system is a cultural staple.

The Act places restrictions on the production of sound in public places or on private premises; that is, it stipulates that noise should not be audible beyond 100m distance and places restrictions regarding hours of the day on the use of sound. In general nuisance caused by noise shall be avoided. Section 3 of the Act makes non-observance of these rules an offence and penalties are prescribed.

The Act does not address noise generated as a result of construction activities. The National Noise Standards for Jamaica, 1999, seeks to address this limitation by setting noise limits, designating noise zones (industrial, commercial, residential and silence) and enforcement mechanisms to manage the impact of noise on communities, such as limits for traffic, both moving and stationary.

National guidelines (NRCA) used for noise levels are an adaptation from Jamaica's National Noise Standards, 1999, and are presented in Table 2-4 below. Values for commercial, industrial and residential areas are specified.

*Table 2-4: National Zonal Noise Standards (NRCA) guidelines for daytime and night-time noise limits*

| ZONE | NRCA Daytime Guideline (dBA) (7 a.m. – 10 p.m) | NRCA Night-time Guideline (dBA) (10p.m. – 7 a.m) |
|---|---|---|
| Industrial | 75 | |
| Commercial | 65 | 60 |
| Industrial | 75 | 70 |
| Residential | 55 | 50 |

The noise levels recommended for vehicles are presented in Table 2-5.

*Table 2-5: Noise limits for moving vehicles*

| Vehicle Type | Noise Limit (bBA) |
|---|---|
| Motorbikes | 85 |
| Motor car | 85 |
| Small Commercial Vehicles | 90 |
| Large Commercial Vehicles | 95 |

### 2.1.5.6 THE NATIONAL SOLID WASTE MANAGEMENT AUTHORITY ACT 2001

The legislation that pertains to solid waste management in Jamaica is the National Solid Waste Management Authority Act, 2001. The Act established the National Solid Waste Management Authority (NSWMA). The NSWMA is mandated to effectively manage and regulate solid waste operations across Jamaica in order to safeguard public health by ensuring that waste is collected, stored, transported, recycled, reused or disposed of, in an environmentally sound manner and promote safety standards in relation to such waste. It provides guidelines for waste collection, disposal, and recycling, ensuring compliance with environmental standards.

The Act emphasizes the importance of educating the public on waste segregation and reduction strategies. The NSWMA also has responsibility for the promotion of public awareness of the importance of efficient solid waste management, to advise the Minister on matters of general policy and to perform other functions pertaining to solid waste management.

Section 23 of the Act stipulates that: "*Every person who- (a) operates or proposes to operate a solid waste disposal facility; (b) provides or proposes to provide solid waste collection or transfer services; or (c) otherwise manages solid waste, shall apply in the prescribed form and manner to the Authority for the appropriate licence*".

This Act's relevance is by virtue of the Developer wanting to have a solid waste management facility onsite, where waste is sorted and stored on site before being transferred to the nearby approved dumpsite. The Developer will therefore be guided by the NSWMA on the minimum specifications relating to equipment used for solid waste management.

Under the Act, solid waste should only be placed at an approved or designated site. The designated site for the Rozelle/White Horses area is the Riverton City Landfill. The MPM Waste Management Limited is responsible for St. Thomas, St. Catherine, St. Andrew and Kingston divisions. For the Rozelle/White Horses region, the MPM trucks offload garbage at the Church Corner disposal site in Morant Bay, where the waste is then transferred to the Riverton City Landfill.

Where the NSWMA is of the view that a solid waste disposal operation has or is likely to have an adverse impact on the natural or human environment, it may refer the matter to the NRCA.

### 2.1.6 CULTURE AND HERITAGE

#### 2.1.6.1 THE JAMAICA NATIONAL HERITAGE TRUST ACT 1985

The Jamaica National Heritage Trust Act established the Jamaica National Heritage Trust (JNHT) and has been in operation since 1985. The JNHT provides for protection of areas, structures, and objects of cultural significance to Jamaica by declaration of any structure as a national monument where preservation is of public interest due to historic, architectural, traditional, artistic, aesthetic, scientific or archaeological importance. This includes the floor of the sea within the territorial waters or the Exclusive Economic Zone.

The Rozelle Falls constitutes a national monument; a cultural heritage tourism (category-natural) site and therefore has to be preserved.

## 2.2 INTERNATIONAL POLICY FRAMEWORK

### 2.2.1 UNITED NATIONS SUSTAINABLE DEVELOPMENT GOALS (SDGS)

Development is change in a direction of economic and social progress of a people. The goal of development is a decent standard of living of a people, where there is equitable allocation of resources, which transforms into equitable distribution of income among social groups. The indicator of a developed state is therefore the quality of life of the people of the country under consideration. Measurable parameters thus include access to basic amenities such as electricity, clean and safe drinking water and sanitation facilities and economic and political freedom. More recently, clean air, reduced or lack of the threat of crime and violence, proper waste management and measures to combat climate change, have demanded their place as factors for achievement assessment.

The United Nations World Commission on Environment's classical definition of sustainable development persists to this day and states that development is sustainable if it "meets the needs of the present generation without compromising the ability of future generations to meet their needs".

Jamaica is a signatory to the UN's sustainable development goals (SDGs) and its Vision 2030 Jamaica Plan is a roadmap to meeting these goals by 2030, through the National Development Plan (NDP). Vision 2030 connects vision, goals and outcomes for Jamaica; to be achieved within a 21-year period (2009-2030) and with these goals and outcomes realized, Jamaica would achieve developed country status.

The project contributes to some of these goals, in providing basic needs of shelter, security and basic amenities for a community.

### 2.2.2. CONVENTION ON BIOLOGICAL DIVERSITY (CBD), 1992

The convention on Biological Diversity (CBD) is an international treaty aimed at "*conserving biological diversity, promoting the use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources*". This is the first global, comprehensive agreement which has as its focus all aspects of biological diversity: with emphasis on a holistic approach to conservation and use, to include genetic resources, species and ecosystems.

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

# 3. METHODOLOGY AND APPROACH

The approach for conducting the study involved several different scientific techniques. The assessment of baseline conditions for describing the natural environment involved fields inspections, GIS mapping and use of various scientific measuring devices and equipment, for instance, to determine stream flow, air quality and noise levels. Modeling software were used to conduct flood analysis to determine the site's vulnerability to flooding and storm surges. Some of the methods are described below.

### *Geotechnical Investigation*

The soil investigation was undertaken through extensive field mapping, subsurface drilling, split spoon soil sample collection, and laboratory soil testing. A total of fifteen (15) geotechnical boreholes and one (1) percolation test borehole was drilled onsite as part of the fieldwork phase of the investigation. The borehole locations for the geotechnical soil sampling and percolation testing were sited in accordance with the site layout plan.

The boreholes were drilled utilizing a CME 55 Truck-Mounted Drill Rig and executed via the rotary drilling method. Standard Penetration Tests (SPT) were performed in each of the boreholes to determine in-situ soil density (N-Value) and the associated bearing capacity of the soil. The samples obtained by spit spoon sampling were analysed by a laboratory. These tests include Grain Size Distribution, Atterberg Limits Tests, and Moisture Content. Soil compressibility was determined from Atterberg Limits Test while shear strength was determined from N-values obtained from the Standard Penetration Test (SPT). Additionally, a desktop review of existing geological and hydrogeological data of the site and its environs was done.

### *Hydrologic investigation*

#### *Stream Discharge Measurements*

Stream discharge measurements were collected on the dates September 19, 2024, October 6, 2024, October 20, 2024, and November 3, 2024. Velocity measurements were recorded at four sites. At the sites 'Dam Head' and Shadey Spring, a mini current meter was employed, while at 'Community Pipe' and 'Above Falls', the measurements were taken using the bucket-based method. The latter method involves capturing the time taken to fill a bucket with 10 litres of water and computing the flow rate in litres per second (LPS) and cubic meters per day ($m^3$/day).

### *Water Quality Assessment*

Water quality analyses were done for six (6) sites; four (4) freshwater and two (2) marine sites. The sampling was conducted over the period September to October, 2024, on the dates: 19 September 2024, 03 October 2024 and 22 October 2024.
The samples were submitted to an approved laboratory for the analyses to be conducted and the reports with the results furnished for analysis and interpretation.

### ***Hydrological Modeling***

Hydrological modeling was employed to estimate the runoff from the site's catchments and to analyze the impacts of the development on the surroundings and vice versa.

This involved:

1. Data collection to define the catchments
2. Delineating catchments and confirmation of streams and rivers
3. Calculating runoff using the US Soil Conservation Service (SCS) method
4. Re-calculating runoff implementing post-development changes throughout the catchments.

### ***Storm Surge and extreme waves***

The Mike 3D numerical model was used for this purpose. The approach was as follows:

1. Extract storms from NOAA database file (HURDAT) for storms from 1942 to 2022
2. Select storm tracks passing within 300km of the project site
3. For the selected storm tracks, use Young and Sobey (1981) hurricane model to generate wind-field associated the selected hurricane
4. Use the third-generation wind-wave model Mike21-SW, to estimate the waves and the coupled Mike 3D to determine water level/storm surge associated with each hurricane
5. Perform extremal statistics (annual maxima) on the resulting wave and water levels obtained

### *Air quality Assessment*

The air quality assessment was conducted at two locations strategically selected to capture conditions upwind and downwind of the development site. The parameters measured included:

- Particulate Matter (PM10)
- Particulate Matter (PM2.5)

The selection of sampling sites was based on safety, security, and accessibility to electricity, ensuring stable and uninterrupted operation of the monitoring equipment.

The upwind monitoring campaign was conducted from October 4 to October 22, 2024, while downwind measurements were taken from February 13 to March 3, 2025.

### *Noise level Assessment*

Continuous ambient noise monitoring was conducted at the downwind site used for air quality monitoring on the said dates. The Polludrone Air Quality Monitoring System was used for these purposes, with the requisite added sensor attached. The system was configured to record hourly noise levels, capturing Leq (equivalent continuous sound level), Lmax (maximum sound level), and Lmin (minimum sound level). This data facilitated the characterization of background noise conditions and provided insight into diurnal noise variations.

### *Socioeconomic Assessment*

A mixed-methods approach was used incorporating quantitative and qualitative data collection for analysis. Primary data was collected using surveys and secondary data used to determine historical and demographic context. A 3km sphere of influence around the proposed development boundary was utilized to determine the study area, hereinafter called the 'zone of influence'. The surveys were of two types:

- Business Survey**:** 35 local business respondents provided views on the project's potential impact between December 8 and December 15, 2024.
- Socio-Economic Survey**:** 376 household respondents from Rozelle, White Horses, and Botany Bay were surveyed during the period December 15, 2024, to January 13, 2025.

### *Ecological/Biological Assessment*

Three separate flora and fauna assessments were deemed required, due to the peculiarity of the site. The first was the typical assessment, done to identify all the flora and fauna species associated with the project site. A second series of assessments was done to make a determination on the occurrence of the endemic Blue Swallowtail Butterfly/Jamaican Kite and the plant its larval stage feeds on; the Black Lancewood. The second series of assessment was necessary as the initial surveys did not reveal the presence of the butterfly. However, the relevant literature documents the general White Horses/Rozelle area as a known breeding site for the butterfly species and so seasonal visits were conducted for this type of assessment.

The initial flora and fauna assessments are herein after referred to as the 'general flora and fauna assessment' and the assessments related to the Blue Swallowtail Butterfly and its plant food source, referred to as the 'Blue Swallowtail Butterfly Surveys'.

A third survey was conducted to identify and geo-tag all trees 30cm and larger within the zone of the property proposed for development (herein later referred to as Zone D). This constituted a Large Tree Survey.

The general flora and fauna assessments were conducted over a number of days during the month of July, in 2023. The flora assessment was done via a series of transects (100m x 5m each) within the boundaries of the development site. A total of nine (9) transects were employed. All plant species encountered within each transect was recorded. For each species, the name, perceived dominance, and growth form was noted. The dominance was graded using the DAFOR scale.

All plants were identified to the species level by examining morphological features such as leaf arrangement, leaf pattern, pattern of branching and morphology of floral and fruiting structure in conjunction with the use of the relevant literature and preserved reference specimens of the Herbarium.

The fauna assessment methodology involved two different approaches. Avifauna were assessed via the line transect method, which entails walking slowly along established routes and noting all the birds seen or heard in the area. The amphibian and reptile surveys were conducted across the different microhabitat types including trees, stone piles, abandoned structures and other debris.

The invertebrate assessment consisted of a series of walk-throughs within the project area. Various microhabitats within the project area were carefully examined. These included tree trunks, leaves, dry wood, and sticks. Insects in flight were also recorded.

The arthropods encountered in the field were identified on the spot; however, arthropods that could not be identified in-situ were later identified using Insects Keys (Triplehorn, Johnson and Borror 2005), the iNaturalist Application, and collections at the University of the West Indies where necessary.

Following the general flora and fauna assessments, a series of additional visits were made to the property, specifically to observe the Blue Swallowtail Butterfly in the general area. Areas within the lower section of the property, that is, the portion proposed to be developed, were examined as well as the remaining upper half of the parent property and immediately West and East of it. Similarly, efforts were made at detecting the occurrence of the Black Lancewood plant over the general parent property extent, to determine its occurrence and distribution.

### *Instrument Calibration*

Below is the calibration statement for the air quality and noise level monitoring equipment (calibration certification provided in Appendix 5).

BAM-1022

Field calibration or the instrument's flow rate, temperature and pressure was performed using reference standards on October 3, 2024. The calibration check/adjustment is accepted when the following parameters are met:

| Parameter | Acceptance Criteria |
|---|---|
| Flow Rate | ± 4% of transfer standard |
| Ambient Temperature | ± 2° C of transfer standard |
| Barometric Pressure | ± 10 mmHg of transfer standard |

The results of the calibration are as follows:

| Parameter | Standard | BAM-1022 | Status |
|---|---|---|---|
| Flow Rate (LPM) | 16.69 | 16.7 | Passed |
| Low flow (LPM) | 14.01 | 14.0 | Passed |
| Mid Flow (LPM) | 17.48 | 17.5 | Passed |
| Ambient Temperature (°C) | 31.87 | 30.5 | Passed |
| Barometric Pressure (mmHg) | 754 | 753 | Passed |

A leak check was performed and passed successfully prior to the calibration checks. Leak check result = 0.42 LPM.

# 4. PROJECT DESCRIPTION

## 4.1 PROJECT BACKGROUND

The Developer for this project is New Rozelle Properties Limited (NRPL). The proposed development comprises a housing development to include eight hundred ninety-five (895) residential units and associated commercial and institutional lots, open (green and recreational) spaces and social services and utilities (Table 4-1). **The development is to be called "Rozelle Estates."**

NRPL endeavoured to incorporate sustainable design principles in its Master Plan. Key features of the proposal includes:

- An onsite tertiary wastewater treatment plant to mitigate risks to groundwater and surface water;
- A proposed community reservoir to augment potable water supplied by the National Water Commission (NWC);
- Preservation of natural drainage systems including the Banfield's Gut River and Chocolate Gully, and use of nature-based solutions (NbS) including detention ponds;
- Measures to safeguard a national monument; the Rozelle Falls;
- Conservation scheme for the Blue Kite Swallowtail Butterfly and Black Lancewood plant

In preparation for the development application process, a site analysis was carried out to ascertain site characteristics, detect features on the site that would necessitate pre-design intervention, activities in proximity that could potentially cause a nuisance for the development, and identify areas for preservation. The site analysis also identified opportunities for sustainable design features.

Concept development plans were submitted to NEPA's Development Assistance Centre (DAC), in April 2021 and comments subsequently received. The Subdivision Application and Applications for Environmental Permit and Licences associated with the wastewater treatment plant were lodged with the St. Thomas Municipal Corporation and the NEPA in June and August 2023, respectively. In January 2024, NEPA requested that an EIA be done to facilitate the completion of the review process. This document hereby establishes the submission of the EIA report, prepared in accordance with the Terms of Reference (TOR) submitted to and approved by the NEPA (attached in Appendix 1).

## 4.2 PROJECT LOCATION

The project site is located at 17°52'26.63' North and 76°27'41.89 West in southern St. Thomas, Jamaica, in the district of Rozelle (Figure 4-1). Rozelle borders the White Horses district to the West and Duhaney Pen to the East. The property for development is located on the landward side of the Rozelle to Morant Bay thoroughfare between the aforesaid communities. The property in question is approximately 417 acres, however, the portion being proposed to be used for the development is 187 acres, occurring in the southern half of the land (Figure 4-5).

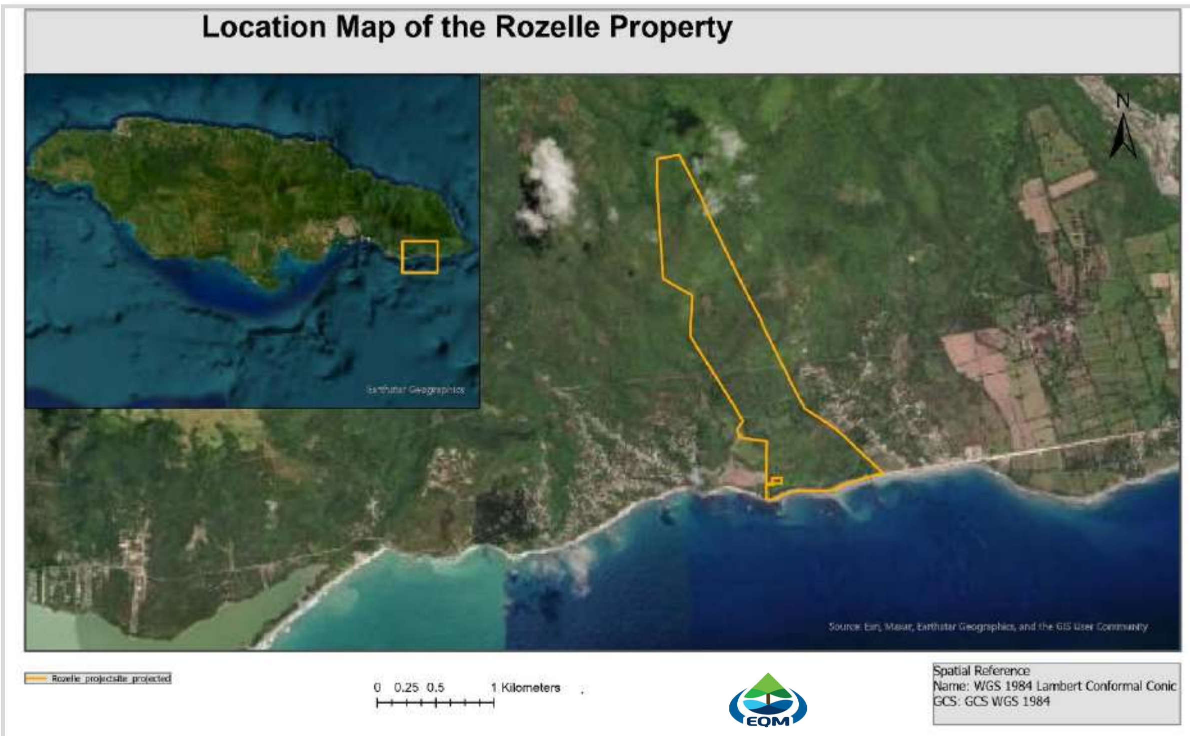



*Figure 4-1: A location map of the Rozelle property showing its location relative to the wider Jamaica*

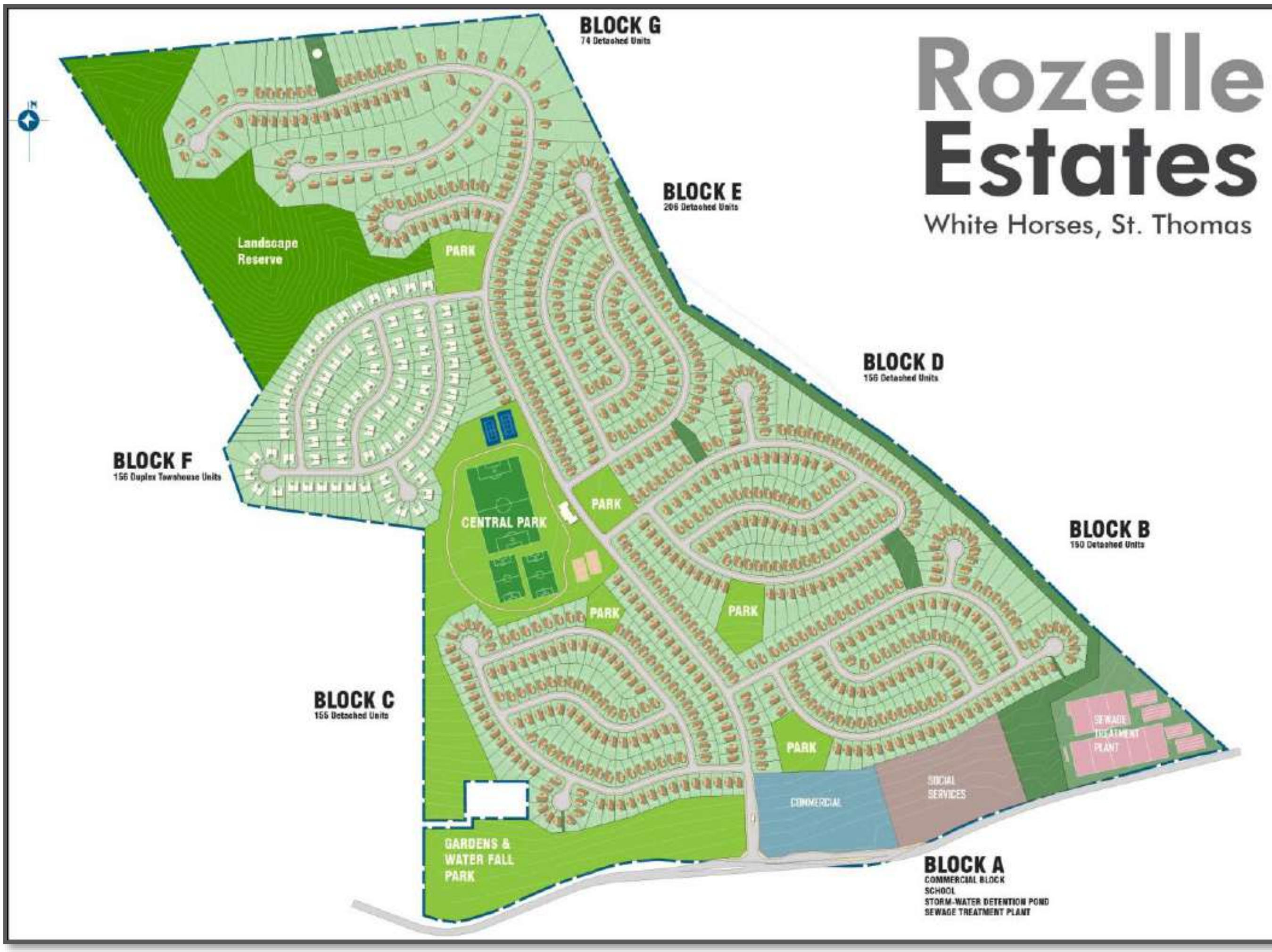



*Figure 4-2: A schematic layout highlighting the different features of the proposed development*

## 4.3 SITE SITUATION

The site is located within the district of Rozelle, which forms part of the larger White Horses community. The nearest major township West of the site is White Horses and to the East is the Belvedere community. The major landmark for the site is the popular national monument, Rozelle Falls, which the community and commuters alike, use for recreational purposes. Land cover is open dry forest and disturbed broadleaf forest. The landuse is agriculture (orchard farming and animal rearing), however, the majority of the property is in ruinate. On the eastern and western limits of the property, landuse includes residential, agriculture and built-up areas (infrastructure).


*Figure 4-3: A location map of the Rozelle property showing the site's situation relative to the surrounding communities.*

## 4.4 PROJECT SCOPE

The proposed development includes 895 residential units on approximately 187 acres of land. The lot sizes ranging from 305 sq. m – 2, 575 sq. m. (Figure 4-4). Table 4-1 presents a summary of the size allotment to each use, while Figure 4-4 shows the Master Layout Plan. The portion of the land to be allotted to housing units constitutes less than half of the parent property (46%). Figure 4-5 shows the extent of the parent property in relation to the portion being proposed for the housing development. The inset map shows the complete extent of the property, while the larger outline shows the section to be developed for the residential scheme.

To minimize environmental impacts and as responsible stewards of the environment, New Rozelle Properties Limited has allocated open spaces for landscape protection in the form of a landscape reserve, riparian forest buffer, and a nature park. The design also avoided areas with slopes greater than 35%, provides an onsite centralized sewage treatment plant to mitigate against groundwater contamination; and maintains the existing tree cover outside of the proposed development footprint. Figure 4-2 shows the open spaces in relation to the overall project area.

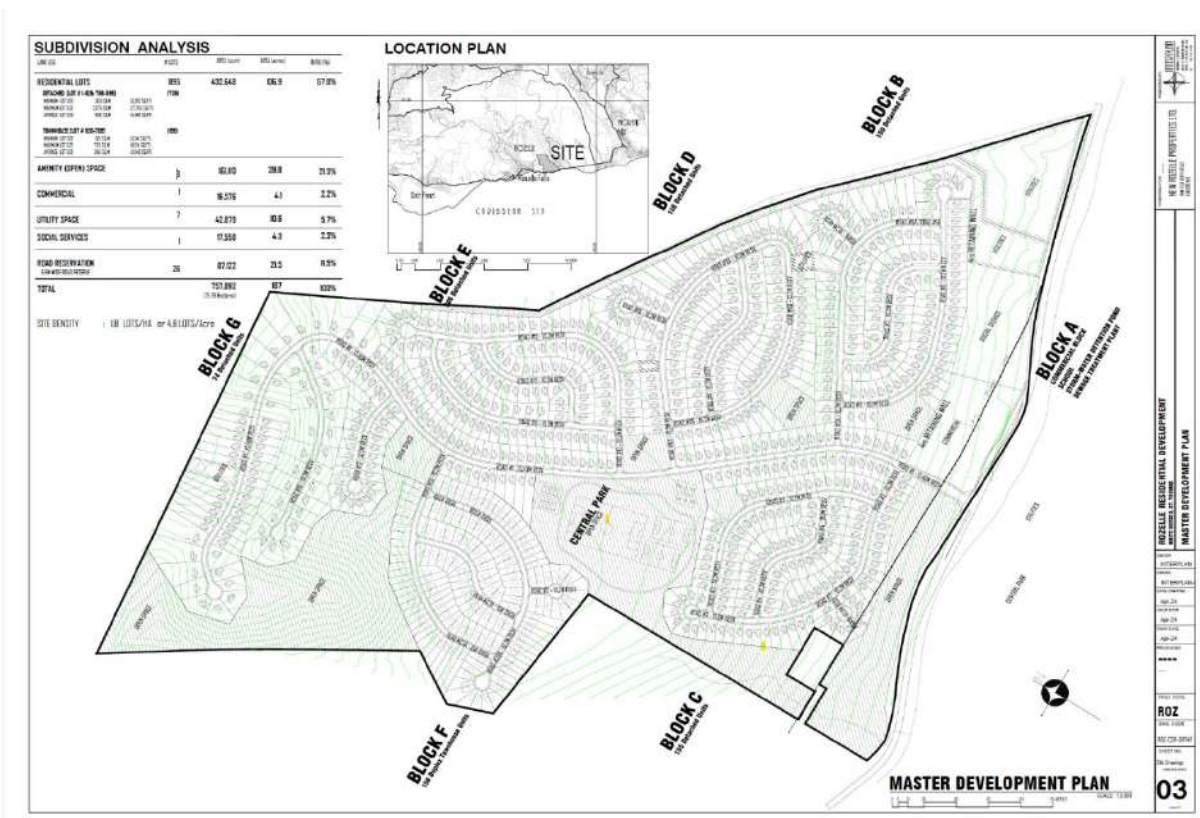



*Figure 4-4: The Master Plan for the development showing the different blocks of residential units, or phases, and the supporting amenities*

*Table 4-1: The proposed acreage allotment for the various uses across the development*

| Land Use | No. of Lots | Area (sq.m) | Area (acres) | Area (Ha.) | Ratio (Percentage) |
|---|---|---|---|---|---|
| Residential | 895 | 432, 648 | 106.9 | 43.3 | 57% |
| Commercial | 1 | 16,578 | 4.1 | 1.6 | 2.2% |
| Open Space | 8 | 163,505 | 40.4 | 16.3 | 21.3% |
| Road | 26 | 87,122 | 21.5 | 8.7 | 11.5% |
| Social Services | 1 | 18, 367 | 4.3 | 1.8 | 2.3% |
| Utilities | 7 | 42,879 | 10.6 | 4.3 | 5.7% |
| **Total** | **917** | **757,892** | **187** | **77** | **100%** |

*Table 4-2: Proposed minimum, maximum and average lot sizes for the development*

| Lot Size | Area (sq. m) |
|---|---|
| Maximum | 2, 575 |
| Minimum | 305 |
| Average | 485 |


*Figure 4-5: A depiction of the property boundaries in relation to the area proposed to be developed for housing solutions*

## 4.5 PROJECT COMPONENTS

The proposed development will consist of a mix of residential units, with supporting commercial complexes. A section is also reserved for an institution. The elements of the residential components are detailed in Table 4-3 below:

*Table 4-3: A summary of the number and types of housing units*

| Block | Number | Solution Type |
|---|---|---|
| A | | Commercial Lots, Institution, WWTP |
| B | 150 | Detached Housing Units |
| C | 155 | Detached Housing Units |
| D | 156 | Detached Housing Units |
| E | 206 | Detached Housing Units |
| F | 156 | Duplex Townhouse Units |
| G | 74 | Detached Housing Units |

The commercial complex will be arranged as a strip mall to provide shops for satisfying the various purchasing demands of the residents of the development, the wider community and commuters. There will be a building designed to accommodate a supermarket of a suitable size to satisfy the projected volume of the community. An area is reserved for the construction of a learning institution; the purpose, size and student complement will be determined by the Ministry of Education (MOE). A wastewater treatment plant will be constructed at the lowest elevation of the development to facilitate centralized sewage treatment for the residents of the development. This plant is of a modular design and is capable of being expanded to accommodate additional residencies and businesses beyond the current number in this proposal. In addition to the wide range of structures that are to be provided for the development, there will be several recreational areas to facilitate outdoor activities.

The main feature of the development is the Rozelle Falls, which is located at the southwestern section of the property. This area has a reserved vegetative buffer in excess 11 acres, and this is being provided to the Ministry of Tourism for preservation and enhancement of the Falls as a possible tourist attraction. Table 4-4 shows a summary of the provisions by Blocks and a panning analysis.

*Table 4-4: A summary of the project presented by Blocks*

**Block A**

| Land Use | Area (Sq.M) | Area (Acres) | Lots | Percentage |
|---|---|---|---|---|
| Commercial | 16,576 | 4.1 | 1 | 15.1% |
| Open Space | 30,057 | 7.4 | 1 | 27.4% |
| Residential | - | - | - | 0.0% |
| Townhouse | - | - | - | 0.0% |
| Road | 7,656 | 1.9 | 2 | 7.0% |
| Social Services | 17,558 | 4.3 | 1 | 16.0% |
| Utilities | 37,979 | 9.4 | 2 | 34.6% |
| **TOTAL** | **109,826** | **27** | **7** | **100.0%** |

**Block B**

| Land Use | Area (Sq.M) | Area (Acres) | Lots | Percentage |
|---|---|---|---|---|
| Commercial | - | - | - | 0.0% |
| Open Space | 4,046 | 1.0 | 1 | 4.9% |
| Residential | 64,408 | 15.9 | 140 | 77.7% |
| Townhouse | - | - | - | 0.0% |
| Road | 12,397 | 3.1 | 5 | 15.0% |
| Social Services | - | - | - | 0.0% |
| Utilities | 1,996 | 0.5 | 2 | 2.4% |
| **TOTAL** | **82,848** | **20** | **148** | **100.0%** |

**Block C**

| Land Use | Area (Sq.M) | Area (Acres) | Lots | Percentage |
|---|---|---|---|---|
| Commercial | - | - | - | 0.0% |
| Open Space | 2,054 | 0.5 | 1 | 2.2% |
| Residential | 77,614 | 19.2 | 179 | 85.0% |
| Townhouse | - | - | - | 0.0% |
| Road | 11,598 | 2.9 | 4 | 12.7% |
| Social Services | - | - | - | 0.0% |
| Utilities | 79 | 0.0 | 1 | 0.1% |
| **TOTAL** | **91,345** | **23** | **185** | **100.0%** |

**Block D**

| Land Use | Area (Sq.M) | Area (Acres) | Lots | Percentage |
|---|---|---|---|---|
| Commercial | - | - | - | 0.0% |
| Open Space | 7,960 | 2.0 | 2 | 9.2% |
| Residential | 66,181 | 16.3 | 141 | 76.1% |
| Townhouse | - | - | - | 0.0% |

| | | | | |
|---|---|---|---|---|
| Road | 11,888 | 2.9 | 4 | 13.7% |
| Social Services | - | - | - | 0.0% |
| Utilities | 943 | 0.2 | 1 | 1.1% |
| **TOTAL** | **86,972** | **21** | **148** | **100.0%** |

**Block E**

| Land Use | Area (Sq.M) | Area (Acres) | Lots | Percentage |
|---|---|---|---|---|
| Commercial | - | - | - | 0.0% |
| Open Space | - | - | - | 0.0% |
| Residential | 67,716 | 16.7 | 159 | 85.9% |
| Townhouse | - | - | - | 0.0% |
| Road | 11,071 | 2.7 | 3 | 14.1% |
| Social Services | - | - | - | 0.0% |
| Utilities | - | - | - | 0.0% |
| **TOTAL** | **78,787** | **19** | **162** | **100.0%** |

**Block F**

| Land Use | Area (Sq.M) | Area (Acres) | Lots | Percentage |
|---|---|---|---|---|
| Commercial | - | - | - | 0.0% |
| Open Space | 59,454 | 14.7 | 2 | 44.7% |
| Residential | 5,687 | 1.4 | 10 | 4.3% |
| Townhouse | 57,126 | 14.1 | 156 | 42.9% |
| Road | 10,888 | 2.7 | 5 | 8.2% |
| Social Services | - | - | - | 0.0% |
| Utilities | - | - | - | 0.0% |
| **TOTAL** | **133,155** | **33** | **173** | **100.0%** |

| Planning Analysis | Required | Provided | |
|---|---|---|---|
| Open Space Required | 22.38 | - | |
| Maximum Density Allowed | 6 | 8.37 | Lots Per Acre |
| Total Units | **1,124** | 895 | |
| Habitable rooms /acre | | | |
| Minimum Res-Det Lot Area | 305 | | |
| Minimum Res-Townhouse Lot Area | **301** | | |

| | | |
|---|---|---|
| Projected Population (4 ppu) | 3,580 | persons |
| Water Requirements | 143,200 | gallons per day |

### 4.5.1 HOUSING DESIGN

The Figures 4-6 to Figure 4-11 show the details of the proposed 1 and 2-bedroom unit designs.

*Figure 4-6: A schematic diagram of the facade for the proposed standard 1-bedroom unit.*

*Figure 4-7: A schematic diagram of the facade for the proposed standard 2-bedroom unit.*

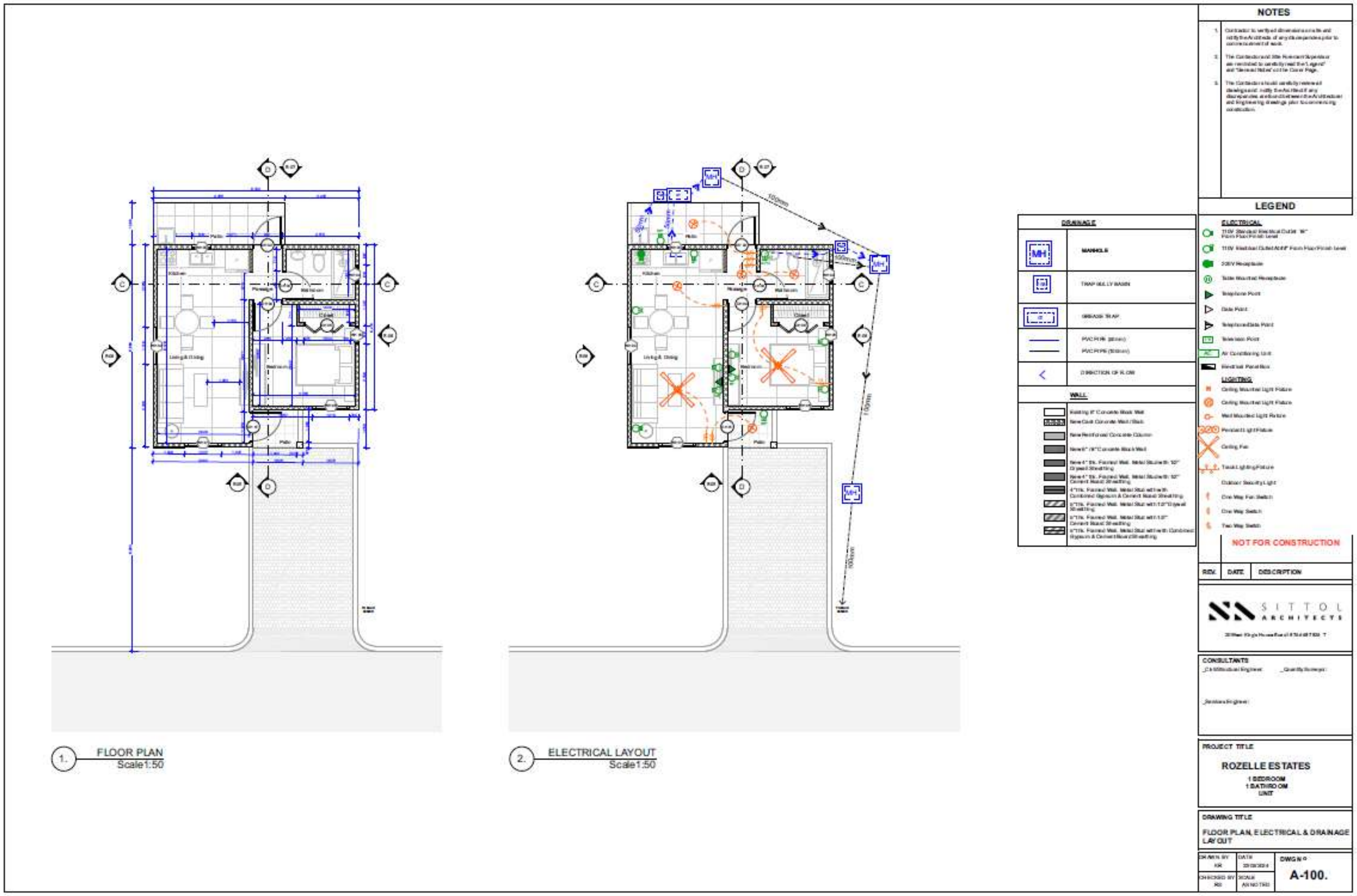



*Figure 4-8: Floor plan and electrical drawings for the standard 1-bedroom unit.*

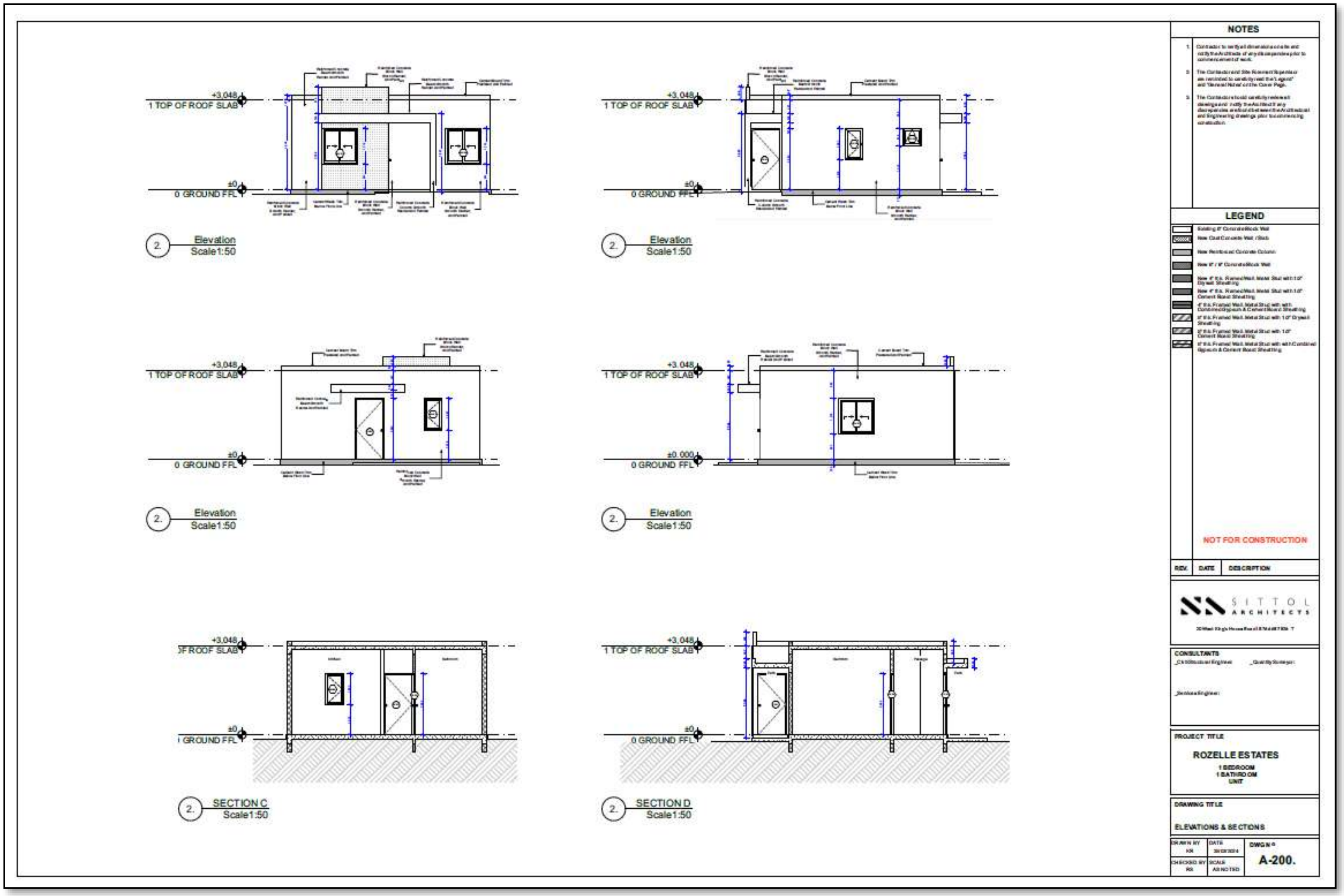



*Figure 4-9: Proposed elevations for the 1-bedroom unit*

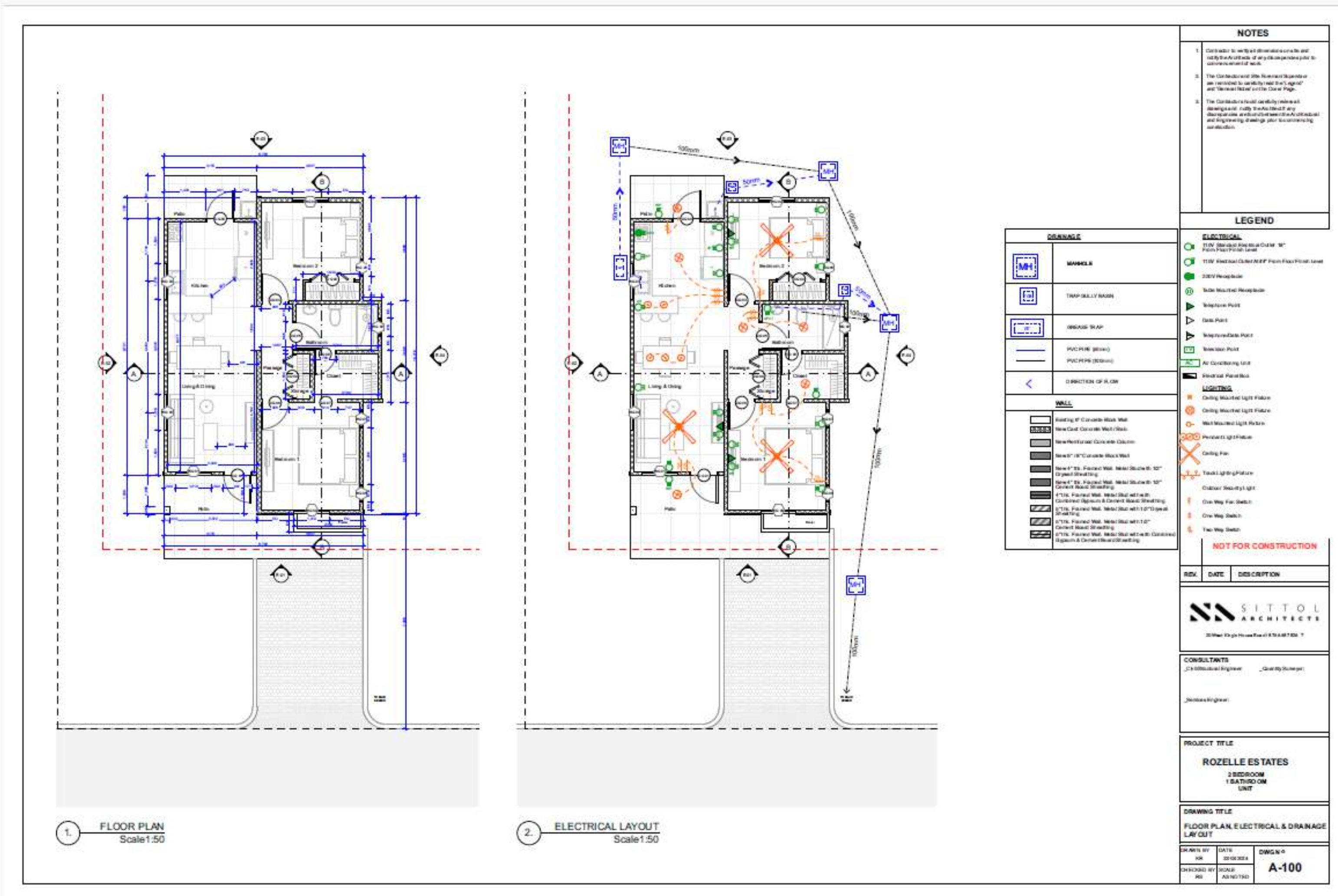



*Figure 4-10: Schematic diagram and electrical drawings for the standard 2-bedroom unit*


*Figure 4-11: Plan elevations for the proposed 2-bedrood unit*

### 4.5.2 STRUCTURAL COMPONENTS

The details in the form of design plans and drawings illustrating roadways, building structural components and wastewater treatment design are attached. Also attached are the details on utilities and services.

#### 4.5.2.1 UTILITIES

##### 4.5.2.1.1 Water Supply

Potable water for the development will be sourced from wells in the parish either independently and treated, or through the National Water Commission (NWC). The NWC has networks adjacent to the project area that serve both from Yallahs and Morant Bay.

Potable water will be delivered directly to a 600,000 US gallon storage tank at the highest point within the development. From there it will gravity feed through a network of PVC distribution pipes throughout the development. This configuration allows for energy efficiency and delivery of potable water at the required pressures.

##### 4.5.2.1.2 Stormwater System

The stormwater runoff will be managed by a stormwater drainage system that will include a network of inlets and subsurface HDPE pipes. The system will feature a number of detention ponds strategically located to manage sediments and to reduce the peak runoff from the development. The final stormwater discharges will be directed to the existing swales adjacent to the highway. These discharges will be at the same or lower rate as the predevelopment rates.

##### 4.5.2.1.3 Electricity

The property is located close to the nearest JPS Power plant, which is the Goodyear Sub-station and thus, connecting to the facility should be with relative ease.

# 4.6 CONSTRUCTION METHODOLOGY

## 4.6.1 PRELIMINARY WORK

The pre-construction activities involve clearing the development footprint of shrubs and trees to provide visibility for line of sight, cutting and filling, setting out the roadways and establishing alignment and setting out markers. Then, preparing the compound for stockpiles of materials, equipment, and establishing site offices and storage. After establishing visibility and accessibility for alignment and setting out of roadways, the excavation will be done to prepare for the construction of the roadways. The provision of the roadways will allow for the delineation of the areas designated for housing, commercial spaces, the WWTP, parks and recreational areas, and any other reserves as indicated in the designs herein submitted. These areas so defined, will then become available for reduced levelling, filling or landscaping, as the schedule of works will indicate. Such activities will be undertaken concurrent with the continuing civil works which will potentially be carried out by different work teams/contractors for the simultaneous completion of works.

### 4.6.1.1 SITE CLEARANCE

Site clearance will involve the use of some heavy-duty equipment including backhoes, bulldozers, dump trucks, and chain saws to cut the trees within the building footprint. The following is the typical procedure for clearing a site:

- Trees to be removed are identified and flagged prior to site clearance.
- All equipment and supplies required are put in place and checked for functionality.
- Traffic management is arranged if necessary.
- Large trees are cut in pieces with chain saw.
- Felled trees are loaded into dump trucks and taken to the dump.
- Bulldozer felt small trees and shrubs. The bulldozer also strips the site of topsoil, which will be stockpiled in the designated area.
- Areas are levelled and compacted.
- All spoils are loaded in trucks taken to the dump
- Surveying and pegging of phase footprint

- Establishing of works yard and materials stockpiling area

#### 4.6.1.2 ACCESS ROAD AND MATERIAL STOCKPILING

The access road for the site is required to allow for trucking of material cleared from the site and the carting of construction material to the site. Figure 4-12 shows the layout plan indicating what will be the main access road for the construction site and highlights the tentative location for material stockpiling. These areas have been chosen to avoid natural and constructed drainage paths.

Materials will be stored in stockpiles and in a designated control area to provide for consistency and accountability. This will necessitate the provision of constructed holding areas using berms or creating bins as the usage may require. The works yard will adopt a migratory pattern as the work progresses and completed units in blocks are handed over.

This area reserved for stockpiling of material will also house:

- Construction-related heavy equipment
- Chemicals used for fuelling vehicles

Locating the material and equipment closer to construction activities is essential for efficiency and timely completion for a project given its scale.

#### 4.6.1.3 INSTALLATION OF SITE OFFICE

Given the magnitude of the development, a temporary site office will be required. Figure 4-12 shows the intended location for the site office. The office area will be a section of the stockpiling area for ease of decommissioning when construction is completed.


*Figure 4-12: Diagram showing the location of the access road, site office and 'works yard' where aggregate material and equipment will be temporarily stored.*

### 4.6.2 CONSTRUCTION PHASE

The order of construction activities for the Rozelle housing project begins with clearing the required lands of shrubs and trees to provide visibility for line of sight, cut and fill, and setting out. The initial clearing will be done in a location best suited to establish a compound for delivery and holding of materials, parking of equipment, site offices and storage.

Here the roadways and verges will be established. This is to be implemented on a phase completion schedule to coincide with the delivery of the units that are to be completed in the respective phases.

#### 4.6.2.1 SUBDIVISION OF ROADWAYS AND HOUSING UNITS

The roadway construction will include the provision of sidewalks and verges, including preparation for laying of pipework for potable water, sewage, and storm water. The installation of utility poles by the electrical contractor will commence after the completion of kerbs and before the construction of sidewalks. The civil works infrastructure is to be carried out on a phased completion schedule to coincide with the delivery of units that are to be completed and delivered in batches in their respective phases.

The reduced levelling or filling respectively for the construction of the housing units will commence as soon as accessibility is available for men and wheeled equipment on the roadways leading to the respective blocks. This will allow for not only the cutting or rolling of the area, but also for lifting of tunnel form work and the pouring of concrete as this will be the method of construction for this project. There will therefore be the commencement of construction of the housing units in Block B. This is the most strategic block to start unit construction because of its proximity to the main road and the site compound. This area will be the first to have the roadway established and therefore the demarcation of the housing alignment.

#### 4.6.2.2 WASTEWATER TREATMENT PLANT (WWTP)

The construction of the WWTP will begin in a timely manner to achieve practical completion in coordination with the take up of the units being handed over to the purchaser. This timeline is not a critical path at the commencement of pipelaying, but this facility must be completed in its modular stage to process the delivery of wastewater relevant to the volume discharged from households comprising the number of units inhabited upon completion of the phases delivered and deemed to be habitable without disruption of ongoing works to complete the other phases.

#### 4.6.2.3 PERIMETER FENCE

This development is slated to be a gated community with the entrance located on the Southern end of the development. A perimeter fence will therefore be required to accomplish this condition. Considering the environmental conditions around the site, a concrete fence is deemed most appropriate. The construction of the fence will start at the entrance in the South and proceed in both directions simultaneously.

#### 4.6.2.4 COMMERCIAL COMPLEX AND INSTITUTION

The construction of the commercial complex and school is not scheduled to be completed before the full completion of the entire project. This is to allow for the maximum usage of these facilities, which are designed to accommodate the full capacity of the development and more.

### 4.6.3 DETAILS OF EQUIPMENT AND MACHINERY

As previously mentioned, the development is to be carried out in phases, over a land extent of 187 acres. Given the geology of the site (Chapter 6), and landscape features, several units of large-scale heavy equipment will be required to complete the clearing, cutting, filling, and shaping of the land within the stipulated timeframe. The list of heavy equipment anticipated to be required for the construction of the housing units include:

- Two (2) 30-tonne bulldozers
- Two (2) front end loaders comparable to Caterpillar 350
- Five (5) backhoes
- Two (2) motor graders
- Six (6) single drum and double drum roller and compactors

At least one bulldozer of a minimum size D9 will be required. Three or more excavator of minimum size 30 tons will be required. Two front end loaders comparable to Caterpillar 350 will be engaged. There will be a minimum of five backhoes employed on the project at every construction stage of the development. Two motor graders will be active on the roadway and open field designs, where such areas are to be shaped, graded and sodding with the specified flora in design. A mix of single drum and double drum roller and compactors will be utilized at different stages of the project. These may number as many as 6 units at a given time in the construction.

#### 4.6.3.1 Concrete and Roadway Asphalting

It is anticipated that batched concrete will be transported to the site to supply concrete for the development. This will necessitate the use of concrete mixer trucks and pump trucks. An asphaltic batching plant will not be required but the paving of the road will necessitate an attending asphalt paver housed on site for the duration of paving. The hot mix asphalt transport trucks may not be required to remain on site unless they are housed for convenience of accessibility and efficiency. The attending static and tire roller will also be housed on site during paving operations. The anticipated equipment for this component includes:

- Two (2) mixer trucks
- One (1) pump truck
- One (1) asphalt paver
- Two (2) rollers

#### 4.6.3.2 Cutting and Filling

Trenchers may be required for effective cutting through rock in areas that are slated for assorted pipe laying to accommodate potable water, sewerage, or any underground cabling design. Depending on the volume of rock extraction, not more than 2 trenchers will be required. For the drilling of holes to plant electrical poles, an auger truck will be employed. Cutting and filling equipment will therefore include:

- Two (2) trenchers
- One (1) auger truck

#### 4.6.3.3 Dumping/Material Disposal

Given the magnitude of cutting and filling that will be required for this undertaking, multiple dump trucks will be employed on the site. These trucks may not necessarily be all housed on the site as the contractor will employ local truckers to supplement the site dump trucks which is more cost-effective as well as conducive to engaging local business arrangements. The number of dump trucks may range between 10 and 20, depending on the stage of cutting for each phase. Only dump trucks required here.

#### 4.6.3.4 Dust Control

Water trucks for dust control and providing water for the various requirements will be needed for the duration of the project. These may number as many as five in any given stage of the construction. Also, there will be an assortment of utility trucks that will traverse the site during construction.

### 4.6.4 HUMAN RESOURCES

There will be simultaneous undertaking of several activities at the commencement of the project. Particularly: the infrastructure activities of road alignment, cutting and filling, wastewater treatment facility, and identification of lots for unit layout. As the construction will be undertaken in phases, the employment will have an initial take up of skilled tradesmen, labourers and equipment operators along with support staff, that will migrate to each phase of the project as the construction progresses. It is therefore estimated that between 300 to 500 persons will be employed for the duration of the project.

The workforce will consist of engineers, technicians, equipment operators, drivers, tradesmen, clerks, skilled labour force and unskilled labour force, and security personnel.

It is anticipated that the majority of the workforce will be from the surrounding area and will not need accommodation on the site itself. However, the experience the project team has had is that lodging for the persons engaged was easily acquired from the nearby districts.

#### 4.6.4.1 INDUSTRY STANDARDS AND REQUIREMENTS

It is the intention of the Developer to provide the standard workday requirements for the workforce engaged with the project.

For daily housing needs such as shelter, sanitary requirements, change rooms, lockers and workstations where necessary. Retrofitted containers and portable water closets will satisfy these requirements. The retrofitted containers will have lockers for storage of personal items and sheds will be erected for lunch areas and shelter from the elements. These containers are also equipped with offices and for the holding of requisite meetings on site.

The Developer commits to using local skills and labour for the development as much as practical, having experienced that this approach is mutually beneficial to all stakeholders.

### 4.6.5 PROJECT SCHEDULE

The development will take place in phases. *Figure 4-2* shows the master site plan. It outlines the different blocks by which the development will be executed. The overall design of the proposed development is organized in phases, or blocks labelled A to G. The facilities located in block A are non-residential and contain all the services; commercial and social, that are deemed necessary for the convenience of the development. The residential blocks will commence immediately after the roadway construction provides efficient access to them, and the proposed blocks will be completed sequentially beginning with the blocks positioned in the location most accessible from the concentration of resources. It is estimated that the project will commence by Summer of 2025. The units are expected to be completed and delivered in batches of 50 and the scheduling of these deliveries should see the project being completed over a period of five (5) years. The details of the project schedule are presented below. This schedule provides a high-level overview of the construction process, allowing for flexibility in timelines based on actual project progress and any unforeseen delays. Each phase includes key activities to ensure a smooth transition from preliminary work to construction to final handover. The phases by block is summarized in Table 4-5 below.

*Year 1*

**Phase 1: Site Preparation (Months 1-12).**


- Site Clearing: Clear vegetation and existing structures.
- Grading and Excavation: Level the site and prepare for construction.
- Road Construction: Cut and align access internal roads to allow for simultaneous activities.
- Utilities Installation: Set up temporary utilities for construction (water, electricity).
- Construction of 100 units located in block B

*Year 2*

**Phase 2: Infrastructure Development (Months 1-12)**

- Road Construction: Build access and internal roads.
- Utility Installation: Install permanent utilities (water, electricity, sewage systems).
- Site Amenities: Develop communal amenities (parks, playgrounds) and perimeter fencing.
- Construction of 160 units located in blocks B and C

*Year 3*

**Phase 3: Construction of phase 3 -Commencements of Landscaping– phase 1 & 2 - (Months 7-12)**


- Construction of 310 units located in Blocks C, D, E, F and G.
- Commencement of Landscaping activities: Implement landscaping plans, including planting trees and shrubs throughout the development.
- Exterior Finishing: Complete driveways, sidewalks and fencing.

*Year 4*

**Phase 4: Final Inspections and Testing (Months 1-6)**

- Quality Inspections: Conduct final inspections for building code compliance.
- System Testing: Test electrical, plumbing and other systems checks.
- Construction of 200 detached houses and, 80 two- bedrooms, 50 townhouse units, in 25 duplex batches, from Blocks E, F, and G.


*Year 5*

**Phase 5: Decommissioning and Site Handover (Months 7-12)**

- Construction of 75 housing units in Blocks F and G.
- Decommissioning: Remove temporary structures and restore the site.
- Handover: Transition the site to a residential subdivision with units ready for sale.

The number of blocks per phase is further summarized below in Table 4-5.

*Table 4-5: Description of the proposed construction phases, by blocks and number of units.*

| Phase | Block/S | Number of Units |
|---|---|---|
| Phase 1 | Block B | 100 |
| Phase 2 | Block B and D | 160 |
| Phase 3 | Blocks C, D, E, F and G | 310 |
| Phase 4 | Blocks E, F, and G | 250 |
| Phase 5 | Blocks E, F, G | 75 |

# 4.7 WASTEWATER TREATMENT PLANT

The treatment plant is an ECOfluid USBF wastewater treatment plant. The USBF process is a single sludge denitrification, extended aeration activated sludge process that incorporates Upflow Sludge Blanket Filtration (USBF), an anoxic selector zone and sludge wastewater treatment plant that will serve the Rozelle Housing development, comprising approximately 895 house lots, and institution and commercial lots. It's estimated that the development will generate approximately 1.2 $m^3$ /d per house, giving a total estimated flow of 1,300 $m^3$. The subdivision and housing development application was submitted prior to the Authority; bearing reference number 2023-03017-EP00277. The treatment system is an up-sludge blanket flow (USBF) one, designed by ECOfluid Systems Inc and built and operated by Aquatic Solutions and Innovations Jamaica Limited (ASI). It is an advanced wastewater treatment system, capable of treating sewage to tertiary level and meeting the Natural Resources Conservation Authority (NRCA) Wastewater and Sludge Regulations, 2013.

## 4.7.1 WWTP COMPONENTS

The components include:

1. *Headworks/Primary Treatment*

A coarse bar screen and an inclined mechanical screen complete with a rejects handling system installed within a concrete channel, screens sewage discharges by gravity into an Equalization Tank (EQT).

2. *Biological Treatment*

- Upflow Sludge Blanket Filters (USBF) bioreactors: Primary treated sewage mixes with recycled sludge from the bottom of the Sludge Blanket Filters (SBF) under anoxic state.
- Membrane Bioreactor (MBR)
- Integrated Fixed Film Activated Sludge (IFAS)

3. *Aeration*

The mixed liquor flows to the aeration compartment equipped with fine bubble aeration diffusers, is aerated and moved in a plug flow manner, and eventually enters the bottom of the Upflow Sludge Blanket Filters.

4. *Tertiary Treatment is carried out via:*

- Sand filtration
- Microscreen filtration
- Cloth Media Filtration
- Membrane filtration
- UV Disinfectant

*Table 4-6:Design parameters of the WWTP*

| Parameter | Unit of Measure | Influent (1) | Effluent (2) (4) NEPA | Effluent (3) (4) Irrigation |
|---|---|---|---|---|
| Average Daily Flow | [m3/d] | 690 | | |
| Peak Hourly Flow into EQT (5) | [m3/h] | 73 | | |
| EQT Volume | [m3] | 120 | | |
| Flow Rate into BR | [m3/h] | 41 | | |
| BOD5 | [mg/l] | 300 | < 20 | 15 |
| COD | [mg/l] | 500-600 | < 100 | < 100 |
| TSS | [mg/l] | 280 | < 20 | 15 |
| TKN | [mg/l] | 15-45 | | |
| Total Nitrogen | [mg/l] | | < 10 | ~20 |
| Phosphorus (PO4-P) | [mg/l] | 5-15 | < 4 | ~8 |
| pH | | | 6-9 | 6-9 |
| Faecal Coliform | [MPN/100 ml] | | < 200 | 12 |
| Residual Chlorine | [mg/l] | | < 1.5 | < 0.5 |
| Oil and Grease | [mg/l] | | | 10 |

## 4.7.2 TREATMENT PROCESS

### 4.7.2.1 BIOLOGICAL TREATMENT PROCESS

The following is an abbreviated description of the relevant biological treatment processes.

Influent wastewater is treated by an aerobic process by microorganisms such as zoogloea, protozoans and rotifers. These microorganisms consume the carbonaceous pollutants and produce flocculent particles that can be separated from the water in the clarifier.

Microorganisms require a continuous source of oxygen to perform their function. They utilize carbon, nitrogen and phosphorus in the ratio of 100:5:1. If these nutrients are not present in the exact ratio, the final effluent may contain residues, or the operation may suffer from nutrient deficiencies. The bioreactor volume provides the necessary retention time to allow for the maximum utilization of nutrients.

In the aeration compartment, nitrogen in the form of ammonia is oxidized to nitrate in a process referred to as nitrification and in the anoxic compartment it is converted to nitrogen gas by biological denitrification.

Phosphorus is removed by a biological process referred to as "luxury uptake" – by exposing the mixed liquor to alternating oxide and anoxic conditions. Under these conditions, the cells store more energy in the form of phosphorus than needed for their survival. If strictly oxide conditions are maintained during clarification, phosphorus will be retained by the cells, and it will be removed with excess sludge.

The activated sludge treatment process relies on simultaneously maintaining a number of operating parameters within specified ranges by controlling the process input variables as described below.

#### 4.7.2.2 HEADWORKS

Raw sewage is collected by a collection system and passed through a Coarse Bar Screen CCBS) followed by an inclined mechanical Influent Screen [IS], then into the Equalization Tank (EQT). The EQT is also equipped with an emergency overflow pipe directly into the BR1.

The EQT is provided with a well sloped bottom, a pump well, and coarse air bubble diffusers to keep the solids in suspension and minimize the solids settling within the tank. The tank is equipped with one set of submersible Equalization Tank Pumps (EQP1,2), with two pairs of submersible pumps lift out systems installed for future phases 2 and 3. Each set is dedicated to a biological treatment module and consists of one duty and one standby pump. Controlled by level switches and timers, raw sewage is pumped through an influent flowmeter and into the anoxic compartment of the Bioreactor (BR1).

The duty pump starts on HI level in the tank and stops on LO level. Should the duty pump fail to start on HI due to 'no current' condition, the standby pump will start, and the condition will be annunciated. Note that operation of both pumps in the same set at the same time is PLC disallowed. The pumps' level switch-controlled operation is overridden by a resettable timer controlling the durations of duty pump ON / OFF periods. The timer can be adjusted based on the actual operating conditions (the initial setting is 180 seconds ON, 300 seconds OFF).

Should both EQP fail, and the level keeps rising, the sewage will overflow to the Rapid Infiltration Basin (RIB) and this condition should be annunciated by the HI/HI alarm.

To ensure trouble free operation, it is important that the presence in the influent of materials harmful to the treatment biology, such as the following, is minimized:

- Oil and fat (in concentrations higher than 30 mg/l)
- Paints and paint thinners
- Acids and alkalis
- Petroleum products
- High strength cleaners and detergents
- Large quantities of chlorine (e.g. pool chlorine)

### 4.7.2.3 BIOREACTORS

#### 4.7.2.3.1 Anoxic Compartment

The bioreactor anoxic compartment is equipped Anoxic Mixers to mix the influent sewage with activated sludge recycled by means of airlift RAS pumps from the bottom of the Upflow Sludge Blanket Filter (USBF), and to keep solids in suspension in the mixed liquor. The anoxic compartment is also equipped with coarse air bubble diffusers which provide mixing if the mixers are inoperative. From the anoxic compartment, the mixed liquor flows to an aeration compartment.

#### 4.7.2.3.2 Aeration Compartment

The aeration compartment is equipped with fine bubble aeration diffusers. The diffusers are laid out in a manner to ensure even aeration of the entire volume of the compartment. Air into the diffusers is adjusted by hand-turned valves and VFDs. Aerated, the mixed liquor eventually enters the bottom of the USBF filter.

#### 4.7.2.3.3 Upflow Sludge Blanket Filter (USBF)

Separation of water from the sludge takes place in the prism-shaped USBF installed within the bioreactor. The USBF has a high specific rate of separation, and it is hydraulically self-regulating. The mixture of microbial cells and water enters the clarifier at the bottom and, as it rises, its upward velocity decreases until the sludge flocs become stationary forming a filtering media and effectively filtering out colloid and very fine particles. The higher the flow, the higher the sludge flocs rise and the larger the filtration area becomes.

During higher flows a very distinct interface between the clear effluent and the sludge blanket should be visible below the effluent surface. The sludge blanket should never rise higher than 10 cm below the effluent weir.

While the operation of the USBF is fully self-regulating, it is important that it is inspected regularly, and any developing problems corrected. No or low flow through the USBF or loss of RAS flow may cause sludge settling at its bottom. Prolonged settling may cause anoxic conditions, which in turn may result in nitrogen gas formation due to denitrification. Rising nitrogen gas may carry lumps of sludge to the surface of the USBF. The lumps can be skimmed off the surface, or they can be broken down by water spray.

It is also possible that the surface of the USBF will occasionally contain internally and externally carried-over materials, such as light plastic, corn kernels, leaves and fats and oils. These should be periodically skimmed off the surface. To that end the USBF is provided with a skimming system and periodically as required, the USBF surface is skimmed by operating the air lift valves of the skimmer system. The surface debris overflows to skimmer troughs and is transferred back into the aeration compartment for further processing.

Clarified treated effluent is collected in a trough on top of the USBF before flowing by gravity to effluent post treatment (chlorine disinfection).

#### 4.7.2.3.4 Recycled Activated Sludge

Recycle of activated sludge from the bottom of the USBF filter is accomplished by means of Recycled Activated Sludge Pumps [RASP] airlift pumps. The rate of flow is adjusted from time to time to be within approximately three to four times the average daily flow.

#### 4.7.2.3.5 USBF Filter Blow-Off

It is possible that due to prolonged low or no flow, or low RAS flow, sludge may deposit at the bottom of the USBF filter. This may result in anoxic conditions, nitrate denitrification and nitrogen gas formation, which may lift 'chunks' of denitrified sludge to the surface of the USBF filter. Should this occur, the bottom of the filter can be cleaned by a reverse air flow blow-off accomplished by shutting the RAS discharge valve. The blow-off should be short in duration (20-30 seconds) and not performed often.

### 4.7.2.4 NUTRIENT REDUCTION

Nitrogen is removed by nitrification and denitrification processes. Nitrification is autotrophic and all USBF® integrated bioreactors are designed for complete nitrification of ammonia to NO3. Denitrification, however, is heterotrophic and requires carbon source. Conventional plants' "separate-sludge denitrification" requires that carbon is added, typically in the form of methanol. This adds to operating costs, and if used in excess, it increases effluent BOD5 content. USBF® technology's "single-sludge denitrification" approach uses an endogenous carbon source to maintain the denitrifies. Influent is combined with nitrified mixed liquor in the anoxic compartment providing the carbon source needed for denitrification. Relatively high nitrified mixed liquor recycle rates are employed and sufficient denitrification retention times provided.

USBF® technology delivers not only high efficiency of organic matter reduction but also increased efficiency of phosphorus removal by biological phosphorus uptake. Biological phosphorus uptake, sometimes referred to as "luxury uptake", occurs with exposure of activated sludge to alternating oxide and anoxic conditions. Under the conditions, the cells store more energy in the form of phosphorus than needed for their survival. If strictly oxide conditions are maintained during subsequent clarification, phosphorus will be retained by the cells, and it will be removed with excess sludge. Unlike most other methods of clarification, the sludge blanket filtration process maintains oxide conditions in the clarifiers, and phosphorus reduction by biological uptake is achievable.

### 4.7.2.5 POST TREATMENT DISINFECTION

From the USBF filters the effluent flows by gravity, passing through a Chlorine Tablet Feeder (CTF1) to receive chlorine for disinfection and then entering the Chlorine Contact Tank (CCT1). The Contact Tank is provided with baffled compartments, and its volume assures a minimum of 30 minutes residence time for the peak flow. From the chlorination contact tank, the treated effluent overflows to Dechlorination Tablet Feeder (DTF1) to decrease the residual chlorine in the effluent, through the effluent flowmeter, and then to Rapid Infiltration Basin (by others).

### 4.7.2.6 AIR MANAGEMENT

Air to BR1 aeration, equipped with fine air bubble diffusers, and air to BR1 anoxic compartment, equipped with coarse air bubble diffusers, is supplied by two Main Air Blowers (ABM1,2), one duty and one standby. The blowers are provided with pressure indicators, pressure relief valve and low-pressure switches to annunciate air delivery failure.

Valves of the manifolds supplying the aeration diffusers are manually adjusted to ensure even distribution of air throughout the aeration compartment of the bioreactor. Small, periodic adjustments may be required. The Dissolved Oxygen (DO1) meter located in the aeration compartment of BR1 should control the VFD on the duty ABM to keep the aeration compartment DO level within target range.

Should the operator wish to manage air manually, small adjustments to duty ABM VFD or to the manifold valves should be made based on DO trends and averages over a period of days. Adjustments should be made a minimum of 24 hours apart and DO readings taken at the same time each day.

Air to coarse air bubble diffusers installed in EQT, SHT1 and the BR1 RAS air lift pumps, is supplied by two Auxiliary Air Blowers (ABA1,2), one duty and one standby. The blowers are provided with pressure indicators, pressure relief valve and low-pressure switches to annunciate air delivery failure. The auxiliary air quantity can be controlled by manually adjusting the VFD of Auxiliary Blower and adjust the valves on manifolds.

#### 4.7.2.7 SLUDGE MANAGEMENT

Since the Sludge Residence Time (SRT) in the bioreactors is in excess of 25 days, less waste sludge is generated, it is stabilized, and its dewatering characteristics significantly improve. Generated sludge is thickened to approximately 1-2 % dry solids in the Sludge Pre-Thickener (SPT1) located within aeration compartment of the BR. Sludge enters the top opening of the pre-thickener compartment and it is thickened by gravity and by hydraulic action in the bottom part. Controlled by a timer, thickened sludge is periodically pumped by a Pre-Thickener Pump (PTP1) to the Sludge Holding Tank (SHT1). SPT1 thus serves two functions, sludge thickening and Sludge Residence Time (SRT) management by MLSS concentration trending. The operator can calculate how much WAS is theoretically generated each day and then set the PTP1 to automatically remove that amount of WAS from the BR1.

The SHT1 is provided with a level monitor and a Sludge Pump (SP1). The level in the tank is recorded daily and the sludge periodically pumped to Sludge Drying Beds (SDB1-4) as required in the event that the HI level float is reached, sludge must be pumped immediately.

##### 4.7.2.7.1 Maintenance and Operation Plan

The Maintenance and Operation Plan for the WWTP is attached.

### 4.7.3 DECOMMISSIONING PROTOCOL

Prior to the closure of the treatment plant, NEPA and the Ministry of Health will be informed at least two (2) weeks prior to decommission works being undertaken. Decommissioning of a treatment plant may be required if the land supporting it is utilized for other purposes, or if the plant functioning is unable to achieve the original design objectives. The location and description of the treatment plant to be decommissioned will be recorded for future use. All works will be completed within six (6) months from commencing the decommissioning work. Proposed timelines for specific activities are outlined in Table 5-4 below. In all circumstances the site will be rehabilitated to its original state and landscaped where necessary.

The following closure activities are to be undertaken:

1. Separate and cap the influent line entering the wastewater treatment plant (WWTP).

2. Remove all wastewater/sludge from the WWTP.

Wastewater will be disposed of at a permitted/licensed wastewater treatment plant.

Sludge will either be disposed of at a permitted/licensed wastewater treatment plant or at a land disposal site approved by the National Solid Waste Management Authority (NSWMA) or used as land application/soil conditioner under the permitted /licensed conditions.

3. Dismantle and remove all piping, mechanical, and electrical equipment from the site. Some of these items can be recycled/salvaged or reused. Items that can't be recycled/salvaged or reused will be removed and disposed of at a land disposal site approved by the NSWMA.

4. Tanks will be demolished and the concrete treated as clean fill or left onsite.

    - If a tank is left onsite the floor will be fractured and covered in order to avoid retention of water and filled completely with clean fill material.

5. Tanks and buildings that are to be kept in place for other uses will be properly cleaned and retrofitted so that they are not a safety or environmental hazard.

6. The effluent line will be cleaned and removed or plugged.

7. Disturbed areas will be properly stabilized and vegetated. Disturbed areas will be considered stabilized when perennial vegetation, pavement, or structures using permanent materials cover all areas that have been disturbed

*Table 4-7: Wastewater Treatment Plant Closure Activities and Timelines*

| # | Closure Activities | Target Completion (weeks) |
|---|---|---|
| 1. | Obtain all relevant permits and approvals from NEPA and Local Parish Council. | 4 |
| 2. | Remove solid waste, wastewater and sludge from the STP via an approved haulage contractor to an approved treatment/disposal facility. | 2 |
| 3. | Undertake pre-closure cleaning and wash out with cleaning solution | 2 |
| 4. | Carry out testing for contaminants and remediate/mitigate where necessary. | 4 |
| 5. | Mobilize contractor and advice NEPA of the proposed dated for the start of demolition activities and the contractor who will be carrying out these activities. | 2 |
| 6. | Disconnect electricity from all equipment, pumps, lighting, signage, etc. | 1 |
| 7. | Hoard entire site to the satisfaction of all stakeholders and construct site office | 1 |
| 8. | Remove all useful parts of the facility to storage, transfer or sell (including pumps, electrical devices, meters, monitors, etc.) | 4 |
| 9. | Demolish all hard structures not stored, transferred or sold. | 3 |
| 10. | Test demolished materials for contaminants (if detected remediate). If no contaminants are found, remove to an | 4-6 |
| 11. | Source and place appropriate topsoil (as approved by NEPA) in the affected area and replant appropriate vegetation to restore site (as necessary) | 4 |
| 12. | Contact relevant agencies to conduct final inspections | 2 |

### 4.7.4 RISK ASSESSMENT AND MANAGEMENT

A possible risk that may occur during the decommissioning of the WWTP is release of improperly treated effluent to the environment. There may also be an increase in nuisance odours arising from the plant as well as possible release of illness-causing air borne pollutants.

During the demolition there may be an increase in noise and dust pollution. The WWTP and its contents will be flushed with potable water before closure activities begin. This will reduce the risk of untreated effluent being accidentally released. Signs will be posted in and around the site to notify the public of the closure as well as other means of communication will be utilized if deem necessary.

The risk of hazardous or harmful substance being generated within the treatment system or being accidentally introduced will also be considered. Where necessary, a detailed Remediation Plan will be developed. The area will then be officially declared a demolition site and all safety requirements as stipulated by the NEPA, Ministry of Health (MOH) and the Local Municipal Corporation, to include noise and dust mitigation, will be observed.

Should a release be detected, while following the NEPA guidelines, the appropriate abatement actions will be initiated to protect human health and the environment. This Remediation Plan will show the method of treatment and disposal of waste produced by closure activities.

### 4.7.5 DETECTING CONTAMINATION

Since effluent will be tested at regular intervals as requested by the NEPA, all contamination should be detected during operation and steps be taken to alleviate any such contamination. If a risk of contamination remains, then a full biological analysis of the area will be done and required laboratory analysis (as specified by NEPA and MOH) will be done.

### 4.7.6 SECURING THE AREA

The site will be manned by security personnel assigned until demolition is complete or onwards as deemed necessary.

### 4.7.7 SOLID WASTE MANAGEMENT

Construction activities produce various waste types, including rubble, packaging materials, and hazardous substances. Other wastes anticipated to be generated includes screenings from the plant and building/structural materials. On-site material control is therefore critical to good waste management practices. Building materials are to be disposed of at a landfill/dumpsite approved by the NSWMA.

The major solid waste generation is anticipated to come from the site clearance activities. Solid waste generation and handling will be monitored during the construction of the plant. This will involve all aspects of management, including collection, handling, transportation, and disposal of all types of solid waste. Different containers will be provided for temporary storage of sorted waste materials to facilitate recycling where possible. A trip ticket system will be implemented to track the offsite transportation of waste materials to the nearby (Morant Bay) dumpsite.

Monitoring of solid waste management will take the below form:

#### 4.7.7.1 WASTE INVENTORY AND DISPOSAL

- Inspections will be carried out routinely to ensure adequate waste receptacles are provided for solid waste collection onsite.
- Inspections of solid waste generated from site clearance and construction activities will be loaded onto trucks to ensure appropriate sorting and handling of the different waste types occurs to encourage recycling. Assessment of the records of the quantity of solid waste generated and records of actual waste disposed of will also be done.
- All receptacles and bins will be checked to ensure they are secure and covered where appropriate, including food waste bins.
- Trash cans are recommended to be removed on a weekly basis, or by a commercial solid waste contractor such as The MPM Waste Management Limited, which will collect the contents in the containers and transport it to the approved dumpsite for disposal.

Collection tickets should be kept safely for inspection by the Authorities, eg. NEPA, NSWMA, Local Public Health Department.

##### 4.7.7.1.1 Burning onsite

No burning will be allowed on the site. All waste will be contained and moved to an appropriate dumpsite.

##### 4.7.7.1.2 Material Handling and Storage

- All hazardous chemicals and materials if any will be properly stored in impermeable containers to prevent discharge into the environment.
- All storage containers will be properly labelled, with hazardous material warning signs where appropriate.

##### 4.7.7.1.3 Waste Disposal, Transportation and Traceability

The below protocols will be in place for the disposal of waste from the facility's compound:

- The solid waste containers will be emptied on scheduled basis during operation.
- Disposal of the contents of solid waste containers and large loads of waste such concrete rubble and refused spare parts will be done at an approved disposal site, as per the approval of the NSWMA.
- Waste will be removed by a suitably qualified contractor and disposed at an approved dumpsite.
- Proof of appropriate disposal must be provided by the contractor for each event.

##### 4.7.7.1.4 Supervision and Monitoring

Inspections will be carried out routinely to ensure adequate waste receptacles are provided for solid waste collection onsite. The Environmental Manager will be conducting audits of the required scheduled inspections and assessments, and will report to the NEPA as required.

##### 4.7.7.1.5 Reporting

Reporting will be done as per stipulated by the Authority (NEPA) in the Environmental Permit granted. A report will be submitted as per the schedule outlined. It is anticipated that NEPA will visit the site periodically to verify these reports.

#### 4.7.7.2 SANITARY FACILITIES

There will be portable toilet facilities provided at the site. The site will be assessed to verify that sufficient self-contained portable toilets are provided to meet maximum expected demand.

# 5. SITE DESCRIPTION

## 5.1 LANDSCAPE FEATURES

### 5.1.1 TERRAIN

The area is comprised of a broken relief with gently to moderately sloping terrain, at a moderate elevation (ranging from 5-350m above sea level) (Figure 5-1). Elevation across the landscape increases landwards, however unevenly. There are mid slopes, flat lands and valleys over the landscape and a significant area in the north-eastern region of the property is comprised of ridges/hilltops. In the northern-most sections, relief changes rapidly from the high ridges to valleys, giving rise to varied landforms. The major landforms can be described as upper slopes, u-shaped valleys, flat lands and incised streams (Figure 5-3).

A 2km radius was used to compare the site's character with the adjoining areas. On the West is the Shady Spring and White Horses communities, and situated on the East of the property is Rozelle district. Similarly to the neighbouring communities, the district is situated on a landscape of similar landforms, with gentle to mid slopes occurring in the lower regions and steeper slopes and hills in the upper regions. Housing appears sparser with increasing elevation (Figure 5-1 and Figure 5-3).

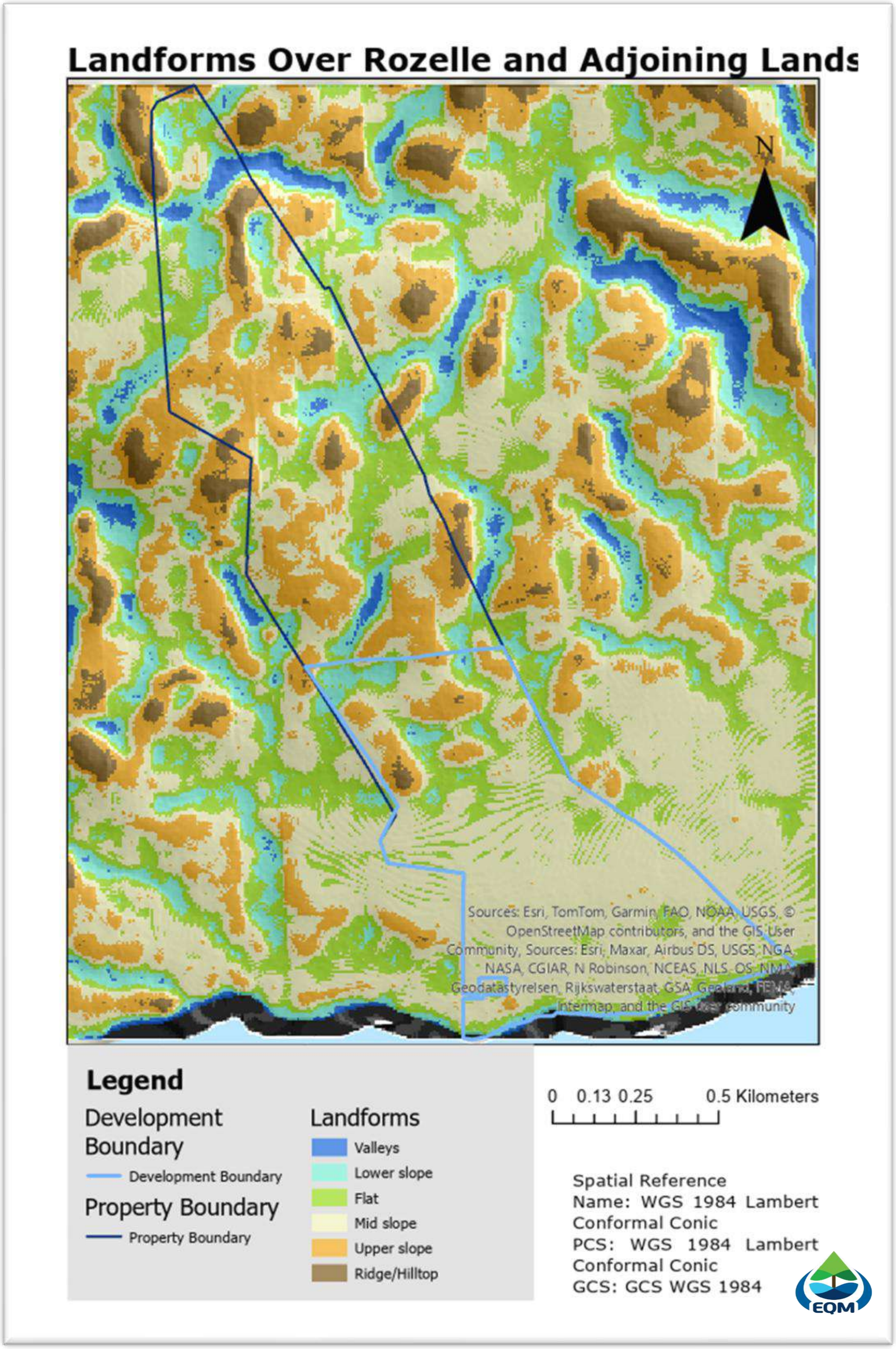



*Figure 5-1: A GIS--based representation of landforms across the site. Notice that the section of the property for development is gentle to mid slopes.*

*Figure 5-2: An aerial view of a section of the lower boundaries of the upper section of the parent property showing the rolling hills and secondary forests. The bare soil East-West demarcation marks a JPS reservation, which is being used to mark the division of the northern and southern portions of the property.*

### 5.1.2 SHARED LANDSCAPE FEATURES

#### 5.1.2.1 CHOCOLATE GULLY, BANFIELD'S GUT RIVER AND SHADEY SPRING STREAM

A branch of the Chocolate Gully traverses the northernmost section of the parent property and continues south-easterly from the property's eastern boundary, then southerly towards the coastline. Another branch traverses a section of the property on its eastern limits (Figure 5-3).

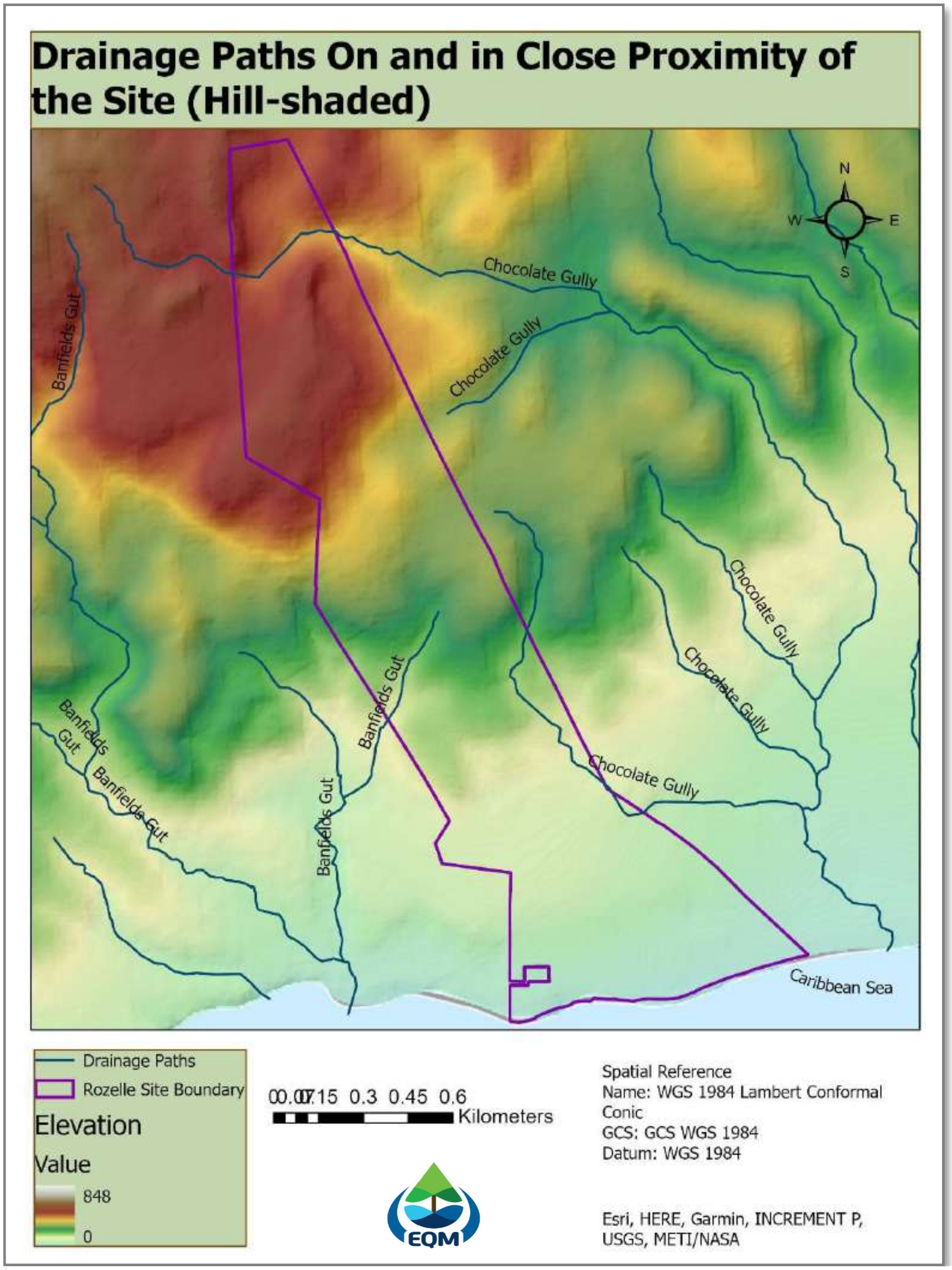



*Figure 5-3: The major water courses connected to the site*

The development will therefore be required to factor its contribution to runoff and how it is directed off the property, without affecting the nearby residents.

Within the site's proximity, the Banfield's Gut River occurs. A tributary of this river traverses the western limits of the property. A site reconnaissance revealed a stream below Banfield's Gut River, which the community calls Shady Spring stream. The said stream traverses the land similarly to the mapped Banfield's Gut River. However, upon surveillance of the area, a dry riverbed was observed where the 1:50,000 map shows the Banfield's Gut River stem. This occurs North of the spring that feeds the Shadey Spring stream (Figure 5-5) and directly in line with the Shady Spring channel. This remained dry on all occasions, despite a number of trips to the area during the rainy season. Figure 5-4 shows a section of the channel above the Shady Spring source. It is therefore thought that Banfield's Gut River is an intermittent/seasonal stream that has confluence with the Shady Spring stream.

Given Banfield's Gut River channel occurs North of the Shadey Spring source, its quality can affect Shadey Spring's.

*Figure 5-4: A section of the Banfield's Gut dry riverbed*

### 5.1.2.2 SPRINGS

#### 5.1.2.2.1 Shadey Spring

Shadey Spring emerges from a rocky substrate at the waypoint labelled "197" in Figure 5-5, where it develops into a small stream as it progresses down gradient before discharging into the Caribbean Sea South-west, West of the Rozelle site, via a culvert.

Points along Shadey Spring Stream and Banfield's Gut River

197

196


| | |
|---|---|
| 195 | Bridge Below Shadey Spring |
| 196 | The stream, above the bridge |
| 197 | Shadey Spring Source (the actual spring) |
| 198 | Up-gradient Shady Spring Source (dry channel) |
| 199 | JPS reservation |

195

*Figure 5-5: Images showing the Shady Spring stream source and Banfield's Gut River location in the relation to the property boundary*

#### 5.1.2.2.2 "Dam Head"

Abutting the site on the East is a natural Spring, referred by the community as "Dam Head". From anecdotal information, this spring was entombed by the RADA on behalf of the Rozelle district for their domestic supply. The community uses the spring for domestic purposes, to water their animals and irrigate their crops. Figure 5-6 shows a section of the entombment, where a lady was washing. Some of the flow from the spring traverses the development site as well and outfalls along the Rozelle to Morant Bay thoroughfare along the property's southern boundary.

*Figure 5-6: A section of the Dam Head Spring entombment, which the community uses for domestic purpose*

### 5.1.3 LAND COVER/LANDUSE CHANGES

Historic topographic maps and aerial images show that the land has been used for sugar cane plantation. The Rozelle property was a Sugar Estate from the 18th – 19th Century. It is also evident that the land was formerly used to grow citrus as well as for pasture ( Figure 5-7) over several decades. In the recent decades, sections of the property, particularly along the western, flatter sections, have been used for orchard farming. Animals such as cattle and goats also graze over sections of the property. There is active apiculture (beekeeping) on the property as well. The site has therefore been impacted over several decades and consequently, its former natural state has been altered over time. This is evident today by the brush-type vegetation between secondary forest patches and grass and shrub undergrowth. There are also sections of the land where bare soil is exposed, where the substrate is limestone outcrops. These areas tend to be the choice for livestock farming. Figure 5-8 also shows that clear cutting of vegetation is periodically done for farming purposes. Figure 5-11 and Figure 5-12 show a more recent aerial image of land clearance on and adjoining the property.

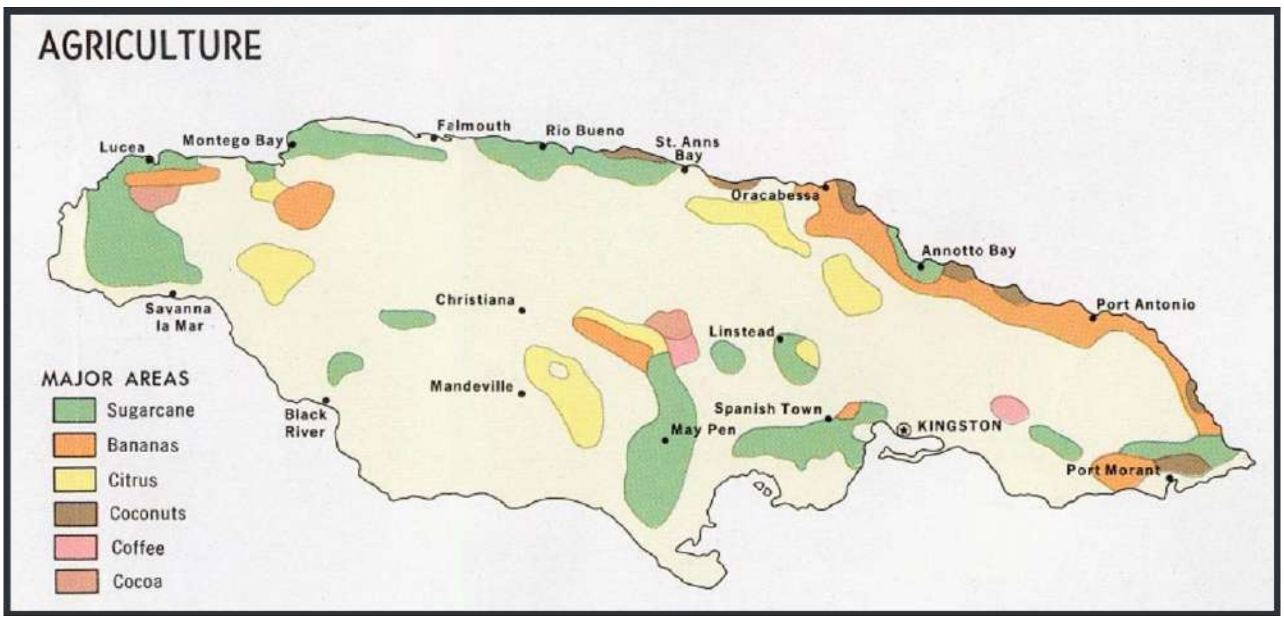



*Figure 5-7: A depiction of agricultural landuse over Jamaica in 1968. Source: https://www.gifex.com/jamaica*

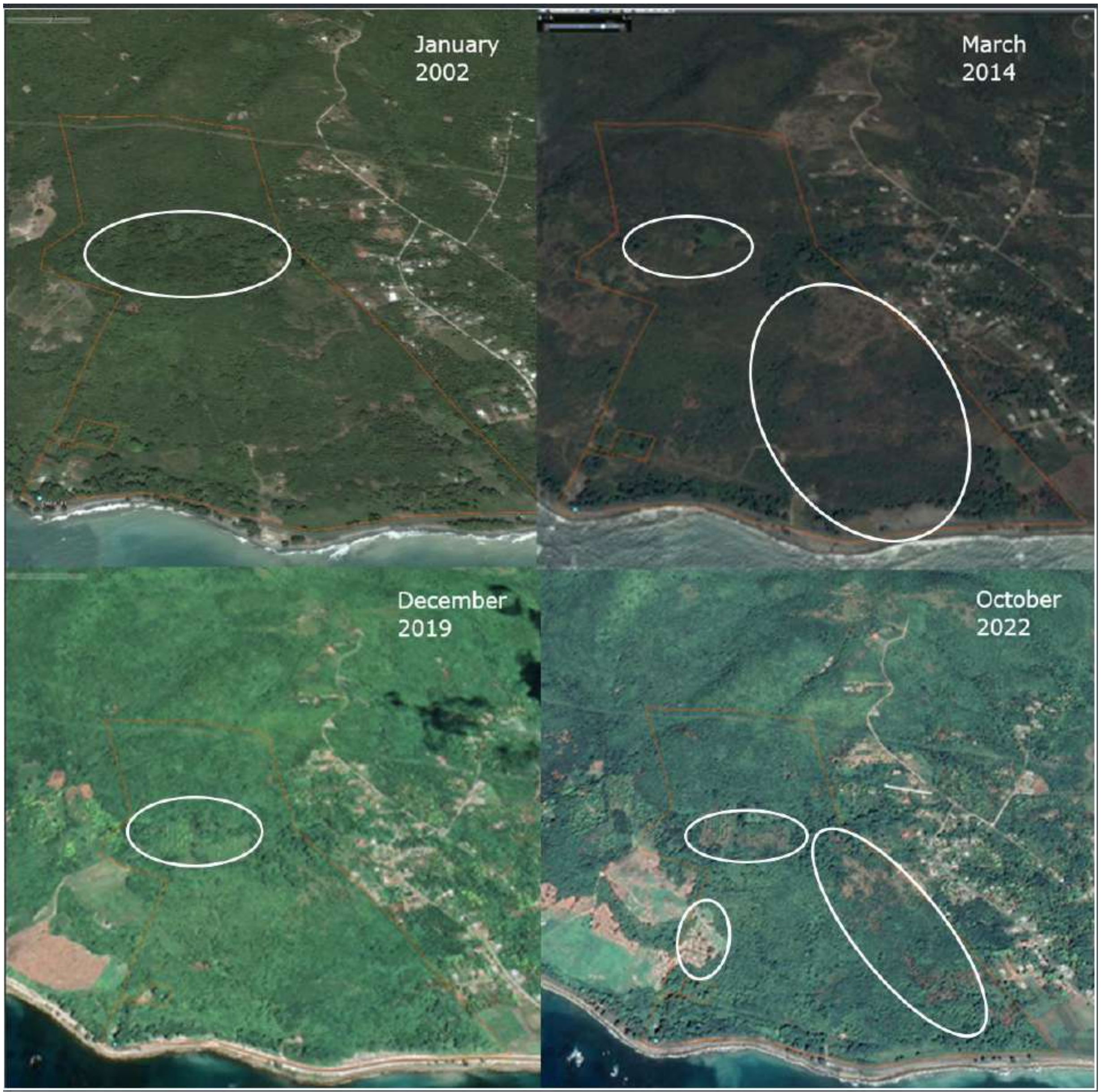



*Figure 5-8: A comparison of historical changes in landuse over the property over 2 decades*

### 5.1.4 EXISTING SITE FEATURES

#### 5.1.4.1 HABITAT TYPES AND ECOSYSTEMS

There are a few distinct ecosystem types and habitats occurring throughout the site. The types of habitats appeared to be associated with the level of human activity on the site over time. Some areas were occupied by secondary forests, while others had savannah like patches, shrublands and pasturelands. Other sections were actively occupied by agricultural use (an orchard). The secondary forest occurred more densely in the upper sections of the development site. The shrublands occurred in the lower regions, where the slopes were gentle. Figure 5-9 shows a section of the shrubland, with ornamentals disbursed throughout. The upper half of the property is occupied predominantly by a mixture of secondary forest and shrubs. The southern section of the property was occupied by a mix of secondary forest and shrubs, with a thin strip of coastal vegetation at the southern tip of the land, along the roadway (Figure 6-47 and Figure 6-51).

##### 5.1.4.1.1 Shrub land and Orchards

As evident in Figure 5-9 there are sections of the orchard that hosts ornamental plants. These mainly occupy the scrublands in the flatter areas. The orchard had mangoes, cashew, banana, jackfruits, otaheite apples, soursop, and sparse banana trees. A detailed list of the plant species found on the property is presented in Appendix 4.

*Figure 5-9: A section of the orchard showing some open fields and grassland. Secondary forest within the background.*

##### 5.1.4.1.2 Secondary Forests

The site has patches of secondary forest located across its extent. However, over time the forest has been altered via anthropogenic activities. Figure 5-8 show sections of the forest being cleared in the past. Figure 5-10 to Figure 5-14 show more recent clearance.

##### 5.1.4.1.3 Stream and Riparian Vegetation

The stream supplying the Rozelle Falls occurs at the western limit of the site (highlighted in Figure 5-10), before it diverts on the neighbouring property (traveling landward). Figure 5-11 and Figure 5-12 show sections of the stream, while Figure 5-14 shows a blown-up version of Figure 5-13 showing the vegetative buffer to be preserved along the stream.

*Figure 5-10: A section of the property highlighting the tree line (riparian forest) along the stream above the Falls*


*Figure 5-11: A section of the stream leading to the Rozelle Falls*


*Figure 5-12: The stream, directly above the Falls. Here the vegetation canopy is predominantly west Indian almond trees*


*Figure 5-13: A recent (March 2025) aerial image captured over the western section of the property showing the areas to be preserved as nature park in the development. This recent drone image shows that the land was recently cleared. Note that this vegetation clearing is not being done by the Developer.*

#### 5.1.4.1.4 Rozelle Falls

Rozelle Falls is of cultural and aesthetic values and is to be preserved by the Developer. Noteworthy is that the recent South Coast Highway Improvement Project (SCHIP) by the government resulted in the bathing area of the Falls being improved in terms of privacy and safety. The area at the base of the rapid was widened, resulting in a separation of the standing/bathing area and the corridor along the Falls. The area for bathing now has a staircase for patrons to safely walk down under the rapid to bathe. There is now some buffer between patrons and road users, thereby providing some protection from passing vehicles, as well as privacy for patrons using the Falls.

In addition to the aforesaid, the development design ensures the sustainability of the Falls; that is, its source is not disturbed by the development, by reserving a vegetative buffer along its stream and designating the neighbouring lands on the East as a nature park, to be preserved in its current state. Figure 5-12 is an aerial image superimposed over the wide vegetative buffer that will be maintained on the western section of the property, for protection of the Falls.

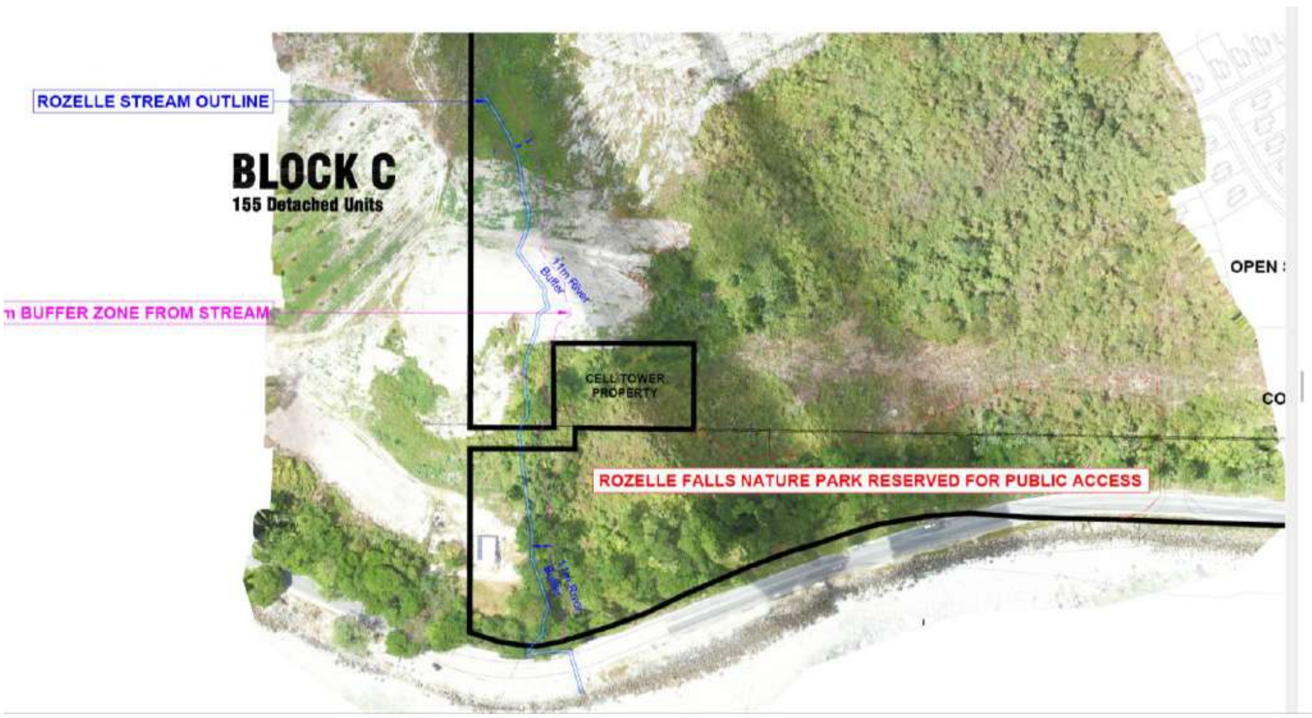



*Figure 5-14: A close-up image of the subdivision layout with the aerial image superimposed, showing the stream source for the Falls and the proposed riparian forest buffer.*

*Figure 5-15: The Falls prior to the road improvement project; 2020*

*Figure 5-18: The area along the Falls, during the SCHIP project, 2022*

*Figure 5-16: Rozelle Falls post-roadworks, 2025*

*Figure 5-17: Another view of the Falls post SCHIP, 2025*

# 6. DESCRIPTION OF THE ENVIRONMENT

## 6.1 PHYSICAL ENVIRONMENT

### 6.1.1 LANDCOVER

More than two-thirds of the site is in ruinate. The lower half of the site for development is covered predominantly by a mixture of grasses and shrubs, with patches of secondary forest, while in the northern half, the landcover is disturbed broadleaf forests.

### 6.1.2 LANDUSE

The landuse that predominates the site is agricultural fields, mainly orchard farming. This occupies less than one-third of the property, while the rest is in ruinate. The central region and flatter areas are open fields. The southernmost, flatter region of the site is zoned for agricultural use (Figure 6-1) while the area beyond the site's limits is proposed to be used for agriculture and forest reserves in the new Town and Country Planning (Saint Thomas Parish) Provisional Development Order (2018) (Figure 6-1). Other expressed planned uses include resort (coastal villas) for the property in general and "nature and adventure" for the Falls in particular, by the Ministry of Tourism (International Institute of Tourism Studies 2021). Considering the adjoining land cover and landuse types, there are no potential future impacts. For instance, none of the adjoining lands are reserved for bauxite exploration. The adjacent landuse types are fields (agriculture) and built-up areas and land cover types include open dry forest and disturbed broadleaf forest, similar to the site.

### 6.1.3 ACCESS

Access coincides with the built-up areas where new roads were constructed for residential development. There is also an earthen roadway; a JPS easement, traversing the central region of the landscape (the bare-ground demarcation running East-West in the lower half of the property in Figure 5-2). The Southern Coastal Highway Improvement Project (SCHIP) resulted in the widening of the roadway South of the property.

The present access onto the proposed development site is a dirt path from the neighbouring property, by the western boundary. There is also a cleared entrance and gateway from the south-central limit. The access to the site for site preparation and construction activities is demarcated in Figure 4-9.

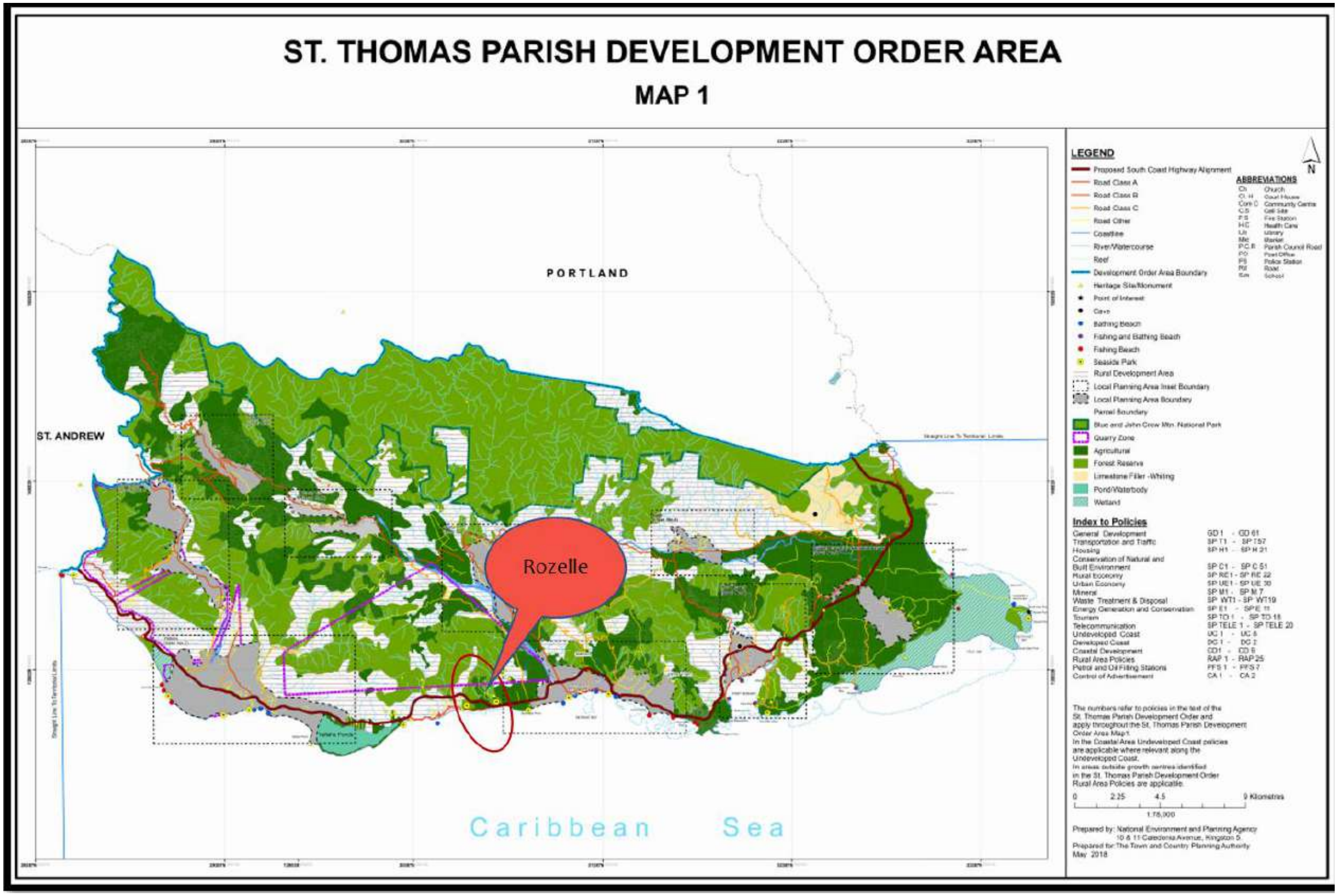
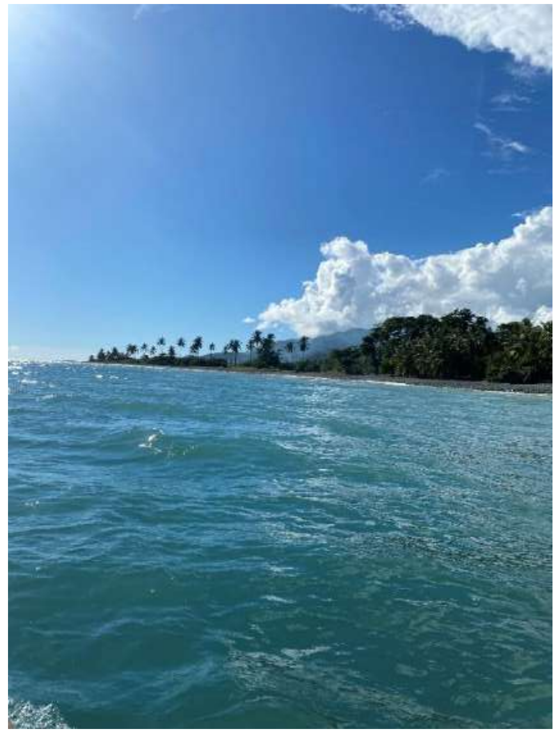



*Figure 6-1: Proposed landuse for the parish as per the St. Thomas Provisional Development Order (2018). Note the areas encircled in purple (quarry zone) and the Rozelle area (highlighted in red oval) in shades of green (agriculture and forest reserve).*

### 6.1.4 CLIMATE



Jamaica experiences a tropical maritime climate. This is characterized by warm temperatures, high humidity, and significant influence from nearby bodies of water like the Caribbean Sea which promotes moderate temperatures and seasonal rainfall. The downside, however, is this allows for high levels of humidity and tropical systems such as storms, depressions and hurricanes.

#### 6.1.4.1 Temperature

According to the Meteorological Service of Jamaica, the years 1996 to 2015 produced mean annual temperatures of 29.8, 31.6, and 31.9 degrees Celsius, which were each recorded at the locations of Worth Park, Sangster International Airport and Norman Manley International Airport. Prior to this, the years 1951-1980 yielded annual temperatures of 28.9, 29.8 and 30.8 degrees Celsius which is a 3-6% increase. Climatic data for the project site was retrieved from the National Meteorological Service of Jamaica.

*Table 6-1: Mean annul temperature 1951-1980 Across Jamaica. Source: Meteorological Service of Jamaica)*

| Location | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Norman Manley Intl Airport | 30.9 | 30.8 | 30.9 | 31.5 | 31.9 | 32.6 | 33.0 | 32.6 | 32.8 | 32.3 | 31.9 | 31.3 | **31.9** |
| Sangster Intl. Airport | 29.8 | 30.0 | 30.5 | 31.4 | 32.1 | 32.9 | 33.2 | 33.4 | 33 | 32.1 | 31.2 | 30.2 | **31.6** |
| Worthy Park | 27.8 | 28.4 | 29.2 | 29.9 | 30.4 | 30.8 | 31.2 | 31.4 | 31.1 | 30.2 | 29.1 | 28.3 | **29.8** |

*Table 6-2: Mean annual temperature across Jamaica for the period 1996-2015 (Data Source: Meteorological Service of Jamaica).*

| Location | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Norman Manley Intl Airport | 30.9 | 30.8 | 30.9 | 31.5 | 31.9 | 32.6 | 33.0 | 32.6 | 32.8 | 32.3 | 31.9 | 31.3 | 31.9 |
| Sangster Intl. Airport | 29.8 | 30.0 | 30.5 | 31.4 | 32.1 | 32.9 | 33.2 | 33.4 | 33 | 32.1 | 31.2 | 30.2 | 31.6 |
| Worthy Park | 27.8 | 28.4 | 29.2 | 29.9 | 30.4 | 30.8 | 31.2 | 31.4 | 31.1 | 30.2 | 29.1 | 28.3 | 29.8 |

More recently, mean max temperatures range between 28.7 and 31.2, while mean minimum temperature range between 21.6 and 25-degree Celsius, as recorded at the Duckenfield station (Table 6-3).

*Table 6-3: Average maximum and minimum temperatures for the years 2013-2022, from the Duckenfield weather station in St. Thomas*

| Month | Max-Temp 2013-2022 | Min-Temp 2013-2022 |
|---|---|---|
| Jan | 28.7 | 21.6 |
| Feb | 28.6 | 21.9 |
| Mar | 28.8 | 21.6 |
| Apr | 29.8 | 22.5 |
| May | 30.1 | 23.6 |
| Jun | 30.8 | 25 |
| Jul | 31.2 | 25 |
| Aug | 31.5 | 24.6 |
| Sep | 31.4 | 23.6 |
| Oct | 31 | 23.4 |
| Nov | 29.8 | 23 |
| Dec | 29 | 22.8 |

While Jamaica's climate provides a stable pattern of warm temperatures and wet and dry seasons, the impacts of climate change have begun to alter these long-established trends. Rising global temperatures have contributed to incremental increases in Jamaica's average temperatures, intensifying heat waves and affecting coastal and highland regions alike. Additionally, climate change has disrupted rainfall patterns, leading to more extreme weather events, including prolonged droughts and intense rainfall episodes, which would especially pose challenges to the flood mitigation efforts across the island.

### 6.1.4.2 RAINFALL

#### 6.1.4.2.1 Extreme Rainfall

Twenty-four-hour (24 hr.) extremes were obtained from the NWA published guidelines for Hydrologic Reports (NWA 2015). The chosen values seen in Table 6-4 are those taken from the White Horses Station, which is the closest station within the proximity of the site.

*Table 6-4: 24 hr. extreme rainfall intensity taken from NWA 2015 Hydrologic guidelines for the White Horses Rainfall Station.*

| **Return period (yr)** | **2** | **5** | **10** | **25** | **50** | **100** |
|---|---|---|---|---|---|---|
| Rainfall intensity (mm/24hr) | 112 | 148 | 174 | 205 | 227 | 249 |

### 6.1.4.3 WIND SPEEDS

Wind speed data was not available from the nearest weather station (Belvedere), hence, data from the Sangster's International Airport station was used. Average wind speeds are generally between 10 and 14 mph. Wind direction is generally to the North.

## 6.1.5 TOPOGRAPHY


*Figure 6-2: A topographic representation of the site*

The Rozelle site is characterized by an undulating topography, marked by gentle to steep hills and valleys that create a varied landscape. The northernmost section of the property is characterized by steep slopes and is in excess of 340m amsl. Slope increases towards the northern section of the property. In the southernmost half of the landscape, the rate of change is low; slopes vary between 0-10$^{0.}$ The steep slopes are found in the upper half of the property (outside of the proposed development limit).

The majority of the site is composed of white limestone formations, originating from the mid-Eocene to lower Miocene periods. These limestone deposits are typical of Jamaica's southeastern coastal region and reflect the island's geological history. To the northwest, the site transitions into the Richmond Beds, which are part of a larger geological formation seen in this area. To the East, the land is influenced by alluvial deposits, which are directly related to the nearby Morant River. These alluvial materials indicate a history of riverine activity and sediment deposition, contributing to the fertility of soils in the area. Together these geological features, white limestone, Richmond Beds, and alluvial deposits highlight the interplay between coastal and riverine forces that have shaped the site over time.

### 6.1.5.1 SLOPE

#### *6.1.5.1.1 Slope Analysis*

The existing slope analysis presents a detailed breakdown of the site's topographical characteristics, categorized by different gradient ranges. The largest area, constituting 27% of the total, *Area 1* with a gentle slope ranging from 0% to 5.00% across 212,674 square meters. *Area 2,* making up 21% (163,582 square meters) of the total area has slopes ranging from 5.00% to 10.00%, which is also considered as a mild gradient. Such mild gradients indicate ease in construction, suggesting this segment might be ideal for foundational structures or expansive amenities.

*Area 3*, accounting for 28% of the total area or 220,660 square meters, has a moderate gradient between 10.00% and 15.00%. Its considerable size combined with the steeper slope could offer unique design possibilities, potentially suitable for terraced landscaping or infrastructure.

*Area 4* is also significant, making up 23% (183,397 square meters) of the total area. With slopes ranging from 15.00% to 35.00%, these areas might require specific grading measures or design adaptations to harness its unique terrain effectively.

In stark contrast, *Area 5,* though making up just 1% of the total area or 11,328 square meters, presents the steepest gradient, ranging from 35.00% and up. Such a sharp incline suggests that this segment might be best left undisturbed as a distinctive natural feature within the site (Figure 6-3).


*Figure 6-3: A GIS depiction of the slope analysis*

### 6.1.6 GEOLOGY AND HYDROGEOLOGY

#### 6.1.6.1 GEOLOGIC STRUCTURE

A review of the 1:50,000 Geology Sheet indicates there are no major fault zones making direct contact with the site. Of note, the eastern, northern and western external boundaries of the site are demarcated by well-established minor fault zones (Figure 6-4). These geological faults are deemed minor fault zones and does not appear to be seismically active. Noteworthy, is that these fault lines represent zones of weaknesses along which displacements can be induced. Further, minor faults are also responsible for increased shearing, jointing, and fracturing of rocks which reduces the overall competency of the limestone rock mass.

#### 6.1.6.2 REGIONAL HYDROGEOLOGY

The hydrogeology of the region is mixed. However, the specific development site is dominated by a limestone aquiclude and coastal aquiclude at its base (Figure 6-4). The coastal aquiclude is associated with sandy limestones and calcareous sandstones with sporadic clays or conglomerates. The limestone aquiclude geologic unit is typified by chalky limestones with low permeability. It is considered to have undergone inadequate karstification to generate any significant permeability. In areas where the Montpelier Formation and Coastal Limestones are faulted, fractured and/or karstified, there may be the development of secondary permeability which promotes the flow of groundwater. This area does not exhibit a significant degree of karstification (the closest mapped cave being the Creighton Hall Cave, located approximately 3.23km northwest of Rozelle Falls), however there are expressions of faults in the outcropping limestones, with one mapped fault traversing the northern section of the site and another being tangential to the southeastern section of the site (Figure 6-4). There are no known sinkholes within 3km of the site.

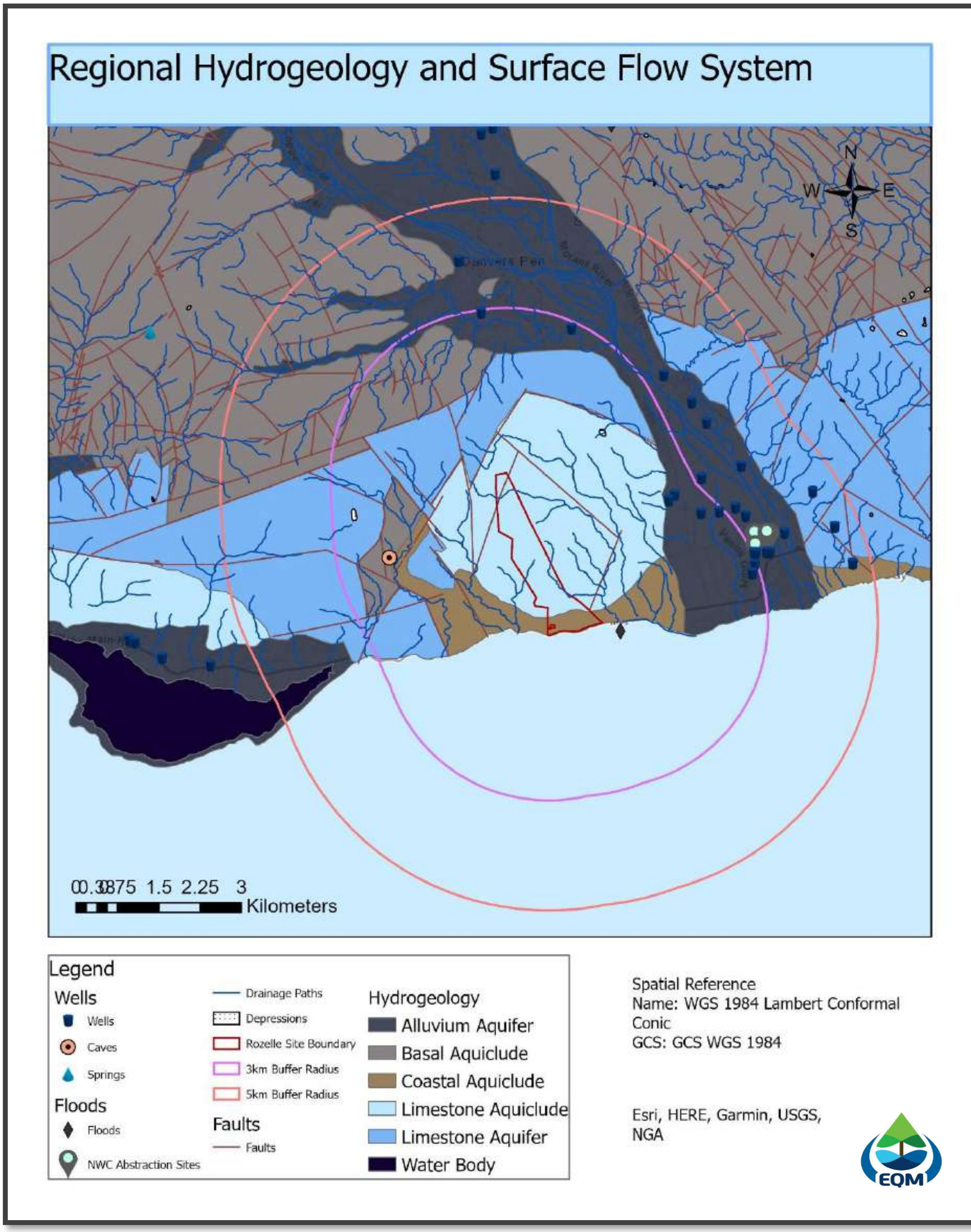



*Figure 6-4: A GIS-based representation of the hydrogeological units making up the Rozelle proposed site and its surroundings*

#### 6.1.6.3 GROUNDWATER DEVELOPMENT POTENTIAL

Groundwater source development potential on the site is unknown. There are no existing groundwater sources on the site.

All wells within a 3km proximity of the site have been drilled in the alluvium aquifer (Figure 6-4). There has been no groundwater exploration of the Montpelier Formation in this area, thus its potential for groundwater development remains undetermined. Information derived from boreholes or core samples in the vicinity suggests that groundwater depth ranges from 1.5m below ground level (Springfield Goodyear #2 pumping well) to 3.7m below ground level (Hall Head #1 pumping well). The estimated groundwater safe yield (exploitable groundwater) in the Morant River WMU for the year 2025 is 327.98 Mm3/year.

From the geological exploration of the site, fifteen (15) boreholes were drilled across the site (Figure 6-7). Groundwater was largely encountered in boreholes drilled towards the southern section of the site within proximity to the coast (Boreholes 1, 2, 10 and 11) (see Table 6-5). The depth of groundwater encountered along the southern section of the site ranges from 6.1m to 9m. At these depths groundwater is not expected to impact on foundation design as the impact of groundwater is considerably deeper than the zone of influence of building loads.

Of note, ground water was encountered in borehole 6; however, other boreholes in close proximity to borehole 6 and at similar elevation such as boreholes 5, 7 and 8 showed no evidence of groundwater. The presence of groundwater in borehole 6 is believed to be the result of a nearby spring or a perched water table.

*Table 6-5: Tabulated groundwater depth at the proposed Rozelle Estates property*

| Borehole Number | Depth of Borehole | Groundwater Depth |
|---|---|---|
| BH-1 | 9.1m | 6.1m |
| BH-2 | 9.1m | 6.1m |
| BH-6 | 9.1m | 6.1m |
| BH-10 | 9.1m | 6.1m |
| BH-11 | 9.1m | 9.0m |

The nearest well from the property is the Belvedere #2 (by Jamaica Flour Mills), located approximately 2.6km East of the site. The NWC's domestic supply sources closest to the property are the Goodyear and Springfield sources, located approximately 3.2km East of the site. The capacities are presented below:

*Table 6-6: The wells within a 3km radius of the site*

| Well Name | Distance from site | Owner | Elevation (m amsl) | Depth (m amsl) | Rest Water (m bgl) |
|---|---|---|---|---|---|
| Belvedere 2 | 2.6km northeast | Jamaica Flour Mills | 32 | 21.95 | 3.66 |
| Belvedere 1 | 2.6km northeast | Seprod Group of Companies | 23 | 21.34 | 1.52 |
| Springfield (Goodyear 2) | 2.6km northeast | Goodyear Jamaica Limited | 14 | 19.81 | 1.52 |
| Springfield 1R | 2.6km northeast | National Water Commission | 16 | 24.99 | 6.24 |
| Hall Head 1 | 2.6km northeast | Serge Island Limited | 62 | 71 | 3.66 |

The Rozelle Spring in the south-western region constitute potential surface sources to be assessed. Below is presented a 3km and a 5km radius, demarcated by the purple and coral outline respectively, showing the existing groundwater development within those radii, providing an indication of the feasibility of source development in terms of distance-related cost.

In addition to groundwater, overland flow of surface runoff is a critical factor in hydrology at the site. The undulating topography and proximity to river systems (like the Morant River) suggest that surface runoff may collect in low lying areas and flow overland during rainfall events. This surface water, driven by precipitation, may also interact with the underlying aquiclude and surrounding aquifers, potentially contributing to localized flooding or runoff that could impact the development.

### 6.1.6.4 KARST

Karst features in the White Horses/Rozelle area are uncommon given that the terrain does not exhibit the features (caves, sinkholes etc.) and the poorly developed surface drainage characteristic of highly soluble rock. However, the subject property being entirely underlain by carbonate formations makes it vulnerable to the natural processes and human-induced hazards which affect soluble rocks such as limestones over time.

The existence of a mapped cave within 3km of the property is an indication that the carbonate rocks in the vicinity of the site, though not mature, are susceptible to dissolution processes in the long term. Once dissolution effects become apparent, karstic hazards can occur rapidly, though some are slow acting such as pollution and saltwater intrusion which can be exacerbated by anthropogenic activity.

In an effort to mitigate against the threats posed by karst hazards, it is important to consider the special nature of karst, the risks involved in developing these areas and strategies to minimize their effects on infrastructure and property Table 6-7. Karst hazards are generally classified into two groups – gravidynamic and hydrodynamic which are further classified based on their occurrence superficially or underground. Subsidence sinkholes are usually created as a result of the dewatering of unconsolidated sediments above karst features, whilst natural collapse of caverns or cave roofs is usually rare. Flooding, which can occur in depressions due to significant rainfall, is usually periodic and predictable.

*Table 6-7: Karst Hazard Types*

| **Karst Hazard** | **Superficial** | **Underground** | **Potential Causes** | **Mitigation** |
|---|---|---|---|---|
| Gravidynamic | Collapse<br><br>Subsidence<br><br>Mass Movement | Cave Breakdown<br><br>Roof Subsidence<br><br>Sediment Invasion | Natural dissolution processes and anthropogenic activity - excavation, construction, over pumping of wells | Boreholes in carbonate formation to map the existence of voids which can be avoided during the construction process |
| Hydrodynamic | Floods<br><br>Subsidence Sinkholes | Rising water in caves<br><br>Water intrusion Pollution | Intense and/or prolonged rainfall.<br><br>Anthropogenic activity | Appropriate drainage to avoid flooding of low-lying areas |

### 6.1.7 SOILS

The soil characteristics across the Rozelle site vary significantly from North to South, reflecting the underlying geological formations and the hydrological influences on the landscape. The northern section of the site is primarily composed of stony loam (Bonnygate), a well-drained soil type that typically supports moderate vegetation. This soil type is therefore characterized by high erosion potential, very rapid internal drainage and very low moisture storage. This soil type is consistent with the site's proximity to coastal limestone formations and the alluvial deposits to the north, which contribute to the soil's texture and drainage capacity. Figure 6-5 and Figure 6-6 (left) show images of a section of the site in the upper region that was cleared to facilitate the topographic surveying of the site. The photograph shows the soil types in that area.

In contrast, the southern section of the site, where the proposed development will occur, the soil is predominantly from the Bonny Gate formation, classified as Killancholly Clay (Figure 6-6, right image). This soil type exhibits moderate to high erosion potential and moderate to rapid internal drainage. In other words, clay is less permeable and more prone to water retention, leading to higher moisture content in the soil. This can create challenges for construction, as clay soils are more susceptible to compaction and may experience slow drainage, particularly in areas of higher water table. Additionally, these areas may be at risk of ponding, especially after prolonged rainfall.

The transition from stony loam to clay aligns with the site's topography and hydrology, where the northern part is influenced by alluvial deposits of the Morant River and the southern section is closer to lower lying areas where water accumulation occurs more readily.

*Figure 6-5: The soil type in a section of the property dominated by limestone outcrops*

*Figure 6-6: A depiction of the different soil types found in the upper (left image) and lower (right image) of the site*

### 6.1.6.1 GEOTECHNICAL REPORT SUMMARY

#### 6.1.6.1.1 Soil Stratigraphy

Standard Penetration Tests were conducted at regular intervals and the soil samples were brought to the laboratory with identification and labelling. A split spoon sampler was used to collect soil samples while conducting Standard Penetration Tests.

The site is underlain by predominantly Limestone Sands and Gravels (marly limestone) at shallow foundation depth. The soils encountered onsite are classified as follows:

1. *Cream-Brown Limestone* ***SAND:*** compact to dense Limestone Sand with varying proportions of Gravel and Silt was encountered at shallow foundation depth in boreholes 1, 5, 6, 7, 9, and 11. The SPT N-Value of compact to dense Limestone Sands range from 11 to 50.

2. *Reddish-Brown Lateritic* ***SAND***: Compact to Lose Reddish-Brown Lateritic Sands with varying proportions of Gravel and Silt was encountered at shallow foundation depth in boreholes 10. The SPT N Values for this soil type ranged from 6 to 27.

3. *Cream-Brown Limestone* ***GRAVEL***: Compact to dense Cream-Brown Limestone Gravel with varying proportions of Sand and Silt was encountered in borehole 3 from 6.1m to 9m. The SPT N Values for this soil type ranges from 13 to 40, indicative of compact to dense soils.

4. *Cream-Brown* ***Limestone***: Combinations of Cream-brown Strong Limestone Rock and Moderately strong to Moderately Weak Marly (chalky) Limestone was encountered in all boreholes drilled onsite. Refusal (N-Value >51) was also encountered in all strata comprising limestone rock material.

#### 6.1.6.1.2 Grain size distribution

Samples collected onsite comprise predominately of coarse-grained cream-brown limestone Sand and Gravel. Sieve analyses were performed to assess the grain size distribution of coarse-grained soils collected onsite. The results of the analyses are presented in Table 6-8.

*Table 6-8: Tabulated results of the sieve analyses (grain size distribution) for the site*

| BOREHOLE NUMBER | DEPTH m | ft. | SOIL CLASSIFICATION |
|---|---|---|---|
| 1 | 2.2 | 7.5 | Cream Brown Limestone Gravelly SAND |
| 4 | 3.0 | 10 | Reddish Brown Silty Gravelly SAND |
| 6 | 1.5 | 5 | Cream Brown Limestone SAND with some Gravel |
| 7 | 0.75 | 2.5 | Cream Brown Limestone SAND with some Gravel |
| 7 | 2.2 | 7.5 | Cream Brown Limestone SAND with some Gravel |
| 9 | 2.2 | 7.5 | Cream Brown Limestone Gravelly SAND |
| 10 | 1.5 | 5 | Reddish Brown Silty Gravelly SAND |
| 10 | 2.2 | 7.5 | Reddish Brown Silty SAND with some Gravel |
| 11 | 1.5 | 5 | Cream Brown Limestone Gravelly SAND |

#### 6.1.6.1.3 Groundwater Conditions

Groundwater was encountered onsite during the subsurface drilling component of the study. Groundwater was largely encountered in boreholes drilled towards the southern section of the site within close proximity to the coast. The Depth of groundwater encountered along the southern section of the site ranges from 6.1m to 9m. At this depth groundwater is not expected to impact on foundation design as the impact of groundwater is considerably deeper than the zone of influence of building loads.

It is important to also note that the presence of water in borehole six in the lower south-west region of the site, is believed to be the result of a nearby spring or a perched water table and is not believed to be groundwater as boreholes within the environs of borehole 6 display no groundwater. Furthermore, borehole six is located within the elevated northern section of the site well above water table encountered along the southern section of the site.

A soil percolation test was conducted on site to assess the infiltration capacity of soils onsite and their suitability for stormwater and wastewater disposal systems onsite. Percolation Borehole One (PB-1) was sited within the southern section of the site representing the lowest elevation on the property as well as the area proposed for sewage treatment plant and the detention pond. A borehole was drilled to a depth of 4.5 m (15 ft) in cream-brown limestone rock material. The percolation borehole was drilled with a standard diameter of 0.15 m (6 inches).

*Table 6-9: Percolation Test Result for Borehole PB-10*

| Borehole Depth | Percolation Rate in Min/Inch | Underlying Rock/Soil Type | Groundwater Condition |
|---|---|---|---|
| 3.65m (12ft) | 15 Min/Inch | Cream-Brown Calcareous Limestone Gravelly Sand | No groundwater encountered |

#### 6.1.6.1.4 Foundation Considerations

Based on the geotechnical engineering analyses, subsurface exploration, and laboratory test results, it is recommended that the proposed buildings be supported by strip and spread foundations.

In general, the bearing capacity of the geological material (compact to very dense limestone, sand and gravel and moderately strong limestone) is such that it will readily accept structural loads imposed by lightly loaded single family residential units. The geotechnical analysis also indicates that foundation settlement is expected to be minimal in compact to very dense limestone Sands and Gravels and should be kept within the tolerable limit of 25 mm (1 inch).

Percolation test conducted onsite also indicates that the site is suitable for onsite wastewater and stormwater disposal. It is important to note that groundwater was encountered at 6.1m below grade in boreholes BH1, 2, 10, and at 9m in borehole 11 located towards the southern section of the site. Notwithstanding, the depth of groundwater level is below the depth of influence (3m - 3.5m) and is not expected to impact on foundation designs.

The site is suitable for the proposed construction based on the geotechnical conditions encountered in the test borings, provided the recommendations are implemented in the design and construction phases of the project.

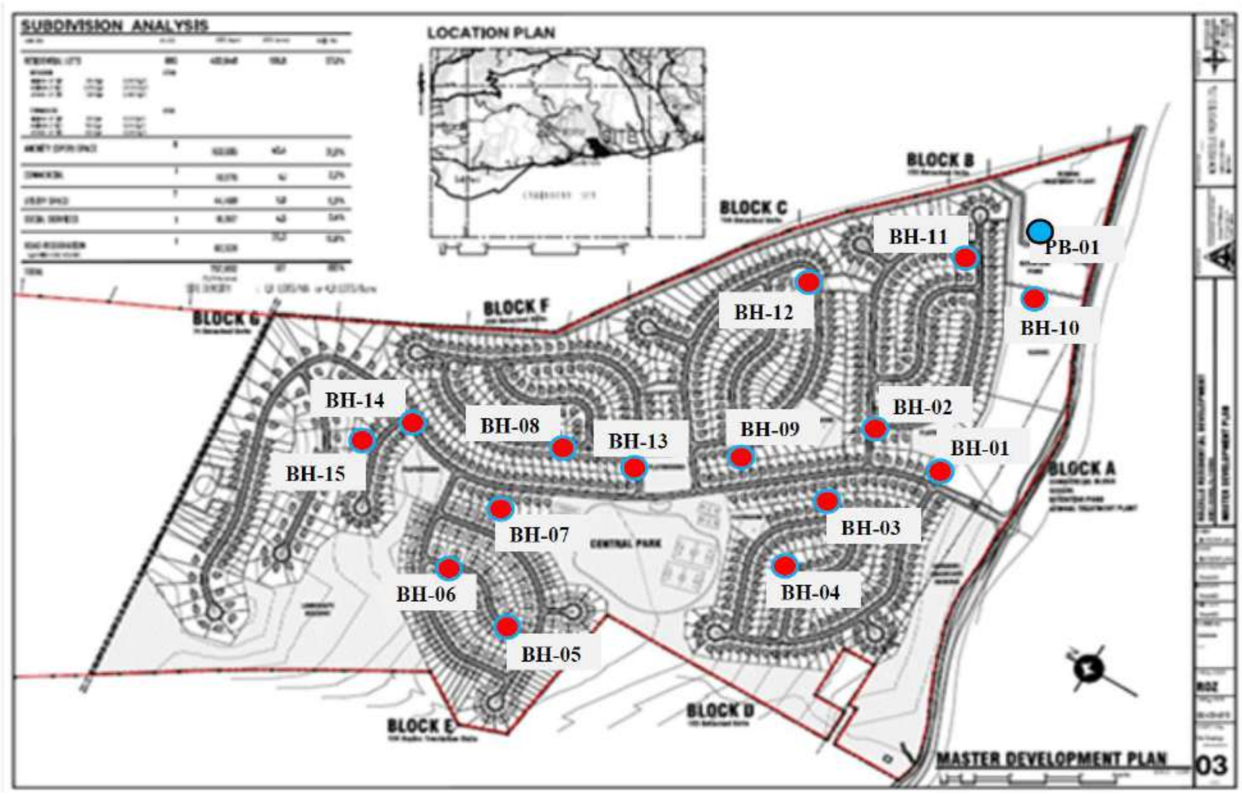



*Figure 6-7: The location of the boreholes dug across the site to understand the site's geology*

### 6.1.6.1.5 Earthworks Consideration

The site is currently highly vegetated and as such site grading shall involve stripping of topsoil containing trees, tree roots, organics or any other deleterious material. This material is not considered suitable for use as structural fill and must therefore be removed from the confines of the building's foundation.

The site should be proof rolled using a heavy, vibrating roller, capable of operating in variable frequency modes prior to the placement of any engineered fill for any structural or civil infrastructure. Where loose/soft soil, or weathered rock mass is encountered this material shall be excavated and replaced using compacted engineered fill.

### 6.1.6.1.6 Excavation Consideration

The site comprises a combination coarse-grained limestone sand and gravel (with minor proportions of fines) with extensive outcrops of marly limestone exposed at grade across the property. Moderately weak marly limestone can be excavated via "easy to hard digging" and can be dug using standard earthmoving equipment. The northern section of the site, however, comprises strong limestone which may require the use of an excavator with hydraulic hammer to excavate the rock material.

### 6.1.7 HYDROLOGY

#### 6.1.7.1 SURFACE WATER

The proposed site is located within the southernmost part of the Blue Mountain South hydrological basin. For water resources management purposes, the site falls within the White Horses sub-watershed of the Morant River Watershed Management Unit (WMU) in the south-western section of the drainage basin. These WMUs are managed by the Water Resource Authority (WRA). A vast flow network occupies the hydrologic region. The major rivers of the drainage basin are the White River, West of the site and the Morant River, which runs East of it. Their drainage network comprises of first and second order streams. Neither river is in proximity to the site.

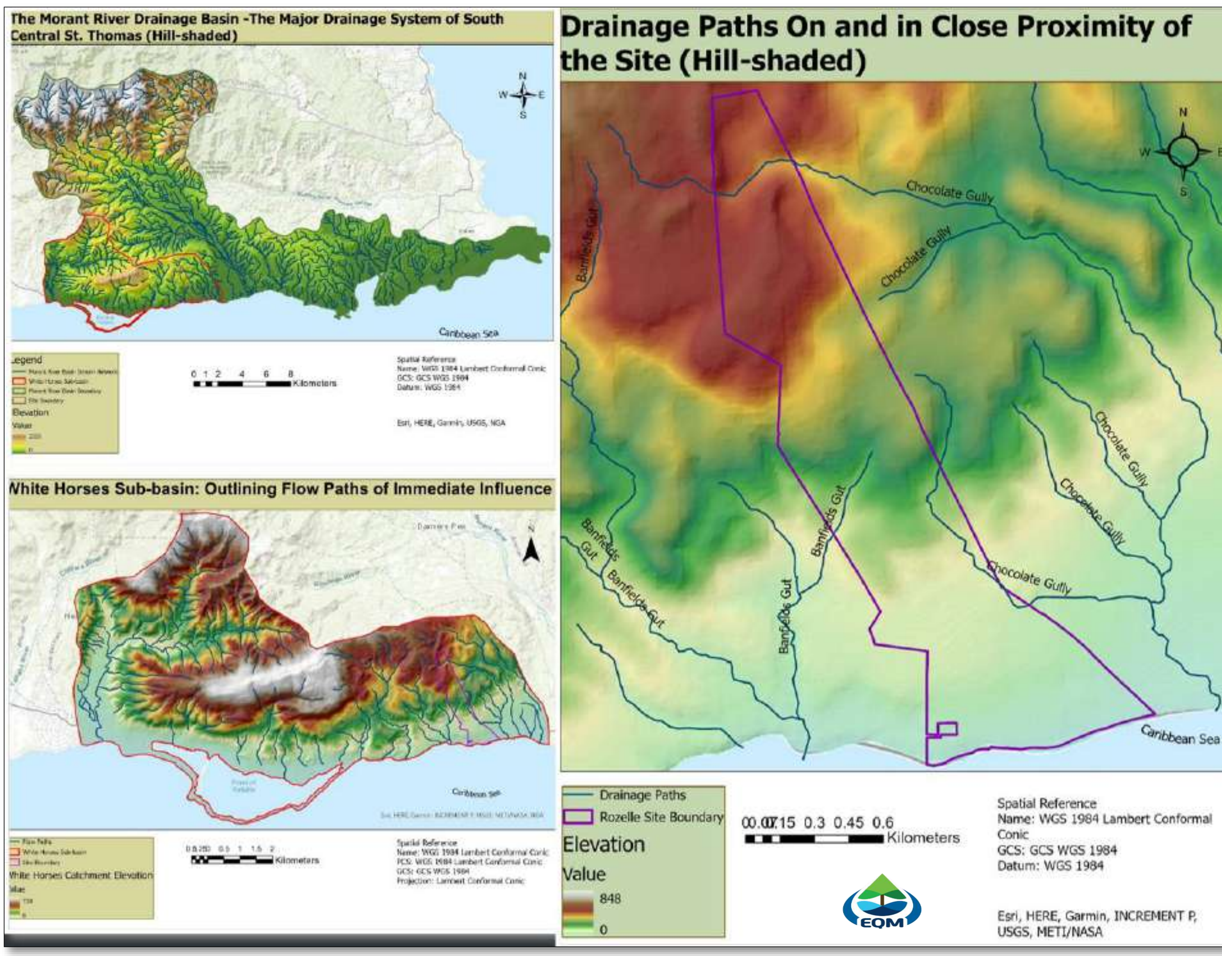



*Figure 6-8: Banfield's Gut and Chocolate Gully in relation to the proposed site and the drainage basin*

The major drainage system within the site is the Banfield's Gut River, a tributary of which traverses the western limits of the property (Figure 6-8).

The Chocolate Gully traverses the northern section of the property and continues south-easterly from the property's eastern boundary, then southerly towards the coast. The flow from the gully can be described as ephemeral; flows are a direct response to precipitation.

Spring sources were identified both on and abutting the property. The occurrence of the springs appeared to be associated with the presence of huge fig and trumpet trees and the springs seemingly emanated from the base of the fig trees. The presence of West Indian almond trees was also an indicator of the stream occurrences. According to anecdotal information from the Rozelle district, only during extreme and extended drought periods have the springs gone dry.

The "Rozelle Spring" is a surface water feature on the south-western section of the site. There are no historical studies on the development potential of the spring, hence, an assessment of its discharge and water quality were incorporated under this study.

### 6.1.8 CATCHMENT GENERATION

#### 6.1.8.1 Boundaries

It was essential to delineate the catchments associated with the Rozelle site to understand how the development of the site will impact runoff in the area as well as how the general runoff patterns and volumes will impact the development. The catchments were delineated using 12,500 contour data with supplementary topographic surveys collected by appointed land surveyors as well as the engineering team. The following results are noteworthy:

- There are three key catchments (Catchments 1, 2 and 3), with an additional sub-catchment (sub-Catchment 3.1 in Figure 6-9) within Catchment 3.
- Catchment 1 is approximately 141 hectares with nearly 30 percent of its area overlapping the northern section of the site. The runoff from this section of the site feeds into a gully that discharges to the West of the site.
- Catchment 2 is approximately 101 hectares and occupies primarily two-thirds of the proposed site area. Outside of the Rozelle Falls no other well defined drainage path was identified in this catchment.
- Catchment 3 is approximately 375 hectares and occupies a small section of the project site along the eastern boundary. The overlapping area has a gully that enters and

leaves the site along the eastern boundary and discharges into the Chocolate Gully further east of the site.

*Table 6-10: The nature of the catchments associated with the site*

| Catchment | 1 | 2 | 3 | 3.1 |
|---|---|---|---|---|
| Area (ha) | 151 | 101 | 375 | 71 |
| 11 | Mostly open space occupied by dense grass, shrubs and trees. | Predominantly open space with 10% falling within the residential and proposed green space area. | Predominantly residential. | Mostly residential with a mix of open space and green space. |

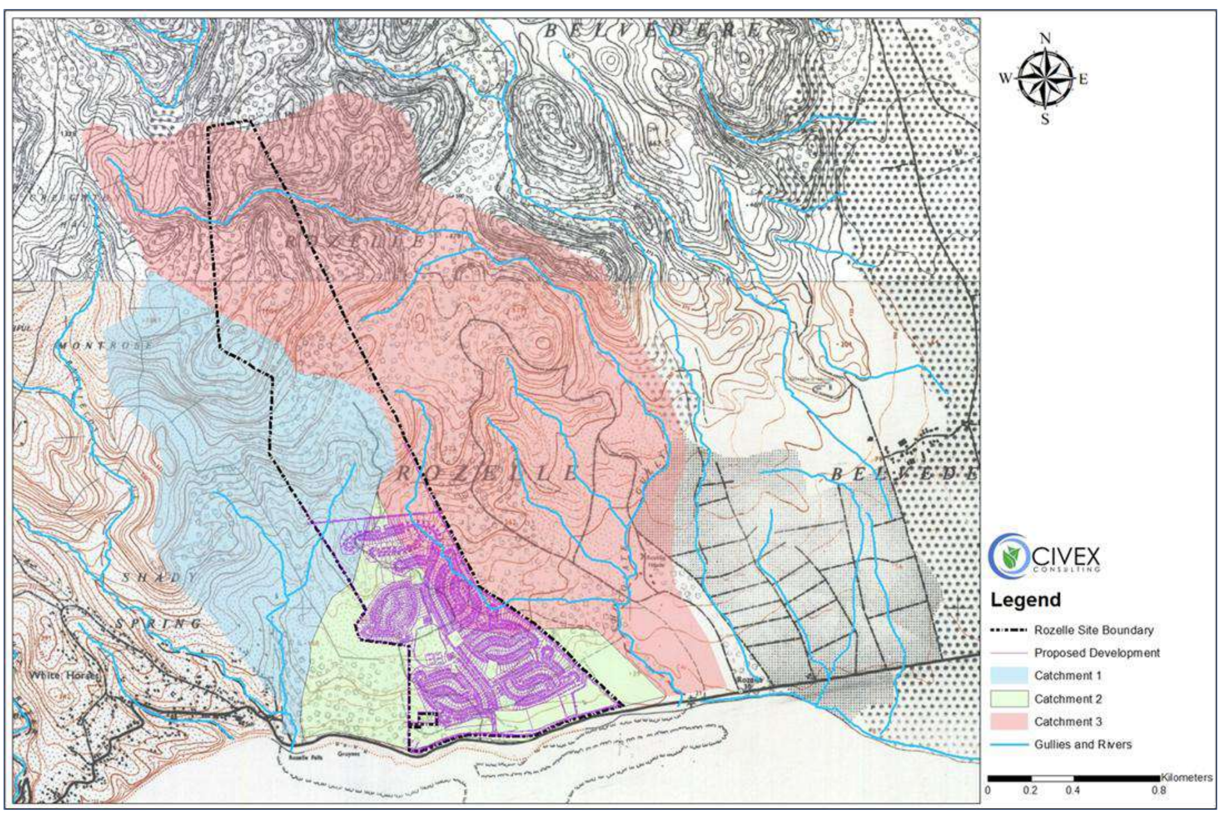



*Figure 6-9: A presentation of the delineated catchments within and within proximity of the site*

#### 6.1.8.2 COMPUTING TOPOGRAPHIC CONTOURS

Topographical data for the proposed site was obtained from a number of sources to include:

1. The survey department's 1:12,500 map series
2. Survey points of the development property provided by the client
3. Survey points from the roadway to the shoreline completed by Civex Consulting

The first set of contour data obtained from the 1:12,500-map series revealed that the overall catchment is sloping in a North-South direction. The catchments extend to the White Horses community in the West and the Duhaney Pen community in the East, as well as approximately 4-5 kilometers North of each respective community. The catchments are moderately sloping South with elevations of 427 meters to 8m above sea level. The second set of survey data provided by New Rozelle Properties Limited detailed the elevation of ground within the property boundary. The elevations within the boundary ranged from 118 m above sea level from the top of the development site to an area of 2 meters above sea level close to the shoreline. Lastly, the third set were survey points provided by Civex Consulting. These survey points captured the elevations of the roadway and shoreline. The data showed elevations varying from a high of 22.26 meters to a low of 0.04 meters below sea level.

#### 6.1.8.3 EXISTING DRAINAGE FEATURES AND FLOOD PRONE AREAS

##### 6.1.8.3.1 Flood Prone Areas and Existing Storm Drains

According to ODPEM, locations such as Morant Bay and Sea Forth are currently listed as flood prone areas. The Rozelle site is not known to be flood prone, neither is it known to contribute to flooding elsewhere.

Stormwater runoff from the project site is intercepted via drains and or gullies, and flows occur in a generally southern direction towards the coast. Several culverts were noted South of the development that conduit runoff from swales North of the highway directly to the sea, sea.

*Table 6-11: Existing drainage features*

| Drainage | Eastings | Northings | Diameter (mm) | Number of Barrels | Comments |
|---|---|---|---|---|---|
| Culvert #1 | 806688.6 | 635956.4 | 900 | 1 | Crosses Highway west of site boundary |
| Culvert #2 | 806592.2 | 635987.4 | 900 | 1 | Crosses Highway west of site boundary |
| Culvert #3 | 806754.4 | 635978.1 | 900 | 1 | Crosses Highway west of site boundary |
| Culvert #4 | 806955.1 | 635909.2 | 900 | 1 | Crosses Highway |
| Culvert #5 | 807139.9 | 635934.2 | 900 | 1 | Crosses Highway |
| Culvert #6 | 807865.6 | 636065 | 900 | 1 | Crosses Highway |
| Culvert #7 | | | | | Crosses parochial Road |

*Figure 6-10: Concrete swale (u-drain) along coastal highway, East of Rozelle Falls*

*Figure 6-11: Concrete swale (u-drain) receiving stormwater discharges and overflow from the Rozelle Falls*

Chocolate Gully, located East of the site, drains runoff from northern sections of the property to the Caribbean Sea (Figure 6-12).

*Figure 6-13: An 800mm culvert that crosses the highway and empties in the foreshore*

*Figure 6-12: Chocolate Gully mouth, approximately 330m of the site's eastern limit*


*Figure 6-14: A map of the location of the existing drainage features within proximity of the proposed development*

## 6.1.9 RUNOFF

### 6.1.9.1 HYDROLOGIC MODELS

It was necessary to employ hydrological modeling to estimate the runoff from the catchments and to analyze the impacts of the development on the surroundings and vice versa.

The methods used for this analysis are:

5. Data collection to define the catchments.
6. Delineating catchments and confirmation of streams and rivers
7. Calculating runoffs using the US Soil Conservation Service (SCS) method.
8. Re-calculate runoffs implementing post-development changes throughout the catchments.

#### 6.1.9.1.1 Soil Conservation Service (SCS)

The SCS method is an empirical model for rainfall runoffs which is based on the potential for the soil to absorb a certain amount of moisture. On the basis of field observations, this potential storage S (millimeters or inches) was related to a 'curve number' CN which is a characteristic of the soil type, land use and the initial degree of saturation known as the antecedent moisture condition. Hydrological modelling of the watersheds encompassed three main elements:

- Precipitation
- Rainfall abstraction model (Curve number method)
- Runoff model (Dimensionless unit hydrograph) The SCS curve number method was used to determine the rainfall excess $P_e$ using Equation 6-1:

*Equation 6-1: Rainfall excess*

$$P_e = \frac{(P^2 - I_a^2)}{P - I_a} + S$$

Where, P = precipitation

$I_a$ = initial abstraction

S = Potential retention which is a measure of the retention capacity of the soil.

The Maximum Potential retention, S, and the watershed characteristics are related through the Curve number CN. Equation 6-3 illustrates this.

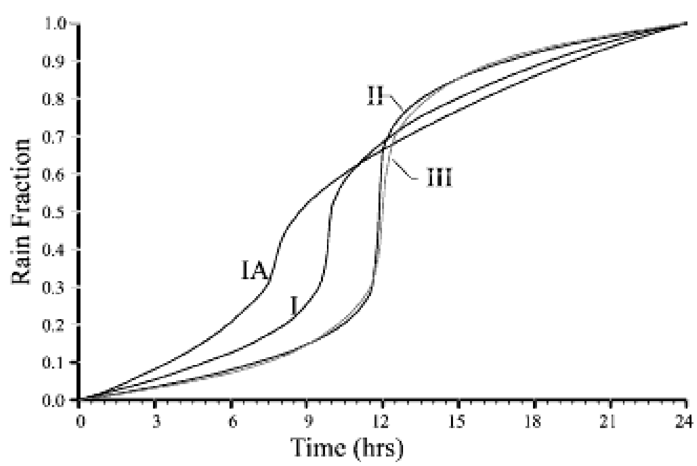
*Equation 6-2: Potential Retention*

$$S = \frac{25400 - (254 \times CN)}{CN}$$

Curve Numbers have been tabulated by the NRCS on the basis of soils group, soil cover or land use, and antecedent moisture conditions (initial degree of saturation).

The peak runoffs are generally calculated using the type III rainfall distribution for catchments in Jamaica. The primary inputs into the model are as follows:

- Drainage area size (A) in square miles (square kilometers)
- Time of concentration (Tc) in hours
- Weighted runoff curve number (RCN)
- Rainfall distribution
- Total design rainfall (P) in inches (millimeters)




#### 6.1.9.1.2 Curve Number (Runoff coefficient)

For catchment 1, the runoff coefficients were estimated for two scenarios to include the current land condition and post development when the residential complex has been constructed as well as some additional development in the catchment. This additional development is estimated to increase the impervious surfaces to approximately 90% in the catchment. Runoff coefficients were chosen based on the NRCS recommended values for Antecedent moisture condition III. Composite runoff coefficient numbers were generated based on the areal extent of the future runoff surface across the catchment; *Equation 6-3*).

*Equation 6-3: Composite runoff coefficient:* $= \frac{\sum A_i CN_i}{\sum A_i}$

*Table 6-12: Weighted Curve Numbers for each catchment*

| Catchment | Area (m²) | Land Use | | NRCS Curve Number (C) | |
|---|---|---|---|---|---|
| | | **Predevelopment** | **Post Development** | **Predevelopment** | **Post Development** |
| 1 | 1,510,446.10 | Forest and shrubs | Open Space | 70 | 70.2 |
| 2 | 1,017,069.90 | Forest and shrubs | Mixed (Open Space, Green Space, Residential, Roads, Industrial) | 80 | 84.5 |
| 3 | 3,750,191.43 | Mixed | Mixed (Includes Sub-Catchment 3.1), additional road and residential units | 73.5 | 73.7 |

### 6.1.9.1.3 Time of Concentration ($T_c$)

Time of Concentration is an integral part of determining the design intensity for both the SCS and Rational Methods. The time of concentration is essentially the time it takes for the entire catchment to contribute simultaneously to the flows at the design point. This is also the point at which peak flow is achieved. Time of concentration was estimated using; the Mannings Kinematic Equation (MKE) for time of entry and the NRCS method for the shallow concentrated flow.

*Equation 6-4: Mannings Kinematic Equation,* for overland sheet flow: $T_c = \frac{L^{0.8}(S+1)^{0.7}}{1.140Y^{0.5}}$

Where,

- $T_C$ = Time of Concentration (hrs.)
- L = Flow length (m)
- Y = average catchment land slope (%)
- S = maximum potential retention (m)

$$S = \frac{1000}{CN} - 10$$

$$t_1 = \frac{5.48\,(nL)^{0.8}}{P^{0.5}\,S^{0.4}}$$

*Equation 6-5 : NRNRCS equations of shallow concentrated flow*

V = 4.9178 $S^{0.5}$ for an unpaved surface

V = 6.1960 $S^{0.5}$ for a paved surface

$t_2 = L/(60V)$

#### 6.1.9.2 RESULTS (RUNOFF RATES AND VOLUMES)

Peak runoff was calculated for three scenarios, they include:

1. Existing condition which considers the catchment in its current state

2. Post development conditions where the changes in the runoff coefficient are considered for the increase in impermeable surfaces in the development.

3. Post development conditions with mitigation measures (detention ponds) included.

The post-development runoff calculations, incorporating detention pond mitigation, are summarized in Tables 6-13 through 6-15 for 2- to 100-year return period events. With mitigation in place, only marginal increases in runoff are anticipated across the three catchments:

- *Catchment 1*: Peak runoff increases are reduced from 1.16% to 0.46% between the 2- and 100-year events.
- *Catchment 2*: Being primarily within the development area, this catchment shows mitigated increases, from 44% down to 21%.
- *Catchment 3*: Runoff increases range from 2.78% to 1.13% across the modelled storm events (see Tables 6-14 to 6-16).

These results indicate that the proposed detention measures are effective in minimizing post-development runoff impacts.

The increased runoff to the existing gullies is largely unlikely as the onsite stormwater is anticipated to be retained within the development and discharged through the onsite systems.

*Table 6-13: Summary of peak runoff from catchment 1 associated with the development*

| Peak Runoff (m3/s) | | | |
|---|---|---|---|
| Return Period | Current Runoff ($m^3/s$) | Future Runoff ($m^3/s$) | Increase (%) |
| 2 | 6.58 | 6.65 | 1.16% |
| 5 | 11.56 | 11.66 | 0.82% |
| 10 | 15.44 | 15.55 | 0.68% |
| 25 | 20.26 | 20.38 | 0.57% |
| 50 | 23.77 | 23.89 | 0.51% |
| 100 | 27.33 | 27.45 | 0.46% |

*Table 6-14: Summary of peak runoff from catchment 2 associated with the development*

| Return Period | Current Runoff ($m^3/s$) | Future Runoff ($m^3/s$) | Increase (%) |
|---|---|---|---|
| 2 | 4.46 | 6.43 | 44.17% |
| 5 | 6.99 | 9.58 | 37.05% |
| 10 | 9.15 | 12.09 | 32.13% |
| 25 | 11.91 | 15.19 | 27.54% |
| 50 | 13.96 | 21.36 | 53.01% |
| 100 | 16.94 | 20.55 | 21.31% |

*Table 6-15: Summary of peak runoff from catchment 3 associated with the development*

| Return Period | Current Runoff ($m^3/s$) | Future Runoff ($m^3/s$) | Increase (%) |
|---|---|---|---|
| 2 | 14.73 | 15.14 | 2.78% |
| 5 | 25.01 | 25.52 | 2.04% |
| 10 | 33.75 | 34.32 | 1.69% |
| 25 | 44.23 | 44.45 | 1.40% |
| 50 | 51.59 | 52.23 | 1.24% |
| 100 | 62.92 | 63.63 | 1.13% |

#### 6.1.9.3 PROPOSED STORMWATER SYSTEM

The proposed stormwater system was designed to accommodate the runoff generated onsite for final discharge to the existing drainage system along the coastal highway. The design philosophy is to ensure the post development runoff discharged from the site is less than the preexisting discharges. This will ensure the highway drainage systems are positively impacted by the development. The design approach was undertaken in two stages as follows:

*Hydrologic Analysis* – The site is divided into sub-catchments according to the topography and layout of the roads, the NRCS (formerly SCS) model was utilized to generate/predict the runoff from the sub catchments for three scenarios; the existing site conditions, the proposed site conditions, and the proposed site conditions with interventions (ponds).

A total of 26 sub-catchments were delineated with runoff ranging from 0.1 cubic meters per second to 7.6 cubic meters per second for the predevelopment scenario and 0.15 to 7.46 cubic meters per second for the post development scenario (Figure 6-16 and Table 6-16).

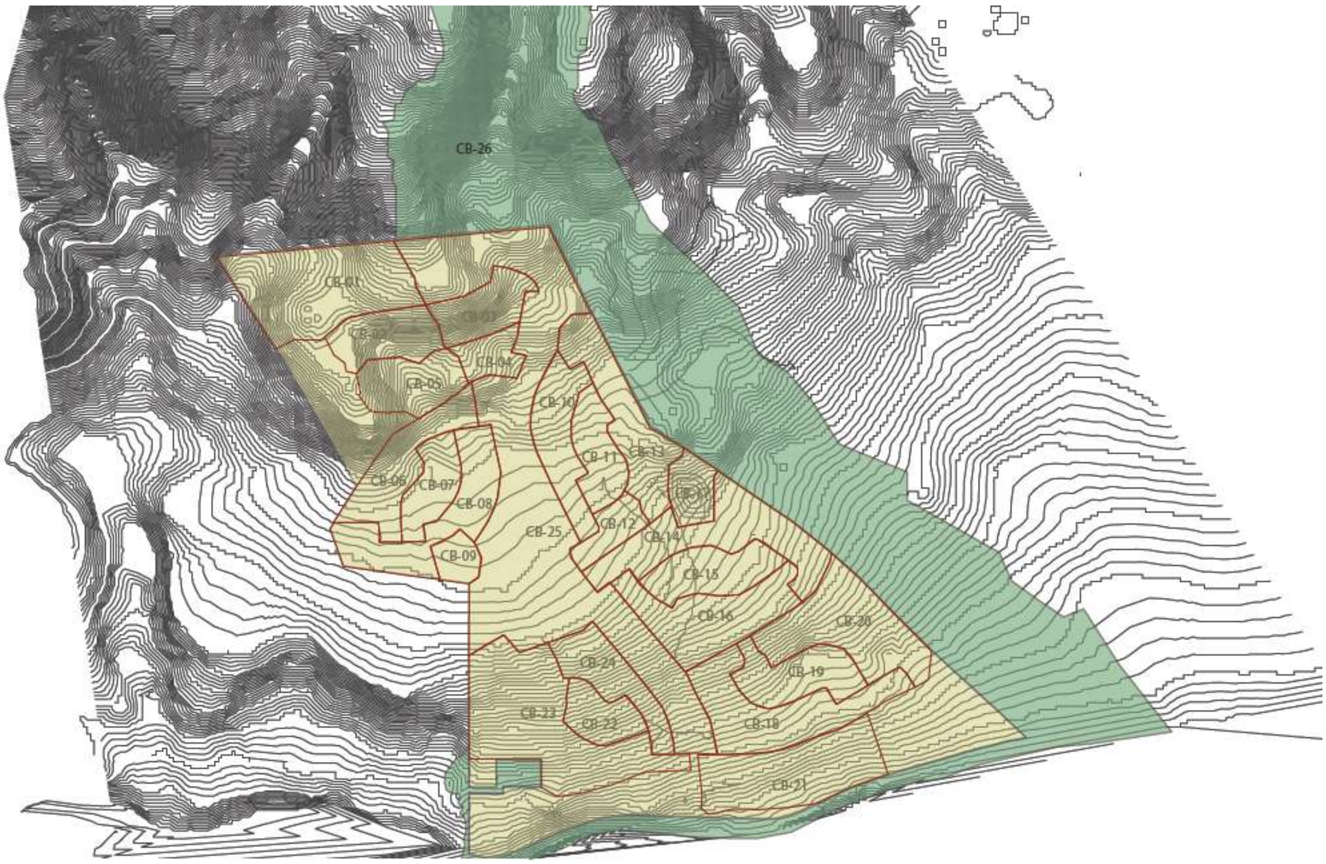



*Figure 6-15: Sub-catchments delineated within the development boundaries.*

*Table 6-16: Summary of peak runoffs from 26 delineated sub catchments within the development boundaries*

| Catch Basin | Area (Ha) | CN - Pre | CN - Post | Predevelopment | Post Development | Increase |
|---|---|---|---|---|---|---|
| CB01 | 4.40 | 73 | 90 | 0.86 | 1.74 | 102% |
| CB02 | 1.67 | 73 | 90 | 0.32 | 0.65 | 103% |
| CB03 | 1.50 | 73 | 90 | 0.27 | 0.56 | 107% |
| CB04 | 0.83 | 73 | 90 | 0.14 | 0.30 | 114% |
| CB05 | 1.71 | 73 | 90 | 0.29 | 0.60 | 107% |
| CB06 | 2.22 | 73 | 90 | 0.34 | 0.72 | 112% |
| CB07 | 1.32 | 85 | 90 | 0.26 | 0.41 | 58% |
| CB08 | 2.77 | 85 | 90 | 0.65 | 1.00 | 54% |
| CB09 | 0.62 | 76 | 90 | 0.10 | 0.20 | 100% |
| CB10 | 2.05 | 73 | 90 | 0.37 | 0.76 | 105% |
| CB11 | 1.46 | 73 | 90 | 0.22 | 0.48 | 118% |
| CB12 | 0.88 | 73 | 90 | 0.07 | 0.15 | 114% |
| CB13 | 2.66 | 73 | 90 | 0.51 | 1.03 | 102% |
| CB14 | 3.36 | 70 | 90 | 0.35 | 0.84 | 140% |
| CB15 | 1.80 | 88 | 90 | 0.49 | 0.45 | |
| CB16 | 2.86 | 70 | 90 | 0.31 | 0.73 | 135% |
| CB17 | 0.92 | 85 | 90 | 0.24 | 0.23 | |
| CB18 | 3.21 | 70 | 90 | 0.34 | 0.81 | 138% |
| CB19 | 1.87 | 70 | 90 | 0.20 | 0.48 | 140% |
| CB20 | 3.42 | 70 | 90 | 0.36 | 0.86 | 139% |
| CB21 | 3.47 | 76 | 90 | 0.37 | 0.80 | 116% |
| CB22 | 1.14 | 73 | 90 | 0.14 | 0.30 | 114% |
| CB23 | 5.21 | 73 | 90 | 0.70 | 1.51 | 116% |
| CB24 | 1.76 | 73 | 90 | 0.22 | 0.49 | 123% |
| CB25 | 13.10 | 73 | 90 | 2.10 | 4.46 | 112% |
| CB26 | 58.18 | 73 | 73 | 7.46 | 7.46 | 0% |

*Hydraulic Analysis* – This process determines the sizes of the drains required to conduct the runoff, the volume and configuration of the detention ponds required to reduce the peak runoffs. The NWA recommended standards were used for minimum drain sizes and detention storage requirements. The storm sewers used in the development will be of the following sizes: 600mm, 900mm, 1,200mm, and possibly 1,500mm and 2,000mm were required for flood mitigation. The total volume of detention provided in the design is 12,267 cubic meters, which is sufficient to reduce post development runoff within the development to below predevelopment levels. It is likely that these volumes may be increased as the average designed detention pond depths are 0.6 meters which may be impractical to construct that shallow in all areas.

*Table 6-17: Summary of detention pond capacities*

| Detention Pond | Pond Area (m²) | DP Capacity (m³) |
|---|---|---|
| 1 | 3522 | 1906 |
| 2 | 2851.80 | 1358 |
| 3 | 5506 | 833 |
| 4 | 1031 | 1702 |
| 5 | 1357 | 2297 |
| 6 | 4817 | 4171 |

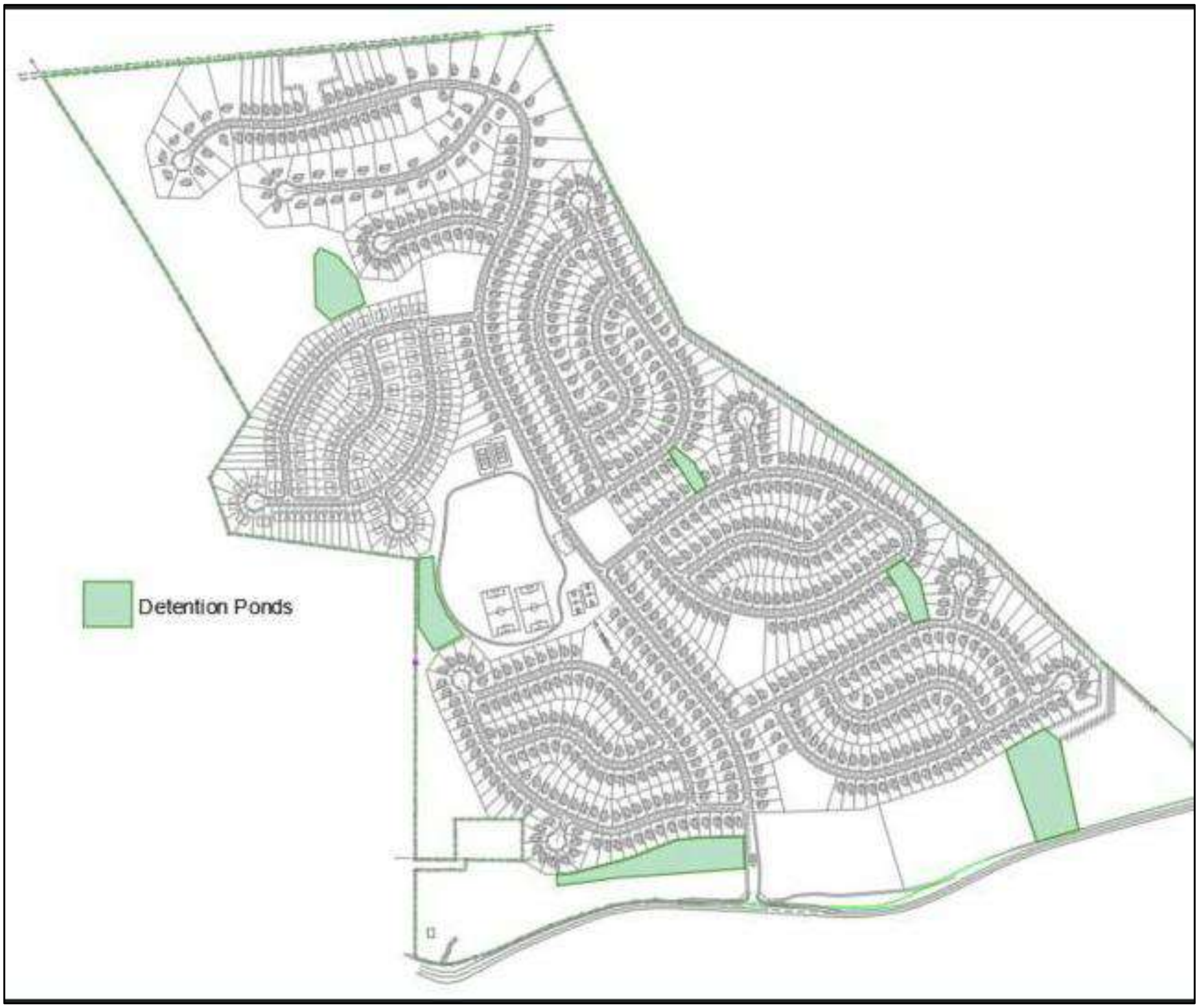



*Figure 6-16: Proposed drainage system layout for the proposed Rozelle Estate*

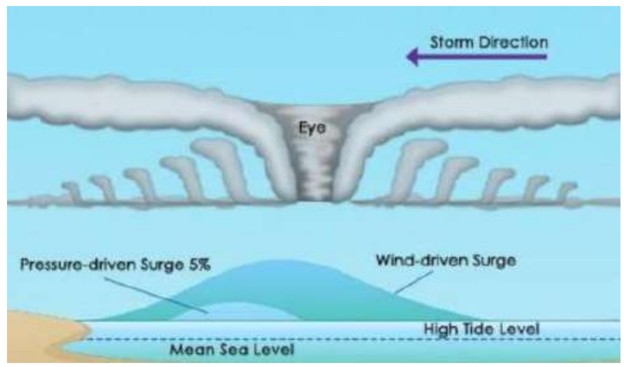
*Subsurface Detention System* – There are low lying or ponding areas within Catchment 2 (62,114.83 $m^2$) that temporarily stores and discharges water in overland streams, contributing to the flows at the Rozelle Falls. Given those areas are designated for housing; it is being proposed to relocate the natural temporary storage underground to facilitate the continued discharges to the Rozelle Falls. The subsurface storage will be located under the main park and will be connected to receive runoff from the landscape reserve and sections of the main park. When filled to capacity, the excess runoff will overflow to the surface detention systems. The subsurface storage area itself is designed to accommodate a total capacity of 23,286.61 $m^3$, using gravel media with 36% void spaces. Figure 11-1 in Appendix A shows the proposed design.

### 6.1.10 STORM SURGE AND EXTREME WAVES

#### 6.1.10.1 RATIONAL AND METHODOLOGY

The southern section of the site lies adjacent to the southern coastal highway and the Caribbean Sea. That section of the island is known to be susceptible to hurricane waves and storm surges. The last major works to protect the coastline was carried out in 2008 by the National Works Agency (NWA). It was therefore necessary to investigate the susceptibility of the project site to storm surge inundation for various return periods.

Hurricane storm surge is an increase in water levels during the passage of a hurricane. The increases in water levels are due mostly to the following:




1. Inverse barometric pressure
2. Tides
3. Waves
4. Wind
5. Bathymetry and coastal morphology

The records do not show any historical storm surge measurements for the studied area; therefore, a numerical modelling approach was adopted. The approach to determining storm surge elevations for various return periods was as follows:

1. Storms were extracted from the NOAA database file (HURDAT) for storms from 1942 to 2022.
2. Storm tracks passing within 300km of the project site were selected.
3. For the selected storm tracks, Young and Sobey (1981) hurricane model was used to generate wind-field associated with the selected hurricane.
4. The third-generation wind-wave model Mike21-SW was used to estimate the waves and the coupled Mike 3D to determine water level/storm surge associated with each hurricane.
5. Extremal statistics (annual maxima) were performed on the resulting wave and water levels obtained.

#### 6.1.10.2 RESULTS

The results are as follows:

A total of 376 systems were observed passing within the 300km radius of the site during the period (1942 to 2022). Those systems included tropical depressions, tropical storms, and hurricanes. Eighty-eight (88) systems were hurricanes varying from category 1 to 5. Figure 6-17 illustrates the occurrences of hurricanes categorized by intensity (Category 1 to Category 5) over several decades. Each category is shown with its linear trendline, reflecting patterns of increase or decrease in frequency over time.

*Table 6-18: A description of the categories of events occurring in Jamaica over the last 8 decades*

| | |
|---|---|
| **Category 1 Hurricanes** | These events show a slight decreasing trend over the decades. While there was notable activity in earlier years (e.g., the 1950s), their frequency appears to decline moving into the later years. |
| **Category 2 Hurricanes** | This category has a consistent frequency throughout the observed period, with no strong upward or downward trend. However, its linear trendline slightly declines, suggesting a marginal reduction in occurrences over time. |
| **Category 3 Hurricanes** | A declining trend is evident for Category 3 hurricanes, which were more frequent in the earlier decades (notably in the 1950s) but have decreased in the later years. |
| **Category 4 Hurricanes** | The data show an increasing trend for Category 4 hurricanes, with a notable rise in occurrences, especially from the 1980s onward. This could reflect changing climatic conditions leading to more intense hurricanes. |
| **Category 5 Hurricanes** | Like Category 4 hurricanes, Category 5 events also display an increasing trend. Their presence becomes more pronounced in recent decades, indicating a steady rise in the strongest hurricanes affecting the eastern region of Jamaica. |

From other analyses conducted, it has been observed that the western section of Jamaica experiences a higher frequency of major hurricanes (Categories 4 and 5) compared to the eastern region. This suggests regional variations in hurricane impacts, possibly influenced by geographical or meteorological factors. The data highlights the variability of hurricane intensity over time in eastern Jamaica, with a notable decline in lower-category storms (Categories 1–3) and a rise in higher-intensity hurricanes (Categories 4 and 5).

*Table 6-19: Decadal numbers of each category of hurricanes from 1942-2022*

| Decade | Cat 1 | Cat 2 | Cat 3 | Cat 4 | Cat 5 | Total |
|---|---|---|---|---|---|---|
| 1940 | 1 | 1 | 2 | 0 | 0 | 4 |
| 1950 | 5 | 4 | 10 | 0 | 0 | 19 |
| 1960 | 7 | 3 | 5 | 1 | 0 | 16 |
| 1970 | 2 | 0 | 0 | 0 | 0 | 2 |
| 1980 | 0 | 0 | 3 | 3 | 1 | 7 |
| 1990 | 1 | 1 | 0 | 0 | 0 | 2 |
| 2000 | 9 | 1 | 1 | 13 | 2 | 26 |
| 2010 | 3 | 1 | 2 | 6 | 0 | 12 |
| | | | | | | 88 |

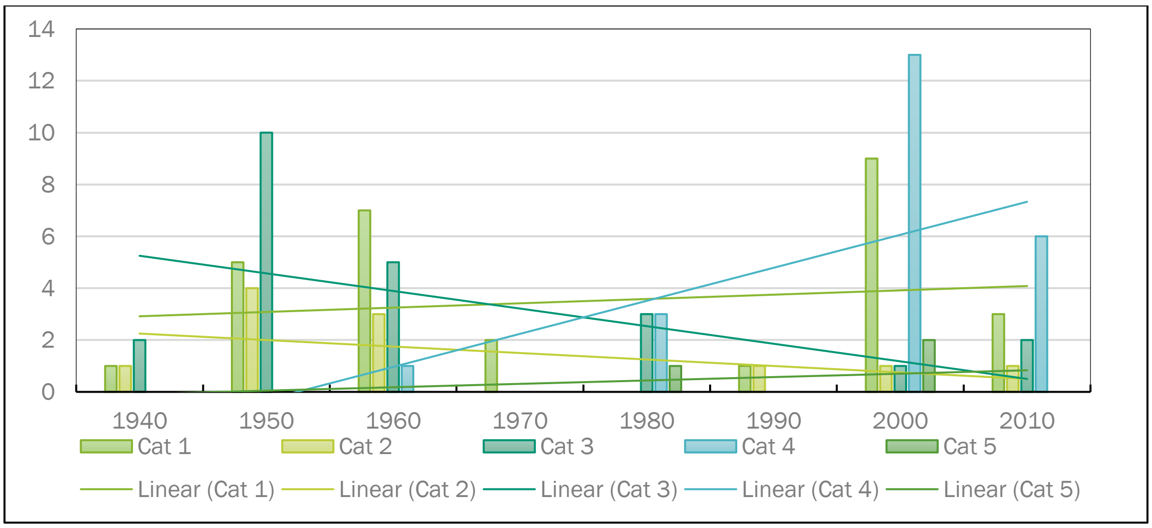



*Figure 6-17: Decadal numbers of each category of hurricanes from 1942 to 2022*

The storm surge and extreme wave conditions at the site were determined by each hurricane that passed within 300km of the project site. This was done using a Mike 21SW FM (flexible mesh) for extreme waves and Mile 3HD for water level setup, see flexible mesh in Figure 6-188. Input information included:

- Bathymetry gathered from field surveys and existing charts
- Bathymetric data of the Caribbean basin
- Shorelines of the Caribbean and project site
- Hurricane track with hurricane characteristics at 6-hour intervals (from NOAA)

The spectral wave model was coupled with the hydrodynamic model to reproduce wave conditions while there are storm surges. The final surge elevations at the shoreline were computed by adding the wave setup due to the waves breaking and shoaling.

Time series of the setups and wave heights were extracted for selected locations and subjected to statistical analysis to determine the corresponding return periods.

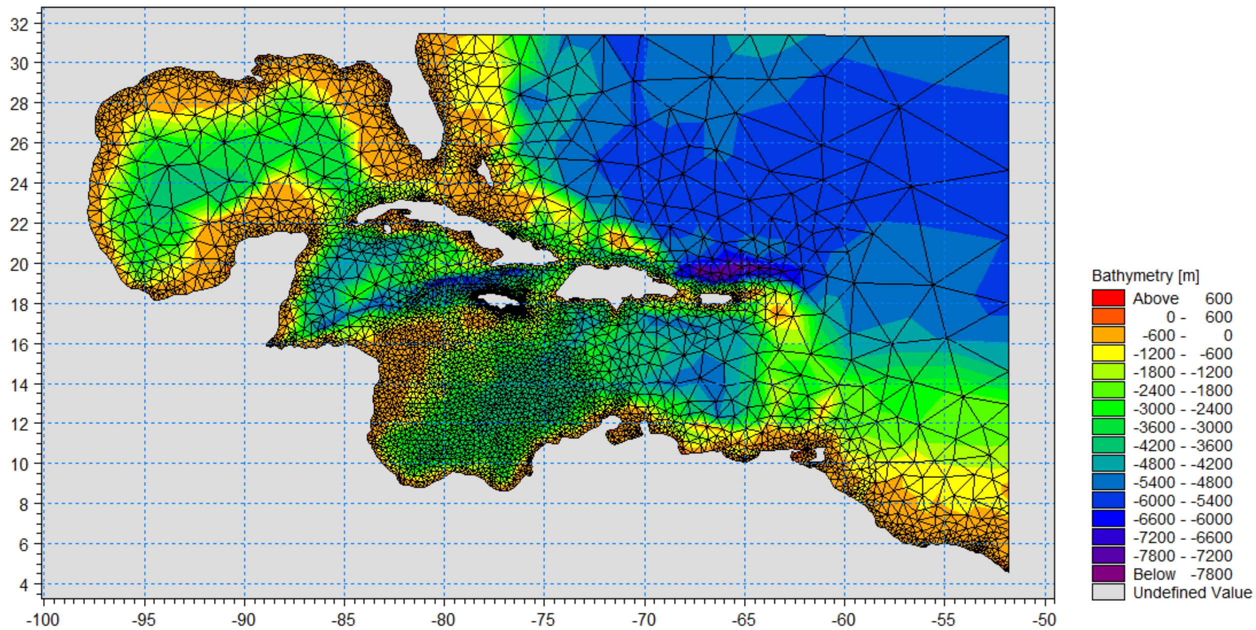



*Figure 6-18 Flexible mesh domain (West Atlantic to Gulf of Mexico)*

Three distributions were selected to fit the resulting time series distribution and the extreme values of storm surge and waves based on L-moment procedures and to compute the quantile estimates at various return periods. The distributions are as follows:

- generalized extreme value probability distribution (GEV),
- generalized logistics probability distribution (GLO) and
- generalized pareto probability distribution (GPA)

The time series were first analysed to select annual maxima which was then sorted or ranked in ascending order of magnitude and the following determined:

1. Basic descriptive statistics such as the sample mean, variance, standard deviation, skewness, kurtosis, coefficient.
2. Probability weighted moment parameters and L-Moment ratio values
3. Goodness of fit statistics (RRMSE, RMSE, MAE, MADI and PPCC)
4. shape (k), scale (α) and location (ξ) parameters of GEV, GPA and GLO probability distributions

Results obtained revealed that generalized logistics probability distribution GEV was the best fit distribution model to analyse the storm surge and waves.

The accompanying graphs (**Error! Reference source not found.** and Table 6-21) illustrates how t hese models compare to observed (model predicted) wave and storm surge data respectively.

*Table 6-20: Extreme water surface elevation nearshore due to Hurricane winds and pressure setup*

| Return Period T | Wave Height (m) | | |
|---|---|---|---|
| | GEV - QT | GLO - QT | GPA - QT |
| 2 | 1.84 | 1.71 | 0.99 |
| 5 | 2.10 | 1.96 | 1.90 |
| 10 | 2.20 | 2.11 | 2.04 |
| 20 | 2.27 | 2.24 | 2.10 |
| 50 | 2.33 | 2.40 | 2.12 |
| 100 | 2.37 | 2.51 | 2.13 |
| 200 | 2.40 | 2.62 | 2.13 |
| 500 | 2.43 | 2.76 | 2.13 |
| 1000 | 2.44 | 2.87 | 2.13 |

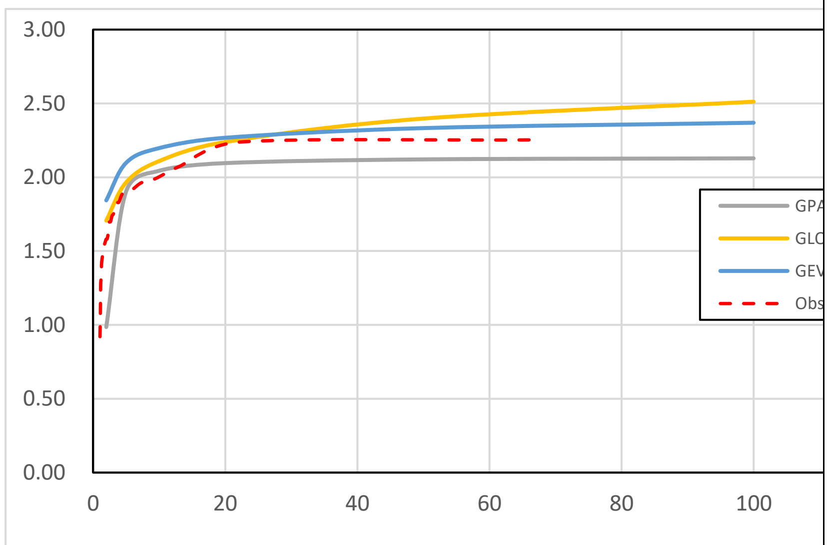
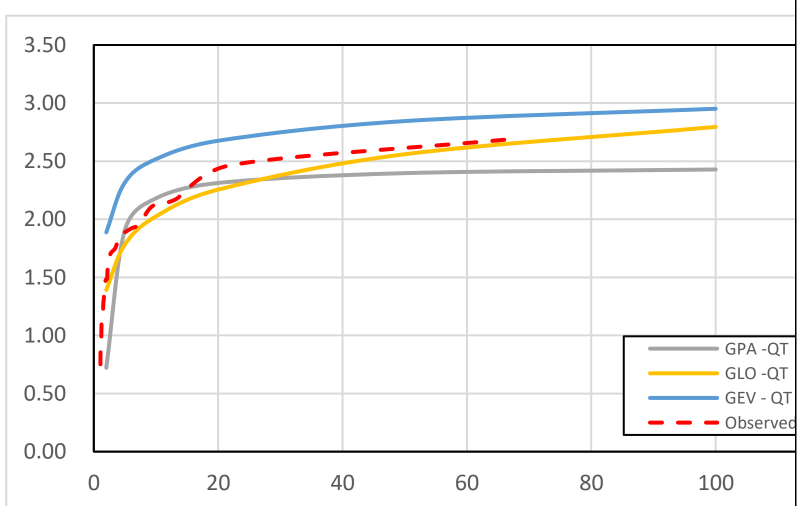



*Table 6-201 Maximum predicted Storm Surge Level including Wave setup at the project site.*

| Return Period T | Storm Surge Elevation (m) | | |
|---|---|---|---|
| | GEV - QT | GLO - QT | GPA - QT |
| 2 | 1.89 | 1.39 | 0.72 |
| 5 | 2.32 | 1.78 | 1.91 |
| 10 | 2.52 | 2.02 | 2.18 |
| 20 | 2.68 | 2.26 | 2.31 |
| 50 | 2.85 | 2.56 | 2.40 |
| 100 | 2.95 | 2.79 | 2.43 |
| 200 | 3.04 | 3.04 | 2.45 |
| 500 | 3.15 | 3.37 | 2.46 |
| 1000 | 3.21 | 3.62 | 2.46 |



The total setup represents the combined storm surge elevation above mean sea level (MSL) due to wave and atmospheric processes. It includes contributions from wave setup at the shoreline and wind and pressure setup, reflecting the cumulative impact of storm-induced forces. The total setup values increase with the return period, indicating a higher storm surge elevation for more extreme and less frequent storm events. The estimated total setup varies from 2.42m for the two-year return event to 3.58m for the 100-year return period (Table 6-22).

*Table 6-21 Maximum predicted Storm Surge Level including Wave setup at the project site.*

| **Storm Surge Elevation above MSL** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Return Period | 2 | 5 | 10 | 25 | 50 | 100 | Units |
| Wave height at breaking, $H_b$ | 1.84 | 2.10 | 2.20 | 2.27 | 2.33 | 2.37 | m |
| Breaking Index | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | |
| Depth at breaking, $h_b$ | 2.36 | 2.69 | 2.82 | 2.91 | 2.99 | 3.04 | m |
| Depth at Shoreline (including tides) | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | 0.22 | m |
| $\eta_b$ | -0.09 | -0.10 | -0.11 | -0.11 | -0.11 | -0.12 | m |
| $\eta_{max}$ | 0.43 | 0.49 | 0.51 | 0.53 | 0.55 | 0.55 | m |
| Wave Setup at shoreline, $\eta_t$ | 0.31 | 0.36 | 0.38 | 0.39 | 0.40 | 0.41 | m |
| Wind & Pressure Setup | 1.89 | 2.32 | 2.52 | 2.68 | 2.85 | 2.95 | m |
| Total Setup | 2.42 | 2.90 | 3.12 | 3.29 | 3.47 | 3.58 | m |


*Figure 6-19: Approximate locations for each return period storm surge water surface elevation contour*

With the implementation of this development, increased runoff volumes due to the addition of impervious surfaces influenced by the hydrological and geological characteristics of the site are anticipated. The southern clayey soils, prone to water retention, present challenges for drainage and foundation stability. Mitigation measures will have to be specifically designed to manage and control flood risks onsite and in low-lying areas.

### 6.1.10.3 Summary

The proposed development introduces carefully planned changes to the hydrology of the site and surrounding area, balancing necessary urban growth with sustainable storm water management strategies and environmental preservation. With the implementation of this development, there is anticipated increased runoff volumes due to the addition of impervious surfaces influenced by the hydrological and geological characteristics of the site. This is mitigated by the implementation of open spaces, green areas, and detention ponds. These measures have been specifically designed to manage and control runoff effectively, reducing flood risks onsite and in low-lying areas.

While most of the proposed detention ponds are adequately designed to manage peak runoff volumes, the third detention pond in catchment 2 exhibits insufficient capacity posing potential flood risk in the southwestern portion of the site.

The southern clayey soils, prone to water retention, present challenges for drainage and foundation stability. Meanwhile the site's underlying limestone aquiclude limits groundwater movement, emphasizing reliance on surface water management (for example, detention ponds & proper drainage networks).
Without adequate mitigation, the increased runoff and altered drainage patterns could adversely affect adjacent communities and ecosystems, particularly through sedimentation in drainage systems and increased flooding risks downstream.

A supplemental drainage strategy is proposed. This incorporates a subsurface storage area, subsurface gravel drains, a cut-off drain, and a detention pond to effectively address the existing ponding/flooding concern while safeguarding the integrity of the natural environment, particularly Rozelle Falls. This system not only mitigates flood risks but also isolates pollutants from the developed areas, preventing them from infiltrating and impacting the Falls.
The following are proposed:

1. Flood and Drainage Management
    a. Ensure during construction to design temporary stormwater management system for runoff mitigation as well as grade construction zone as needed to direct water to the designated drainage areas.
    b. Regrade areas prone to ponding and install bio-retention areas, vegetative swales, and sediment traps.

2. Enhancement of Detention Pond Designs
    a. Increase capacity of DP-3 in catchment 2 to sufficiently manage calculated inflow volumes in that area.
    b. Regularly assess and maintain all detention ponds to ensure optimal functionality during more extreme storm events.
3. Improvement of Drainage Systems
    a. Implement minor systems to divert runoff away from the edges of Catchment 1 (West-point) and Catchment 3 (East-point) and simultaneously contain and direct the runoff already onsite via the proposed drainage system (Appendix 6-Figure 11-1) to their respective outlets.
    b. Consider the installation of additional drainage structures along vulnerable areas, especially along the main road near to Duhaney Pen and Belvedere.
    c. Realign gully (Chocolate Gully) that occupies the eastern portion of the site so that the flow path is not directly impacting the site.
    d. Consider incorporating additional subsurface storage areas in conjunction with subsurface gravel drainage systems, a cut-off drain, and a detention pond to effectively manage runoff in the natural areas (open spaces) along the north-western site boundary, directing it towards Rozelle Falls.

## 6.1.11 HYDROLOGICAL ASSESSMENT OF SURFACE SOURCES ON AND ABUTTING THE SITE

The Rozelle Spring is a surface water feature on the western section of the site. There are no known studies on its reliable yield. Additionally, the only freshwater resource with historical water quality data is the Rozelle Falls. Analysis of historical data (1962-1994) from the WRA show relatively good water quality, with chloride and electrical conductivity being borderline good; an indication of some dissolved solutes, which is not cause for concern in and of itself. However, the analysis is outdated. It was therefore determined to conduct an assessment of the sources identified on the site and in close proximity, to detect their yield and quality.

Figure 6-21 shows the location of the proposed water quality sample and stream flow sites from which baseline conditions was assessed.

### 6.1.11.1 STREAM DISCHARGE

The hydrological field assessment of four (4) sources relating to the property, was conducted during the period September-November 2024. Discharge measurements were taken on September 9, 2024, October 6, 2024, October 20, 2024, and November 3, 2024.

The studied sources included:

1. "Dam Head"- East of the property
2. 'Community Pipe'- at the southern section of the property
3. 'Above Falls'- at the south-eastern section of the property
4. Shady Spring-Northwest of the property.

Note that these sights were also used for water quality assessment, along with other marine sites.

### 6.1.11.2 METHOD

Velocity measurements were recorded at the sites "Dam Head" and Shadey Spring using a mini current meter. At 'Community Pipe' and 'Above Falls', the measurements were taken using the bucket-based method, capturing the time to taken to fill a bucket with 10 litres of water, and computing the flow rate in litres per second (LPS) and cubic meters per day ($m^3$/day).

The flow discharge of a river or stream is a measure of the volume of water passing a given point per unit time. It is often expressed in cubic meters per second ($m^3$/s), cubic meters per day ($m^3$/day), or gallons per day (gpd). In the dataset below, the discharge is computed using the formula:

*Formula for Discharge:*

$Q=A\cdot V$

Where:

- Q: Flow discharge ($m^3$/s)
- A: Cross-sectional area of the flow ($m^2$)
- V: Average velocity of the flow (m/s)

### 6.1.11.3 RESULTS

*Table 6-22: Stream discharge measurements from the freshwater sites measured via a mini-current meter*

| Site | Date | Sectional Area ($m^2$) | Average Velocity (m/s) | Flow Discharge ($m^3$/s) | Discharge ($m^3$/day) | Discharge (gpd) |
|---|---|---|---|---|---|---|
| Dam Head | | | | | | |
| | 19-Sep-24 | 0.4 | 0.3 | 0.12 | 293.59 | 77,558.20 |
| | 06-Oct-24 | 0.52 | 0.35 | 0.18 | 440.38 | 116,337.00 |
| | 20-Oct-24 | 0.83 | 0.14 | 0.12 | 293.59 | 77,558.20 |
| | 03-Nov-24 | 0.7 | 0.17 | 0.12 | 293.59 | 77,558.15 |
| Shadey Spring | | | | | | |
| | 06-Oct-24 | 0.83 | 0.25 | 0.21 | 513.78 | 135,726.8 |
| | 20-Oct-24 | 0.86 | 0.4 | 0.34 | 831.84 | 219,748.1 |
| | 03-Nov-24 | 0.94 | 0.61 | 0.57 | 1394.55 | 368,401.2 |

*Table 6-23: Stream flow measurements from the freshwater sites measured via the bucket method*

| Site | Date | Av Time (s) | Av Flow (LPS) | Avg Flow ($m^3$/day) | Flow (GPD) |
|---|---|---|---|---|---|
| Community Pipe | | | | | |
| | 19-Sep-24 | 2.55 | 3.95 | 341.69 | 90,263.73 |
| | 06-Oct-24 | 2.05 | 4.89 | 422.89 | 111,716.20 |
| | 20-Oct-24 | 2.55 | 3.95 | 341.04 | 90,093.07 |
| | 03-Nov-24 | 2.31 | 4.35 | 376.20 | 99,382.53 |
| Above Falls | | | | | |
| | 19-Sep-24 | 1.28 | 7.95 | 686.70 | 181,407.06 |
| | 06-Oct-24 | 1.55 | 6.61 | 571.37 | 150,940.89 |
| | 19-Sep-24 | 1.28 | 7.95 | 686.70 | 181,407.06 |
| | 06-Oct-24 | 1.55 | 6.61 | 571.37 | 150,940.89 |

#### 6.1.11.4 ANALYSIS

Stream discharge at Dam Head was consistent with the exception of October 6, 2024, which indicated a peak. This may have been due to increased groundwater storage or rainfall. Daily discharge rates remained constant over the assessment period with the exception of October 6, 2024.

Shadey Spring's discharge increased significantly over the monitoring period, with a 171% rise between the first and last measurements. Daily discharge rates nearly tripled over the time period.

At Above Falls, daily discharge rates remained fairly consistent over the assessment period with only the minor fluctuation in flows. The fluctuation was attributed to increase in flows on November 3, 2024.

For the Community Pipe source, daily discharge rates remained fairly consistent over the assessment period with the minor fluctuation in flows where there was an increase on October 6, 2024. Figure 20 shows a graphic of the flows compared with rainfall measurement over the assessment period.

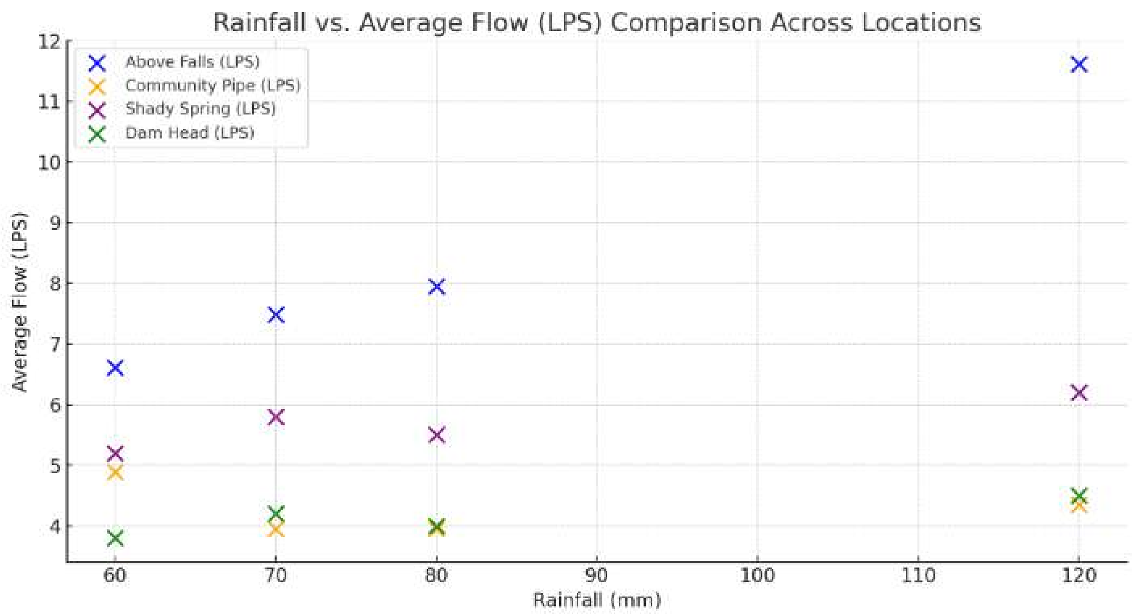



*Figure 6-20: Rainfall/flow relationships across the study sites*

### *Rainfall vs. Average Flow (LPS):*

- Above Falls showed the strongest positive correlation between rainfall and flow, indicating direct dependence on precipitation.
- Shady Spring and Dam Head: Both show moderate positive correlations, with flow increasing with rainfall but less sharply than Above Falls.
- Community Pipe displays minimal correlation with rainfall, reflecting controlled and regulated infrastructure.

### *Rainfall and Flow Over Time:*

- Above Falls: Flow closely follows rainfall trends, with significant peaks after high rainfall events (e.g., on 03-Nov-24).
- Shady Spring and Dam Head: Flows show a slight increase with rainfall but remain relatively stable due to regulated inflows.
- Community Pipe: Flow remains almost unchanged across rainfall events, emphasizing independent control mechanisms.

*Correlation Coefficients (Rainfall vs. Avg Flow):*

- Above Falls: 0.997. This indicates a strong positive correlation between spring discharge and rainfall
- Community Pipe: -0.175. This indicates a weak negative correlation between spring discharge and rainfall
- Shady Spring: 0.868. This indicates a moderate positive correlation between spring discharge and rainfall
- Dam Head 0.881. This indicates a moderate positive correlation between spring discharge and rainfall

#### 6.1.11.4.1 Flow Variability

The data exhibits modest fluctuations in the flow rate across the measurements points. The Above Falls source indicates strong dependency on natural conditions and rainfall which means that this source fluctuates with rainfall and will show seasonal variability with rainfall. Both Shady Spring and Dam Head indicated moderately influenced by rainfall and are dominantly groundwater fed. This will have sustained flow within the dry period but will demonstrate minor seasonal variability. The Community Pipe flows are largely decoupled from rainfall and are solely groundwater fed. This source will demonstrate minor seasonal variability but can go low if groundwater levels fall.

- Possible Influences: The sources discharges may indicate fluctuations during the dry season. The assessments were done during the wet season with little indication of the expected flows during the dry season.
- Average Flow: The average flow for all sources is fairly consistent, which suggests the availability and sustainability of the resources.
- Water Usage: The wet season flow rates can help in designing infrastructure for the housing development

#### 6.1.11.5 WATER QUALITY

Similarly to the discharge assessment regime, water samples were collected bi-monthly over a three-month period.

##### 6.1.11.5.1 Sampling Regime

###### 6.1.11.5.1.1 Sample Network

The sample sites consist of a total of six (6) sites; 4 freshwater inland sites and 2 within the marine environment bordering the site. Figure 6-20 shows the location of the sample sites. Note that the freshwater sites were the same sites used for the stream flow measurements.


*Figure 6-21: The location of the discharge and sample points (freshwater and marine) over the site and adjacent marine environment. It should be noted that the SCHIP road improvement project resulted in construction of drains that take runoff from the roadway into the sample environment, however, these were the only points accessible from land.*

*Table 6-24: The list of sample sites used to capture baseline conditions at the project site as well for post approval. Monitoring.*

| Sample Site Code | Sample Site Name | Location | Description |
|---|---|---|---|
| FRW1 | Freshwater site #1 (Community Pipe) | 0345273.00E<br>1976662.00 N | The second and smaller of two rapids along the Rozelle main thoroughfare. This one is a piped outflow from which the community collects water |
| FRW2 | Freshwater site #2 (Above Falls) | 0345109.00 E<br>1976670.00 N | Just North of the Rozelle Falls |
| FRW 3 | Freshwater site #3 (Dam Head) | 0345471.00 E<br>1977390.00 N | A spring -fed source; the main source for the district of Rozelle (raw, untreated water) |
| FRW 4 | Freshwater site #4<br>(Shadey Spring) | 0344626.00 E<br>1977462.00 N | Shady Spring -West of the property boundary<br>The spring contributing to the Shady Spring stream that outflows below the road West of Rozelle |
| MR1 | Marine site #1 | 0345956.31 E<br>1976739.31 N | Directly below the proposed WWTP site |
| MR2 | Marine Site #2 | 0345618.79 E<br>1976633.92 N | Outlet (culvert) also carries runoff from the road |

#### 6.1.11.5.1.2 Sampling Frequency

To capture the physico-chemical properties of the different freshwater and marine sources on and in proximity of the proposed development site, water samples were collected on a bi-monthly basis. Three (3) sampling sessions were conducted over the period September to October 2024. The dates included:

1. 19 September 2024
2. 03 October 2024
3. 22 October 2024

#### 6.1.11.5.1.3 Sampling Parameters

Table 6-26 presents the water quality parameters that were assessed at different aquatic environments (freshwater and marine) for analysis to determine water quality status; with standard limits based on NRCA's ambient freshwater and marine limits and the standards for sewage effluent, which will serve as baseline against which the ambient environment will be sampled for post approval monitoring. Table 6-27 shows the results of the analyses, based on the average value for each parameter.

*Table 6-25: The water quality parameters analysed for the different monitoring sites*

| Site Type | Parameters | Number of Sample Sets |
|---|---|---|
| Freshwater | pH | 4 |
| | Phosphate | |
| | Nitrate | |
| | Salinity | |
| | Conductivity | |
| | Hardness | |
| | BOD | |
| | Faecal Coliform | |
| | Total coliform | |
| Marine | pH | 2 |
| | Phosphate | |
| | Nitrate | |
| | TSS | |
| | BOD | |
| | COD | |
| | Faecal Coliform | |
| | Residual Chlorine | |
| | Fats, oils and grease | |

*Table 6-26: Water quality analyses results, presented as average parameter values for the assessment period.*

| Sample Point | pH | Phos | NIT | Salinity | COND | Hard | BOD | Faecal coll. | Total Coli. |
|---|---|---|---|---|---|---|---|---|---|
| FW1 | 7.9 | 0.11 | 5.12 | 0.17 | 506.7 | 222 | 0.46 | 101.5 | 487.3 |
| FW2 | 7.8 | 0.09 | 4.25 | 0.17 | 461.7 | 220 | 0.5 | 128.5 | 1180 |
| FW3 | 7.56 | 0.1 | 7.63 | 0.17 | 519.46 | 112.05 | 0.44 | 33 | 1373.33 |
| FW4 | 7.75 | 0.07 | 4.95 | 0.178 | 517.3 | 252.5 | 0.6 | 61 | 220 |
| | **pH** | **Phos** | **NIT** | **TSS** | **BOD** | **Res. Chl.** | | **Faecal** | **Fats** |
| MRN1 | 8.1 | 0.07 | Negl. | 87.33 | 57.4 | 0.035 | | 350 | 7.5 |
| MRN2 | 8.1 | 0.2 | Negl. | 64.66 | 3.966 | Negl. | | 4.5 | 7.33 |

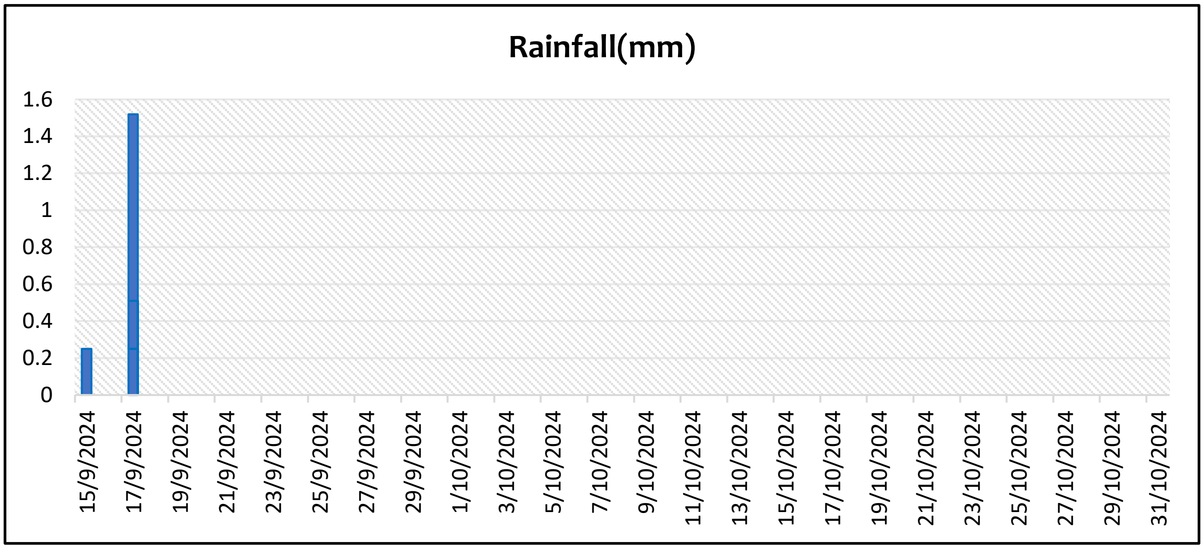



*Figure 6-22: Rainfall over 4 days prior to each sampling date. Note that there were only two rainfall events for the duration of the assessment period.*

### 6.1.11.5.2 Discussion

The above results show that for the most part the freshwater sites are not significantly impacted. However, the phosphate levels at FWI (above Falls) source suggest some influence, possibly agricultural runoff or animal waste. Total coliform levels, especially at FW2 (Community Source) and FW3 (Dam Head), suggests potential contamination. These sources may therefore contain harmful microorganisms such as pathogens. Nitrate levels, while just above the standard limit, indicate human influence on water quality, the most likely cause being agricultural activity.

The levels of phosphate, BOD and faecal coliform suggests that the marine environment is being impacted by anthropogenic activities. The likely cause is runoff from the upgradient areas being collected and released into the environment from the drains along the roadway.

The graph above (Figure 6-22) shows rainfall 4 days prior to each sampling event. Note that for the sampling period, it only rained for 2 days, those being 4 and 2 days prior to the first observation. It can therefore be inferred that rainfall did not have much of an influence on the resultant water quality outcome.

### 6.1.12 AMBIENT AIR AND NOISE

A pre-development ambient air quality assessment exercise for the proposed site was conducted. The objective of the assessment was to establish baseline environmental conditions by measuring key air quality and noise parameters. This section presents the results of the assessment, providing an evaluation of ambient conditions in relation to applicable environmental standards.

#### 6.1.12.1 SAMPLE SITE DESCRIPTION

The Rozelle Housing Development project site spans approximately 147 hectares and is located between the White Horses and Duhaney Pen communities. The site is positioned near the coastline and is characterized by lush vegetation and hilly landscapes.

The area is rural, with agriculture being the primary landuse activity. There are no major air pollution sources in the vicinity, contributing to relatively undisturbed ambient air quality conditions. The methods employed are described below.

#### 6.1.12.2 METHODS

Monitoring was conducted at two locations strategically selected to capture conditions upwind and downwind of the development site. The parameters measured included:

- Particulate Matter (PM10)
- Particulate Matter (PM2.5)
- Ambient Noise Levels

Sampling was performed at two locations, representing upwind and downwind conditions relative to the project site. The selection of sampling sites was based on safety, security, and accessibility to electricity, ensuring stable and uninterrupted operation of the monitoring equipment.

*Figure 6-23: The location of the upwind and downwind sites used for air quality monitoring*

The upwind monitoring campaign was conducted from October 4 to October 22, 2024, while downwind measurements were taken from February 13 to March 3, 2025.

##### 6.1.12.2.1 Air quality Monitoring

###### 6.1.12.2.1.1 Upwind Sampling (October 4–22, 2024)

PM10 measurements were collected using the Met One BAM-1022 Continuous Particulate Monitor, a US EPA-designated Federal Equivalent Method (FEM) instrument for ambient particulate monitoring. The monitor was installed on the roof of a residential structure situated upwind of the development site to ensure representative background air quality data. The instrument was mounted at a height within the US EPA-specified range of 2–7 meters above ground level to prevent localized ground interference and ensure compliance with regulatory sampling protocols.

Data collection was conducted continuously for two weeks and five days before early termination due to adverse weather conditions affecting the region.

###### 6.1.12.2.1.2 Downwind Sampling (February 13–March 3, 2025)

$PM_{10}$ and $PM_{2.5}$ concentrations were measured at the downwind site using the Polludrone Air Quality Monitoring System, an integrated multi-parameter instrument designed for real-time air quality assessment. The system was configured to record hourly measurements, allowing for high-resolution temporal analysis of particulate matter trends over the sampling period.

##### 6.1.12.2.2 Noise Monitoring

Simultaneous with the particulate matter assessment, continuous ambient noise monitoring was conducted at the downwind site using the Polludrone Air Quality Monitoring System. The system was configured to record hourly noise levels, capturing Leq (equivalent continuous sound level), Lmax (maximum sound level), and Lmin (minimum sound level). This data facilitated the characterization of background noise conditions and provided insight into diurnal noise variations.

##### 6.1.12.2.3 Data Quality and Compliance

All monitoring equipment was deployed following manufacturer specifications and established regulatory guidelines to ensure the accuracy and reliability of collected data. The height and placement of the instruments were selected to minimize interference from local sources while adhering to US EPA air quality monitoring standards.

The collected data was subjected to post-collection processing and validation, including identification of anomalous readings, cross-referencing with meteorological conditions, and ensuring completeness of the dataset. The results were analysed in accordance with US EPA National Ambient Air Quality Standards (NAAQS) to assess compliance with established air quality and noise criteria.

*Figure 6-24: BAN-1022 on roof (upwind) while image on the left shows Polludrone on roof (downwind).*

#### 6.1.12.3 RESULTS

This section presents the results of the monitoring exercises conducted throughout the project area. The results recorded during October 2024 were taken at the upwind location, while the results recorded during February and March 2025 were taken at the downwind site. The results of the assessment exercise were compared to the limits and standards below to assess compliance and determine areas of concern. Figure 6-25 to Figure 6-27 show the results graphically.

*Table 6-27: Ambient Air Quality Guidelines and Limits*

| Parameter | Unit | Limit | Duration | References |
|---|---|---|---|---|
| Particulate Matter ($PM_{10}$) | µg/m³ | 150 | 24-hr | NEPA |
| Particulate Matter ($PM_{2.5}$) | µg/m³ | 35 | 24-hr | US EPA |
| Ambient Sound (Daytime) | dB(A) | 55 | Hourly/Daytime (07:00 - 22:59) | WHO/EPA |
| Ambient Sound (Nighttime) | dB(A) | 45 | Hourly/Nighttime (23:00 - 06:59) | WHO |
| Ambient Sound (24-hour Avg) | dB(A) | 55 | 24-hr | EPA |

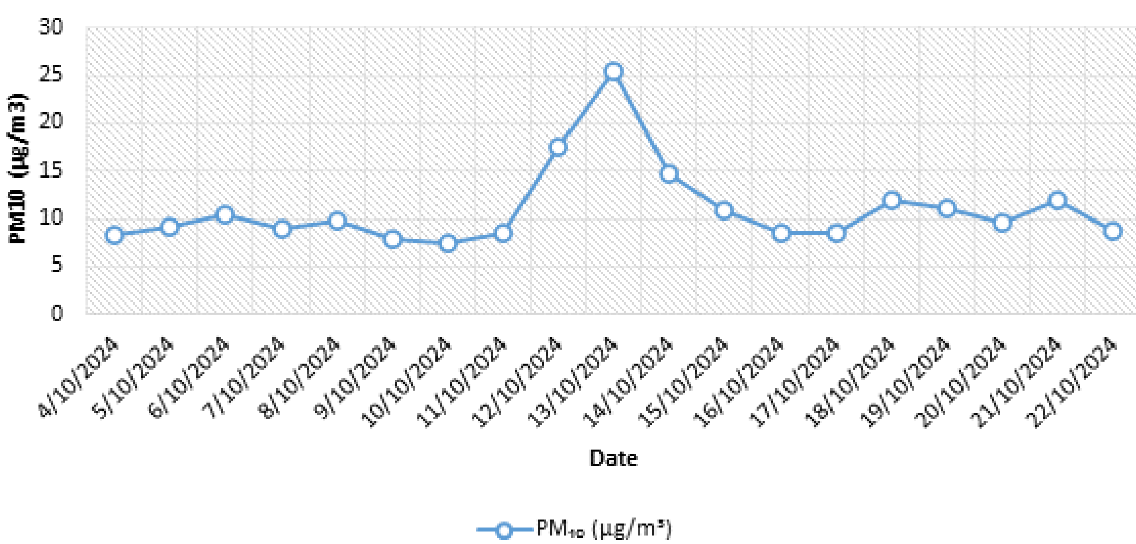



*Figure 6-25: Diurnal trends in $PM_{10}$ Concentrations October 4th to 22nd, 2024*

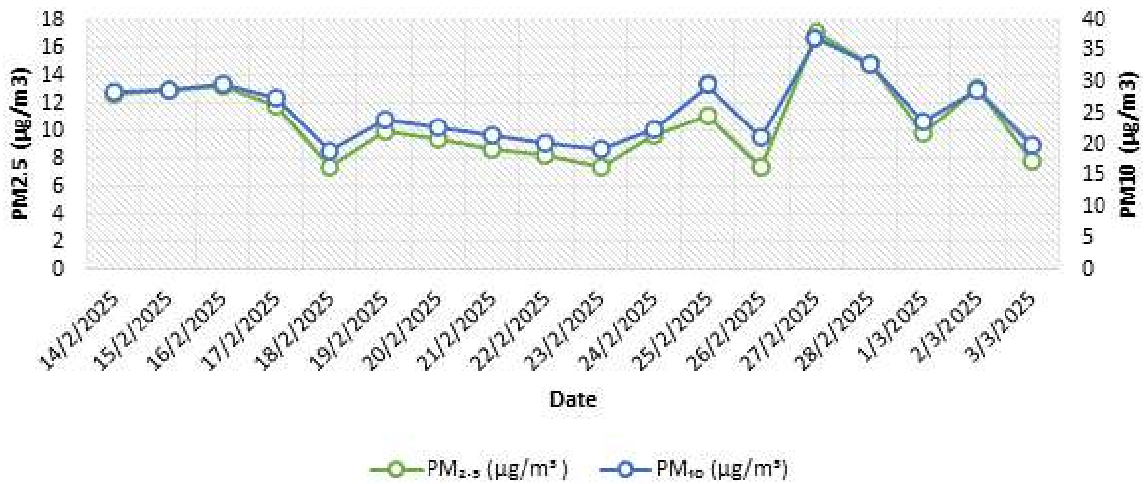



*Figure 6-26: Diurnal trends in PM10 and PM2.5 Concentrations Feb 13th to March 3rd, 2025*

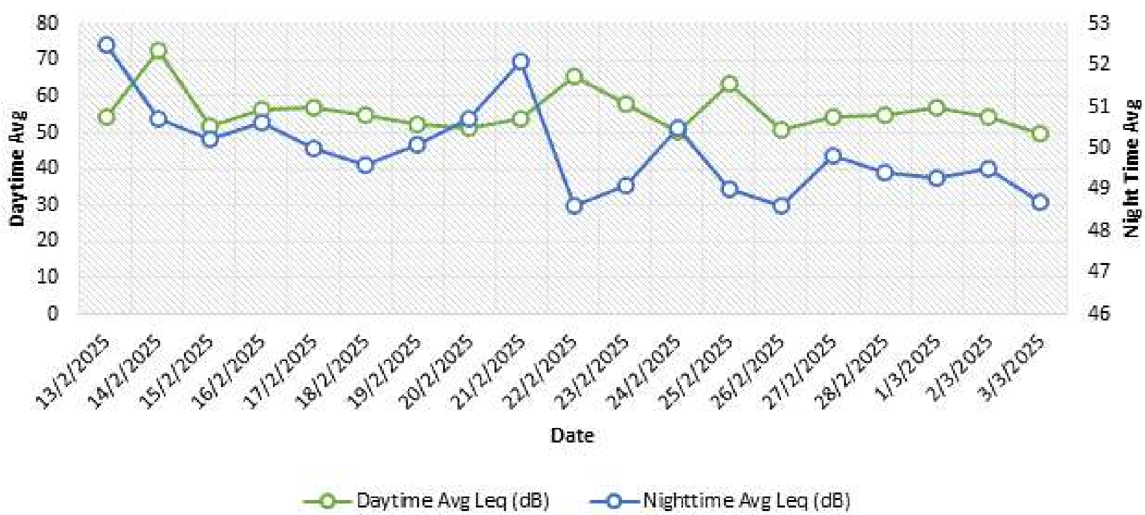



*Figure 6-27: Daytime and Nighttime Trends in Noise Levels Feb 13th to March 3rd, 2025*

### 6.1.12.3 ANALYSIS

#### 6.1.12.3.1 Particulate Matter

The recorded 24-hour average concentrations were evaluated against the following regulatory limits:

- $PM_{2.5}$: 35 µg/m³ (24-hour standard, US EPA)
- $PM_{10}$: 150 µg/m³ (24-hour standard, NEPA)

$PM_{10}$ and $PM_{2.5}$ results were within the NEPA and US EPA National Ambient Air Quality Standards (NAAQS) throughout the monitoring period.

The observed $PM_{2.5}$ concentrations ranged from 7.31 µg/m³ to 17.05 µg/m³, while $PM_{10}$ levels ranged from 18.91 µg/m³ to 36.99 µg/m³. At no point did the measured values approach or exceed the regulatory thresholds.

##### 6.1.12.3.1.1 Evaluation of Compliance and Trends

The monitoring site is located in a rural area with limited anthropogenic sources of particulate emissions. There are no major industrial activities, heavy vehicular traffic, or significant combustion sources that would contribute to elevated $PM_{2.5}$ or $PM_{10}$ levels. As a result, particulate concentrations were expected to be low, and the recorded data align with these expectations.

$PM_{2.5}$: The highest recorded value (17.05 µg/m³ on February 26, 2025) was less than 50% of the US EPA 24-hour standard, indicating that fine particulate pollution remains low and within acceptable air quality levels.

$PM_{10}$: The maximum recorded concentration (36.99 µg/m³ on February 26, 2025) was also well below the 150 µg/m³ threshold, suggesting that coarse particulate matter levels are not a significant concern in the area.

Both parameters showed slight daily variations, likely influenced by natural factors such as wind movement, humidity, and localized resuspension of dust from unpaved surfaces or vegetation. The data confirm that ambient air quality remains well within regulatory limits, with no indication of sustained high particulate levels.

### 6.1.12.4 RESULTS

#### 6.1.12.4.1 Particulate Matter

$PM_{10}$ and $PM_{2.5}$ results were within the NEPA and US EPA National Ambient Air Quality Standards (NAAQS) throughout the monitoring period. The recorded 24-hour average concentrations were evaluated against the following regulatory limits:

- $PM_{2.5}$: 35 µg/m³ (24-hour standard, US EPA)
- $PM_{10}$: 150 µg/m³ (24-hour standard, NEPA)

The observed $PM_{2.5}$ concentrations ranged from 7.31 µg/m³ to 17.05 µg/m³, while $PM_{10}$ levels ranged from 18.91 µg/m³ to 36.99 µg/m³. At no point did the measured values approach or exceed the regulatory thresholds.

##### 6.1.12.4.1.1 Evaluation of Compliance and Trends

The monitoring site is located in a rural area with limited anthropogenic sources of particulate emissions. There are no major industrial activities, heavy vehicular traffic, or significant combustion sources that would contribute to elevated $PM_{2.5}$ or $PM_{10}$ levels. As a result, particulate concentrations were expected to be low, and the recorded data align with these expectations.

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Both parameters showed slight daily variations, likely influenced by natural factors such as wind movement, humidity, and localized resuspension of dust from unpaved surfaces or vegetation. The data confirm that ambient air quality remains well within regulatory limits, with no indication of sustained high particulate levels.

#### 6.1.12.4.2 Ambient Noise Levels

The ambient noise monitoring campaign was conducted to establish baseline conditions for the project site before development. Measurements were taken from a fixed monitoring station positioned on the roof of an occupied residential property within the community. The area is classified as rural and is not subject to significant traffic noise. Notable environmental factors influencing sound levels include the presence of domestic animals, such as pet dogs, and the surrounding vegetation, which may contribute to natural background noise.

##### 6.1.12.4.2.1 Comparison with Applicable Noise Standards

The measured equivalent continuous sound levels (Leq) ranged from 50.52 dB to 61.26 dB over the monitoring period. The highest recorded Leq value was 61.26 dB on February 14, 2025, while the lowest was 50.52 dB on February 27, 2025. Maximum noise levels (Lmax) varied from 60.83 dB to 71.18 dB, while minimum noise levels (Lmin) remained relatively stable between 45.85 dB and 48.82 dB.

The results were evaluated against international noise guidelines, specifically those established by the World Health Organization (WHO) and the United States Environmental Protection Agency (EPA). WHO recommends an Leq of 55 dB during the daytime for residential areas to prevent significant community annoyance. The EPA similarly identifies 55 dB as the threshold for outdoor residential environments to minimize adverse effects on public health and welfare. The measured Leq values exceeded this threshold on several occasions, indicating that noise levels in the area, even before development, may already be approaching the upper limit of acceptable residential exposure.

##### 6.1.12.4.2.2 Sources and Influences on Measured Noise Levels

Given the absence of major traffic sources, the elevated noise levels observed on certain days are likely attributable to localized factors such as domestic activities, pet disturbances, and environmental conditions, including wind movement through trees. The Lmax values, which reached up to 71.18 dB, suggest intermittent high-noise events, potentially from short-duration disturbances such as barking dogs or other transient sources. The relatively stable Lmin values between 45.85 dB and 48.82 dB indicate a consistent background noise level typical of rural environments with minimal human activity.

### 6.1.12.5 SUMMARY

The findings of the assessment indicate that particulate matter (PM10 and PM2.5) levels remained well within the US EPA and NEPA regulatory limits throughout the monitoring period, with no significant exceedances observed. Given the rural nature of the site and the absence of major anthropogenic emission sources, particulate concentrations were expected to be low, and the recorded values align with these expectations.

In contrast, ambient noise levels demonstrated periodic exceedances of the WHO and EPA recommended thresholds for residential areas, particularly during the daytime. While background noise levels remained relatively stable, intermittent high-noise events contributed to elevated Leq and Lmax values on certain days. The primary influences on measured noise levels were identified as natural environmental conditions, domestic activities, and pet disturbances rather than vehicular or industrial sources.

While current air quality conditions do not pose a concern, construction activities have the potential to introduce temporary increases in particulate emissions and noise levels. To mitigate such impacts, best practices for dust control and noise management will be integrated into the project's Environmental Management Plan.

## 6.2 HUMAN ENVIRONMENT

### 6.2.1 CULTURE AND HERITAGE

The site was inspected to carry out a detailed assessment of artifacts, archaeological and cultural features of the site by the Jamaica Heritage Trust (JNHT).

A total of 131 pieces of artefacts were retrieved from the Rozelle site. The largest number of artefacts that was collected were Taíno pottery. The presence of Taíno pottery sherds suggests Taíno occupation in the area. The Tainos usually made coarse earthenware in the form of pots, bowls, griddles and zemis both decorated and undecorated.

Also evident were shell and stone inclusions in the paste of pottery. Some of these were not only used for domestic purposes but often utilized as burial goods and or offertory bowls. The stones were often used by the Tainos to make stone implements or tools and not metals as the Europeans did. The British and African Jamaican artefacts also reflect occupation by these two groups. Given that the site was a sugar estate the absence of the European cultural material was noticeable.

It was evident that the topsoil was cleared from some of the areas. Therefore, artefacts may have been removed and dumped elsewhere. The time period of the artefacts ranges from 650 AD to the late 19$^{th}$ Century. A detailed report is attached.

## 6.2.2 SOCIOECONOMIC ASSESSMENT

### 6.2.2.1 METHODS

A Social Impact Assessment (SIA) was done to evaluate the potential social and economic impacts of the proposed Rozelle Housing Development.

A mixed-methods approach was utilized, incorporating primary research from surveys and secondary data for historical and demographic context. A 3km sphere of influence around the proposed development boundary was used as the study area (Figure 6-28), hereinafter called 'White Horses Proper'. Surveys were conducted within this buffer zone.

- *Business Survey*: 35 local business respondents provided views on the project's potential impact between December 8 and December 15, 2024.
- *Socio-Economic Survey*: 376 household respondents from Rozelle, White Horses, and Botany Bay were surveyed during the period December 15, 2024, to January 13, 2025.

The report utilizes historical information from the Social Development Commission (SDC) Community Profile Report (2009) to establish key socio-economic trends. The 2009 study examines the surroundings of the proposed development area, making the data more directly comparable to the 2024-2025 Business and Socio-economic survey's conducted by the consultant team. The 2011 STATIN Census, while contains more recent data, provides data on a wider geographic scale, for the Parish of St. Thomas as a whole, or broken into sub-parish divisions that do not directly overlap with the communities under examination. Data lacking from the 2009 study, specifically housing unit type and housing material type, were taken from the 2011 census.

Based on the St. Thomas Community Profile survey done, there were 787 households in White Horses area. The socio-economic survey conducted by the consultant team, surveying 376 households, well exceeds the standard 5% sample size at 47%.

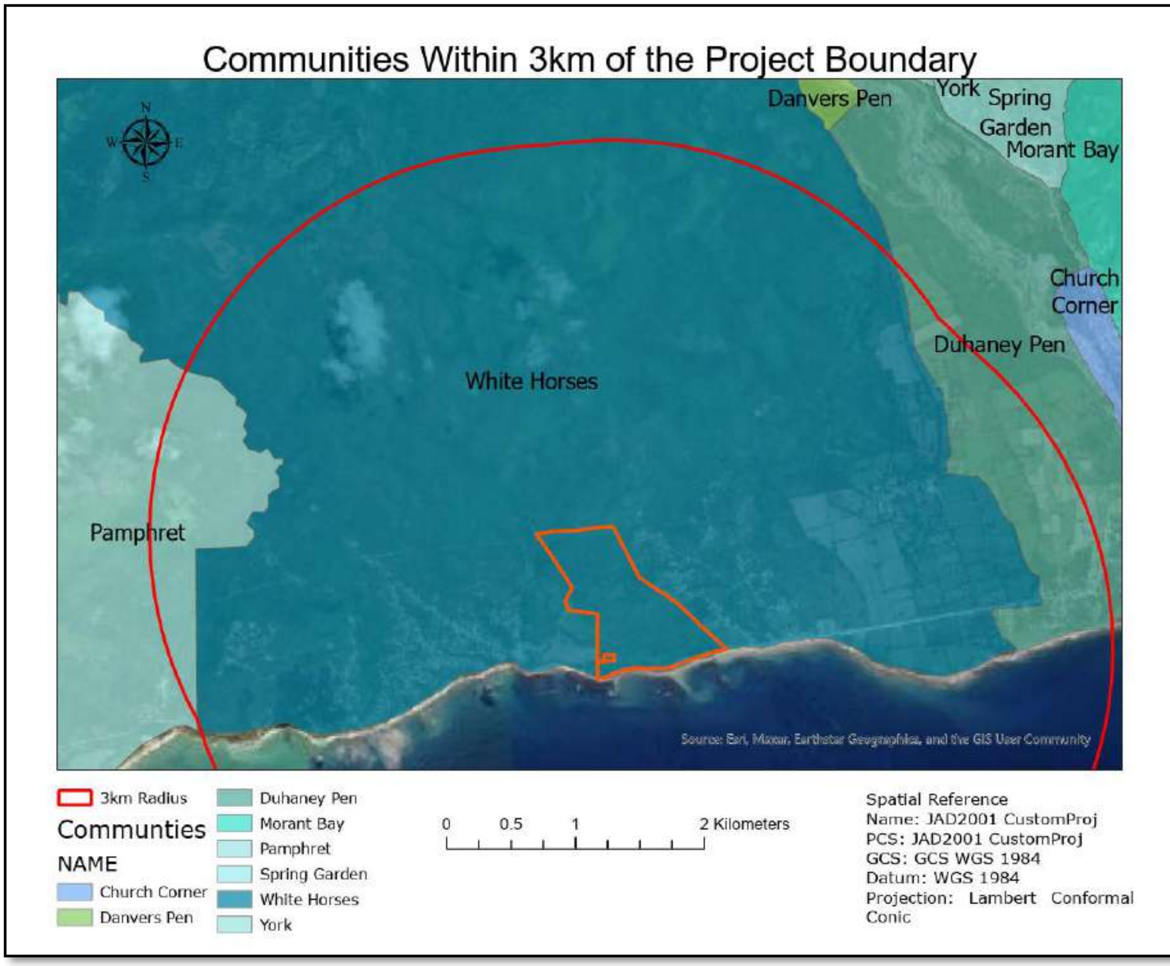



*Figure 6-28: A diagram of the major communities within a 3km radius of the site. The districts are listed in section 6.2.2.2.*

### 6.2.2.2 COMMUNITY CONTEXT

White Horses Proper is an area of approximately eight kilometers (8km). There are four (4) main districts within its limits; namely:

- White Horses Proper;
- Rozelle;
- Botany Bay and;
- Green Wall

Green Wall is considered the hub of the community. White Horses Proper is also made up of a number of areas/settlements sometimes loosely referred to as districts; these include Shady Spring, Healthful Hill, Port Royal and Hamburg Lane. The area has a vibrant agricultural history and is known for fruit production. Rozelle is also home to the Rozelle Waterfalls, a site of natural and cultural significance.

#### 6.2.2.2.1 Key Community Features

- Population (White Horses): ~2,774
- High levels of elementary and secondary education
- Limited internet access (4%)
- High dependence on public services
- Vulnerability to flooding and hurricanes
- Cultural site: Rozelle Falls

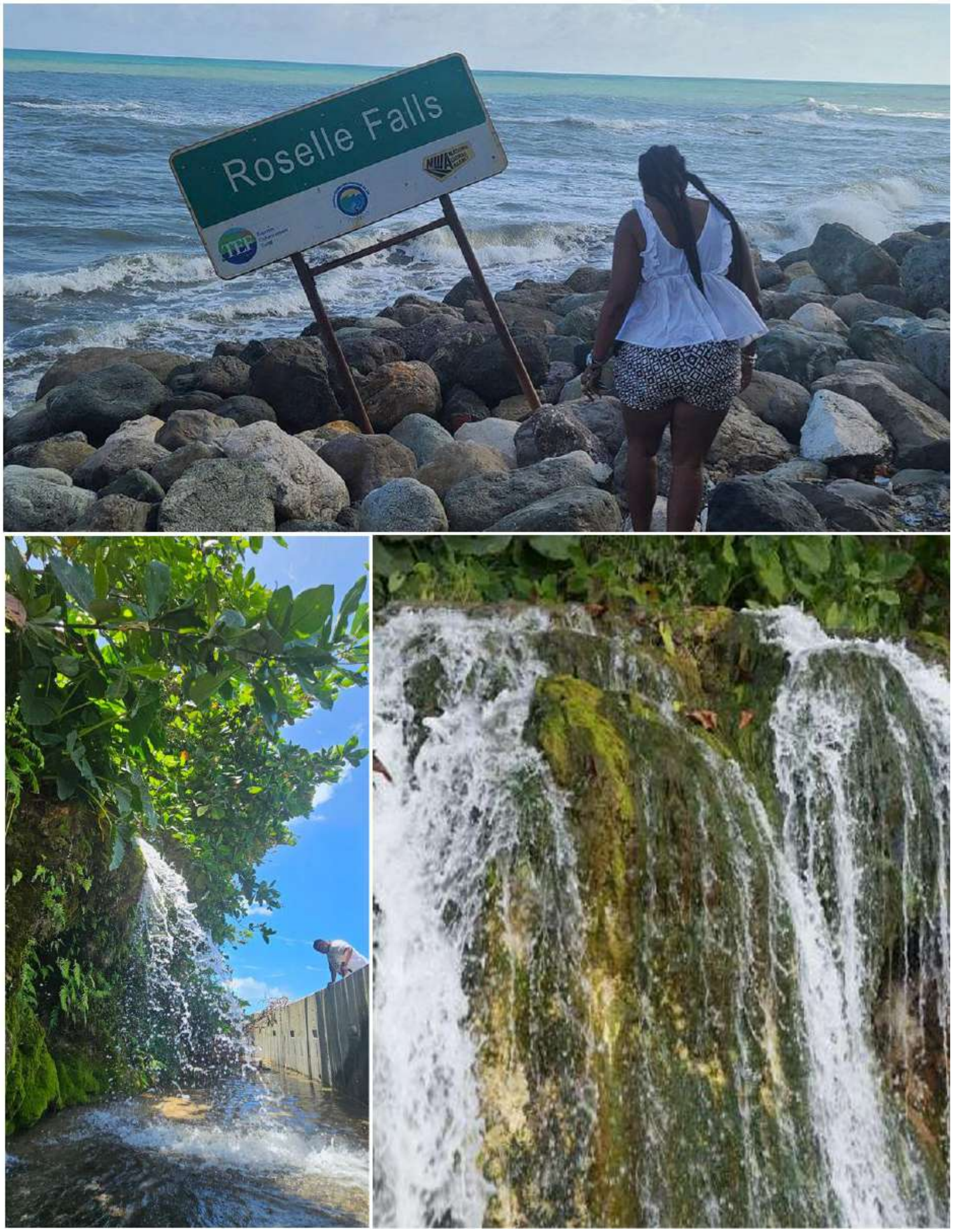



*Figure 6-29: Images of the Rozelle Falls*

#### 6.2.2.2.2 Social services

The map below shows the distribution of the social services across the parish. Note the map excludes churches in the White Horses community.

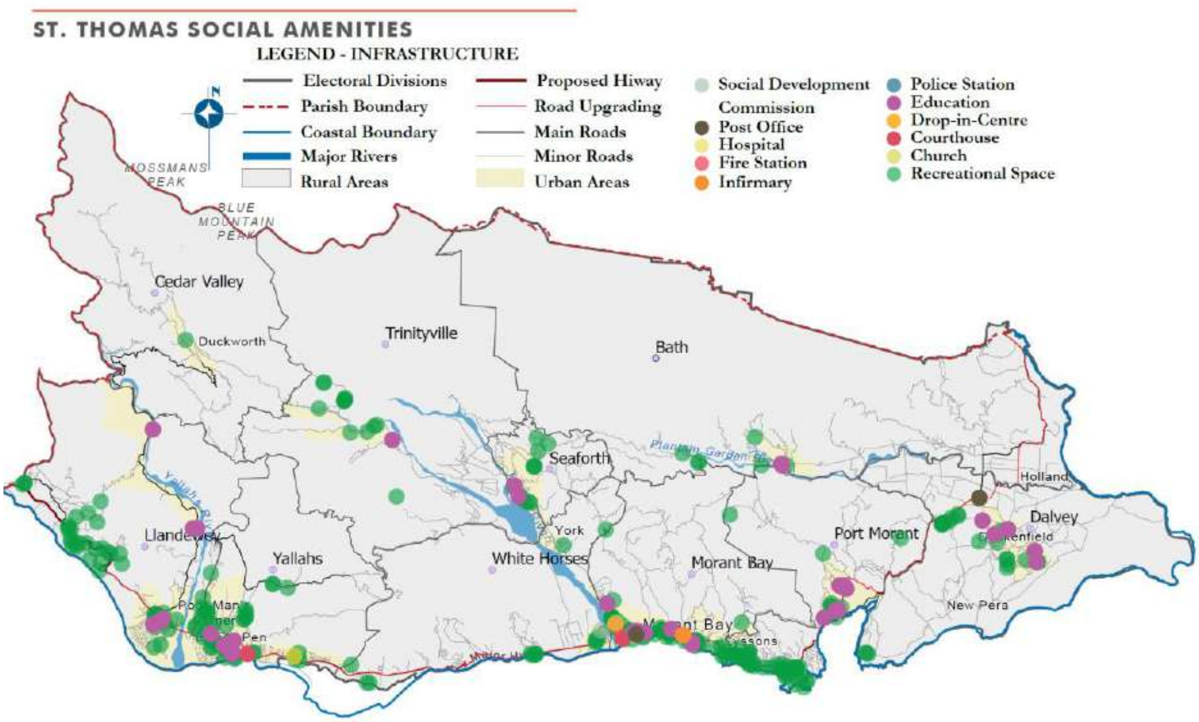



*Figure 6-30: A map of the parish showing some of the distribution of social services*

There are no major health, police, or fire service stations within the 3km sphere of influence, however there are 3 churches, a primary and infant school and a periodic family planning health center in the area which are outlined in Figure 6-31 below. Outside of the boundary, but within close proximity, are the Christian Prep School and the Paul Bogle High School.

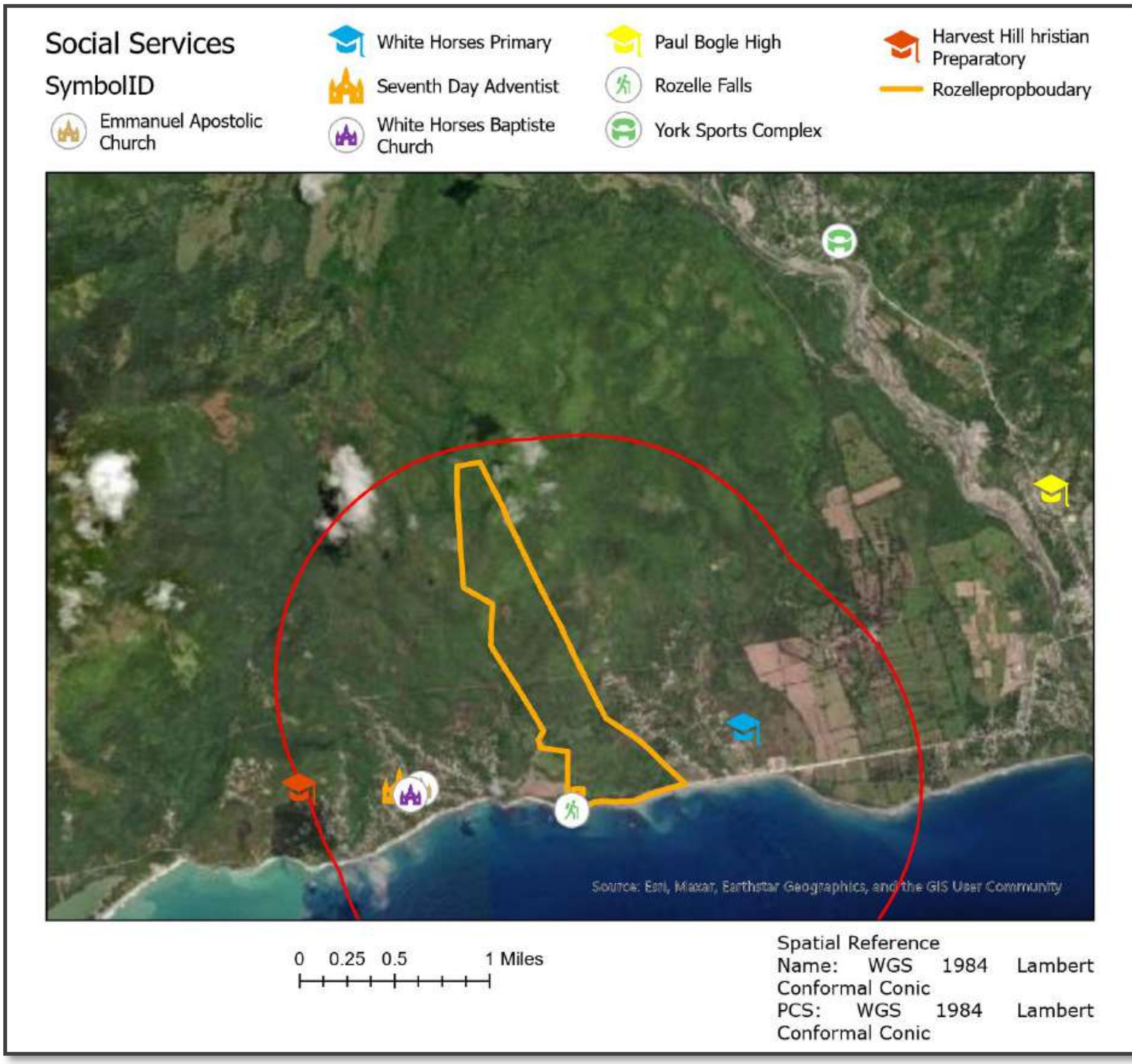



*Figure 6-31: Key social amenities identified during the survey*

*Table 6-28: Key social amenities within the sphere of influence*

| Type of Institution | Number | Name |
|---|---|---|
| Religious | 3 | Church of God (Seventh Day) White Horses |
| | | White Horses Baptist Church |
| | | Emmanuel Apostolic Church |
| Educational | 2 | White Horses Primary |
| | | White Horses Basic School |
| Health | 1 | White Horses Health Centre (Type 1 Health Center, offering family health services) |
| Recreational | 1 | York Sports Complex |
| Security | X | No Police Station |
| Fire Service | X | No Fire Station |


*Figure 6-32: Images of educational institutions within the sphere of influence*

### 6.2.2.3 CHANGES OVER TIME: HISTORICAL VS. CURRENT DATA

This section compares key socio-economic indicators between the baseline conditions recorded in the White Horses Community Profile (2009) and the current conditions reported in the 2025 Socio-Economic and Business Surveys for Rozelle, White Horses, and surrounding areas.

#### 6.2.2.3.1 Population Demographics

- 2009: White Horses had an estimated population of 2,774 with an average household size of 3.8. The age structure indicated a youthful population, with 51% aged 0–24 years and 68% in the working-age group (15–64 years) (SDC 2009) .
- 2025: While precise population data for Rozelle alone was not provided in the survey, average household size remains similar at 3.81 persons. The community still shows a majority working-age population with 83% between 15-64, but aging appears to be increasing, with a mean respondent age of 50.45 years.
- *The community is gradually aging, likely due to youth migration or lower birth rates.*

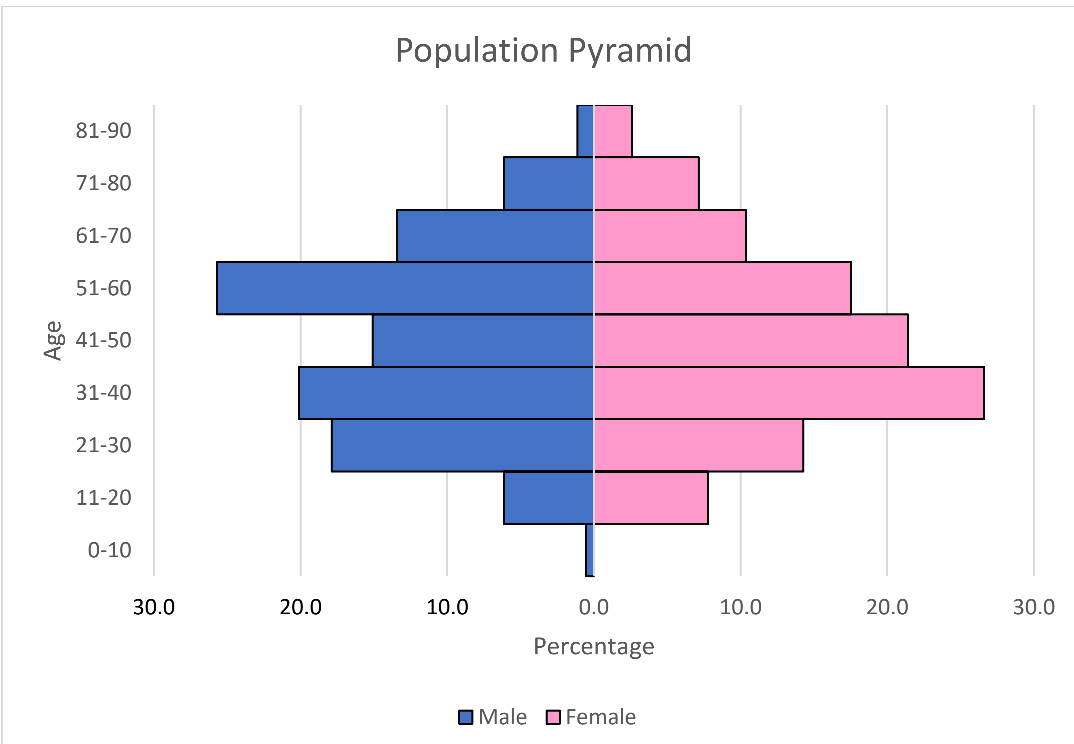



*Figure 6-33: 0-15 Population Pyramid: 2025. Source Maresol Socio-economic Survey, 2025*

#### 6.2.2.3.2 Gender Distribution

- 2009: 54% male and 46% female in White Horses (SDC 2009).
- 2025: The broader survey area now has 53.72% male and 46.01% female respondents.

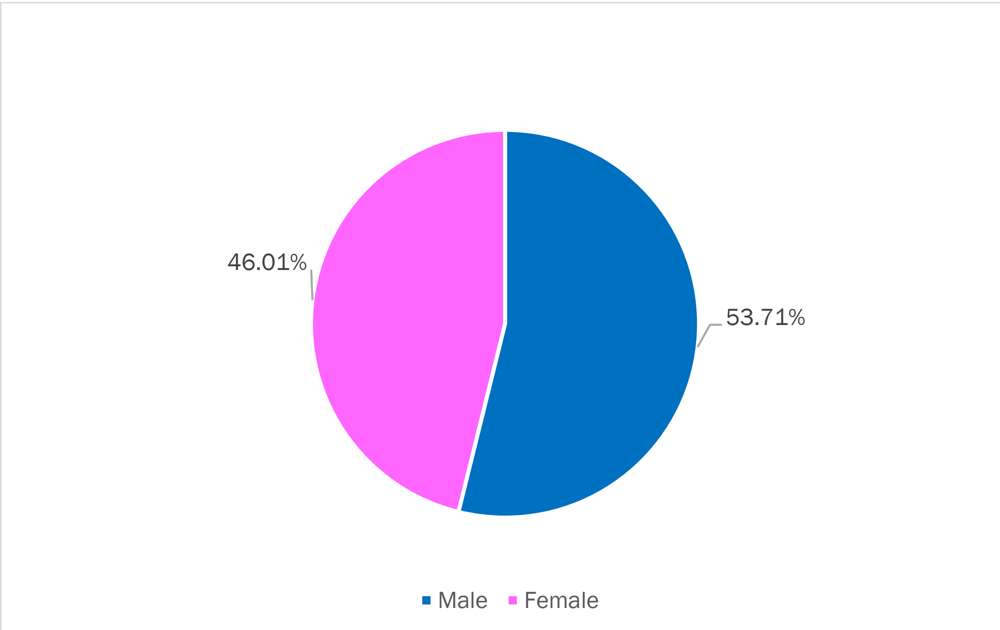



*Figure 6-34: Gender Distribution, 2025: Source Socio-Economic Survey, 2025*

*Key Insight: Gender distribution has remained relatively stable over time.*

#### 6.2.2.3.3 Employment and Economic Activity

- 2009:
    - 60% of household heads employed.
    - Main occupations: elementary jobs (30%), service/sales (25%), skilled trades (20%).
    - Majority earned J$3,700–5,999 monthly (SDC 2009).
- 2025:
    - 69% of the heads of household were employed
    - Main occupations: other (43%), farming (27%), commerce or retail (10%)
    - 55% earn J$100,000 a year or less (J$8,300/month or less)

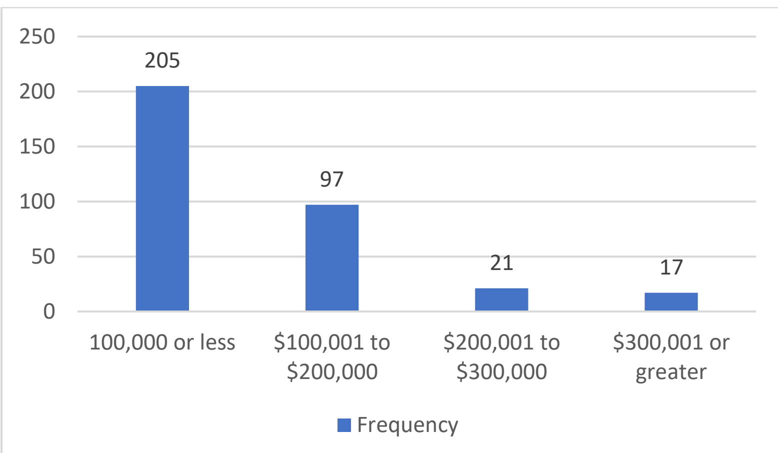



*Figure 6-35: Annual Salary Distribution, 2025*

*Key Insight: Employment patterns remain rooted in low-income, service-based work. Economic opportunities are still limited, and the community continues to express a need for job-creating developments.*

#### 6.2.2.3.4 Education and Training

- 2009:
    - 35.3% of household heads had secondary education.
    - 51.6% of household members had no academic qualification.
    - Vocational certification was low (6.6%) (SDC 2009).

- 2025:
    - 54% of the respondents have secondary education
    - 18% of the respondents have vocational training
    - 16% of the respondents have tertiary education
    - 10% of the respondents have primary education

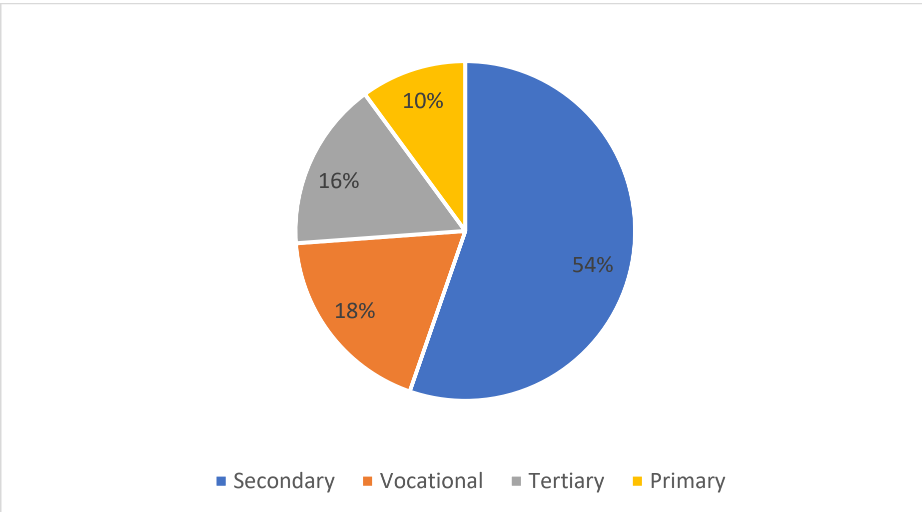



*Figure 6-36: Education attainment, 2025. Source: Maresol Economic Survey, 2025*

*Key Insight: Educational attainment remains limited but has improved significantly since 2009.*

#### 6.2.2.3.5 Infrastructure and Services

- 2009:
    - Water: Standpipes (80%), piped water (10%)
    - Sanitation: Pit latrines (85%)
    - Electricity: 80% coverage.
    - Garbage collection: 45% served by NSWMA.
    - Internet service 4% (SDC 2009)

- 2025:
    - Water: Indoor piped water 48%, standpipe 13%, with 39% experiencing weekly lock offs while 34% don't experience water lock offs
    - Sanitation : 32 % septic tank 16% pit latrine
    - Garbage collection: 69% NSWMA, 27% burn waste
    - Internet service: 81% internet service at home (60% via broadband access/46% via smartphone), 79% access to smartphones

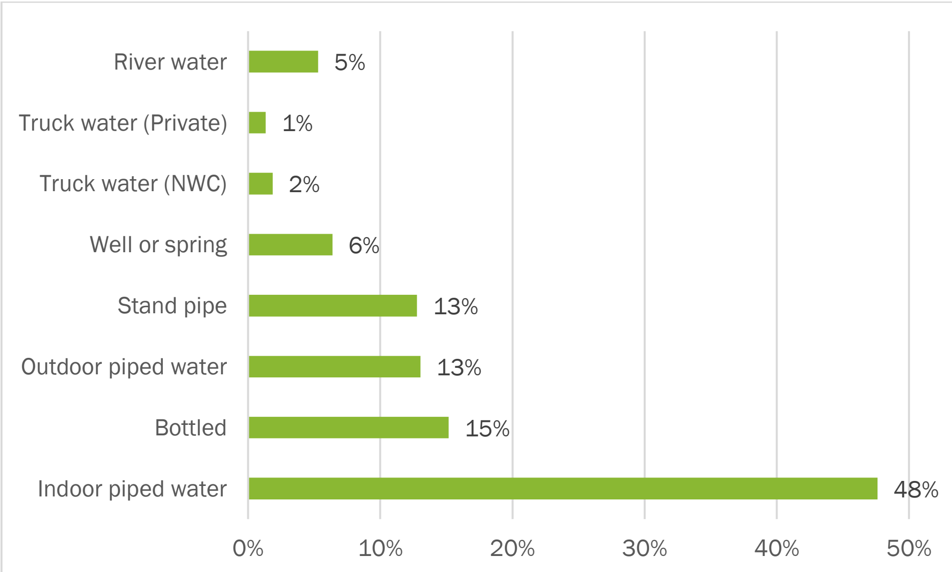



*Figure 6-37: An illustration of the proportional use of the different water supply sources. Source: Maresol Socio-Economic Survey, 2025*

While many of the respondents (48%) have access to indoor piped water, 6% of the population uses a well or spring. Of those that use a spring for their water supply, 83% reported using Rozelle Spring (Figure 6-37).

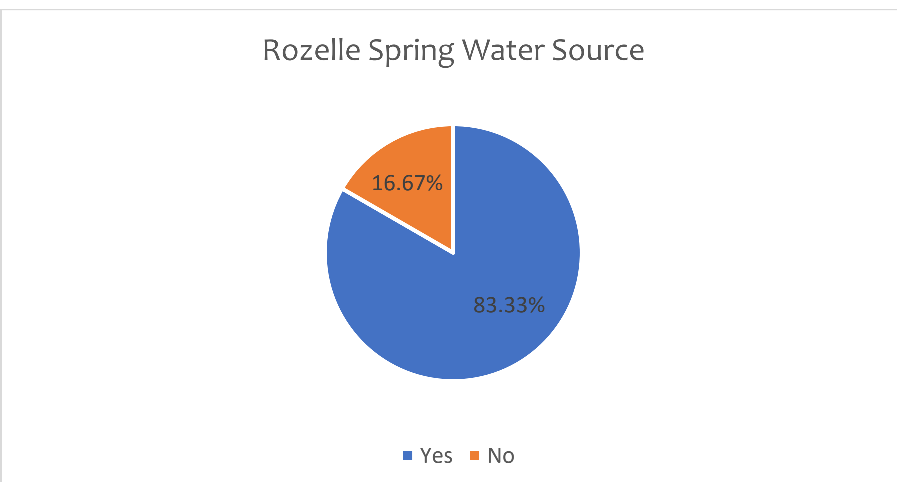



*Figure 6-38: Rozelle Spring as the major source of water use. Source: Maresol Socio-Economic Survey, 2025*

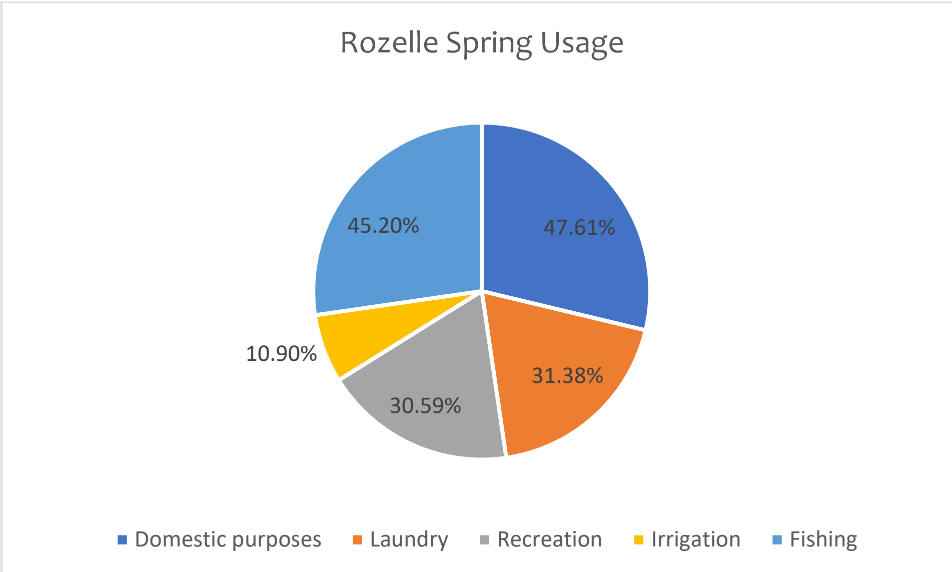



*Figure 6-39: Rozelle Spring Usage. Maresol Socio-Economic Survey, 2025*

Nearly half of the respondents that utilise Rozelle Spring use it for domestic purposes (48%) and a further 45% use the spring (Dam Head) for fishing (crayfish). This highlights the cultural importance of springs for everyday life and food security to the community (Figure 6-39).

*Key Insights: Internet access has become almost universal. Water adequacy still an issue; spring water is a critical natural resource (e.g. Rozelle Spring). Residents expressed 49.5% concern about impact on water sources. If the quality and quantity of the water were to deteriorate, and access to the Rozelle Spring be curtailed, there will be immediate negative repercussions to the wider community.*

- 2011:
    - 96% Single detached homes
    - 61% concrete and blocks (STATIN 2011).
- 2025: The vast majority of the homes in the area are still single detached homes built out of concrete and blocks.

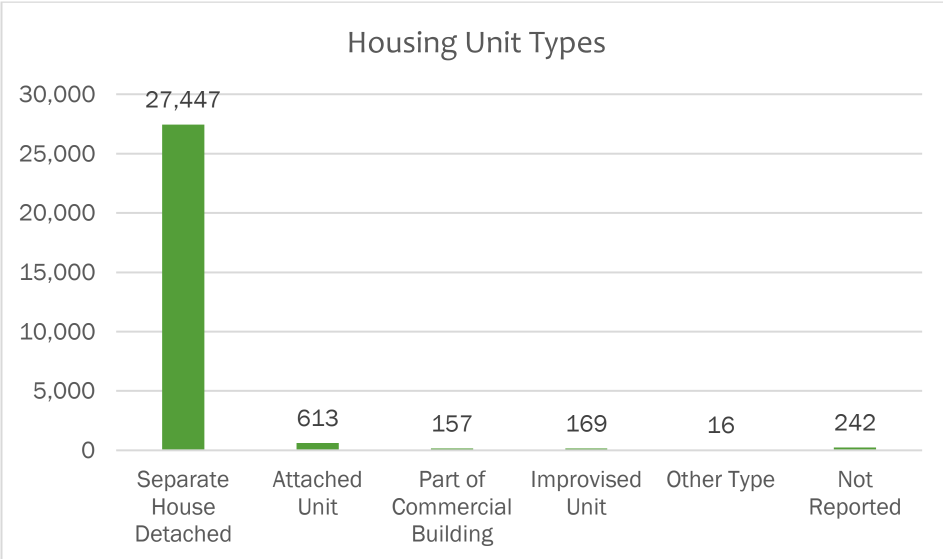



*Figure 6-40: Housing Unit Types. Source: STATIN, 2011*

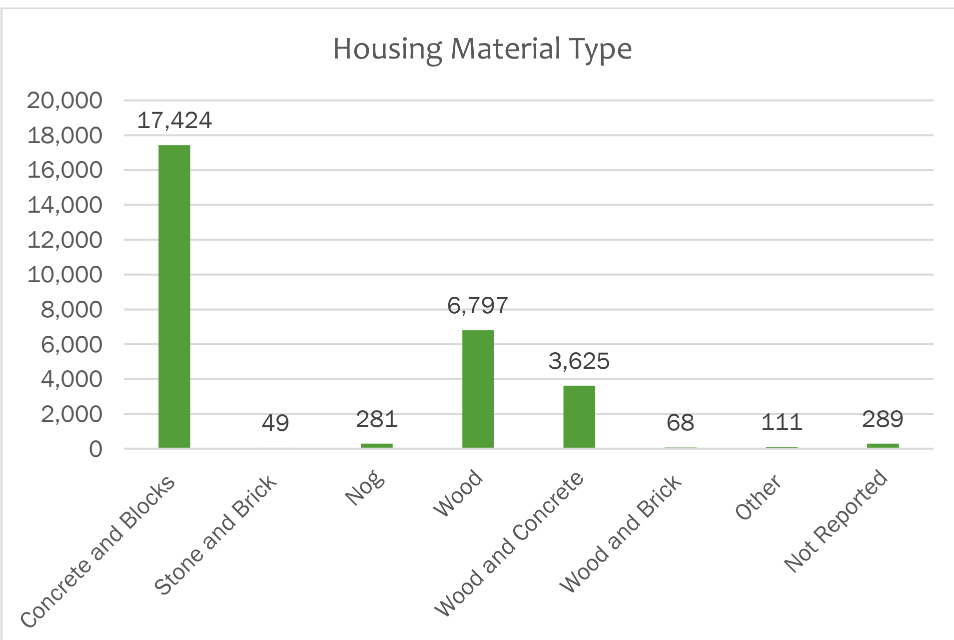



*Figure 6-41: Housing Material Types. Source: STATIN, 2011*

*Figure 6-42: Examples of Common Housing Materials throughout the community. Maresol Socio-Economic Survey, 2025*

#### 6.2.2.4 BUSINESS Survey Highlights

- 85.7% of respondents were business owners or managers
- Business types included bars, shops, internet cafés, schools, grocery stores
- 80% were aware of the proposed development
- 85.7% approved of the project
- 68.6% predicted a positive impact on their businesses due to expected increase in customer base, profits, and community development
- 62.8% believed other local businesses would support the project

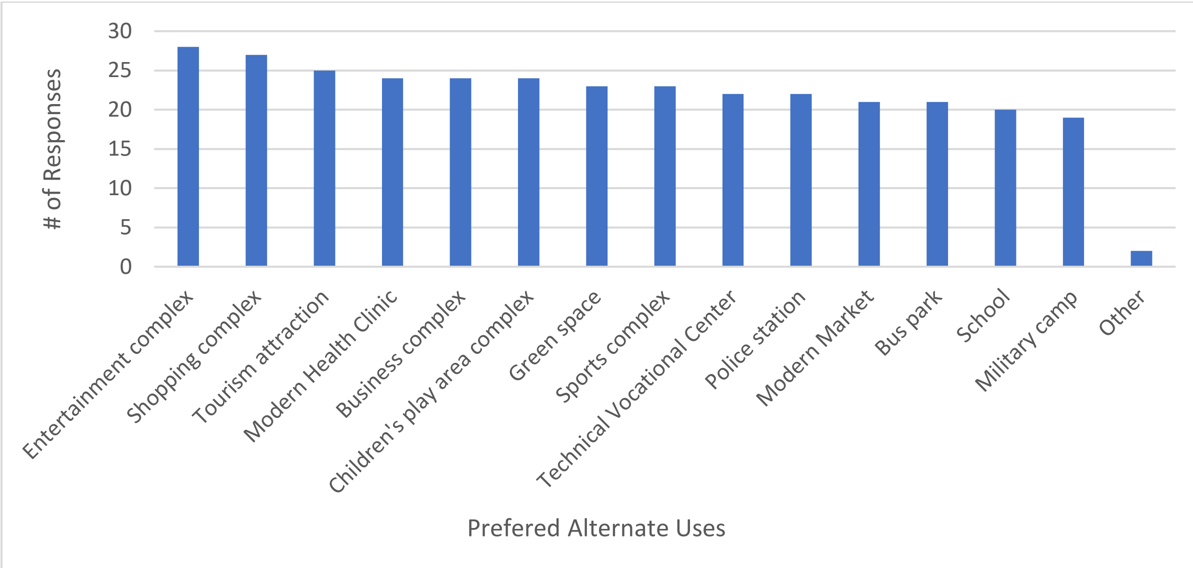



*Figure 6-43: Business Community Preferred Alternative Uses for the subject property. Maresol Socio-Economic Survey, 2025*

*Figure 6-44: A seafood bar and restaurant in the community. One of the business operators interviewed during the socioeconomic survey*

*Key Insight: There is an extremely high level of support from the business community for the proposed development as designed. It is notable that the top three alternative uses suggested in order of preference were an entertainment complex, a shopping complex and a tourism attraction, all of which highlight the desire for some form of development instead of leaving the land undeveloped in its natural state.*

### 6.2.2.5 COMMUNITY PERCEPTION OF THE PROPOSED DEVELOPMENT

- 58% of the community had prior awareness of the proposed development
- 47% of the respondents felt the proposed development was necessary
- 48% of the respondents viewed the proposed development as very necessary
- 16.5% of respondents cited business growth as a primary reason to support the development.

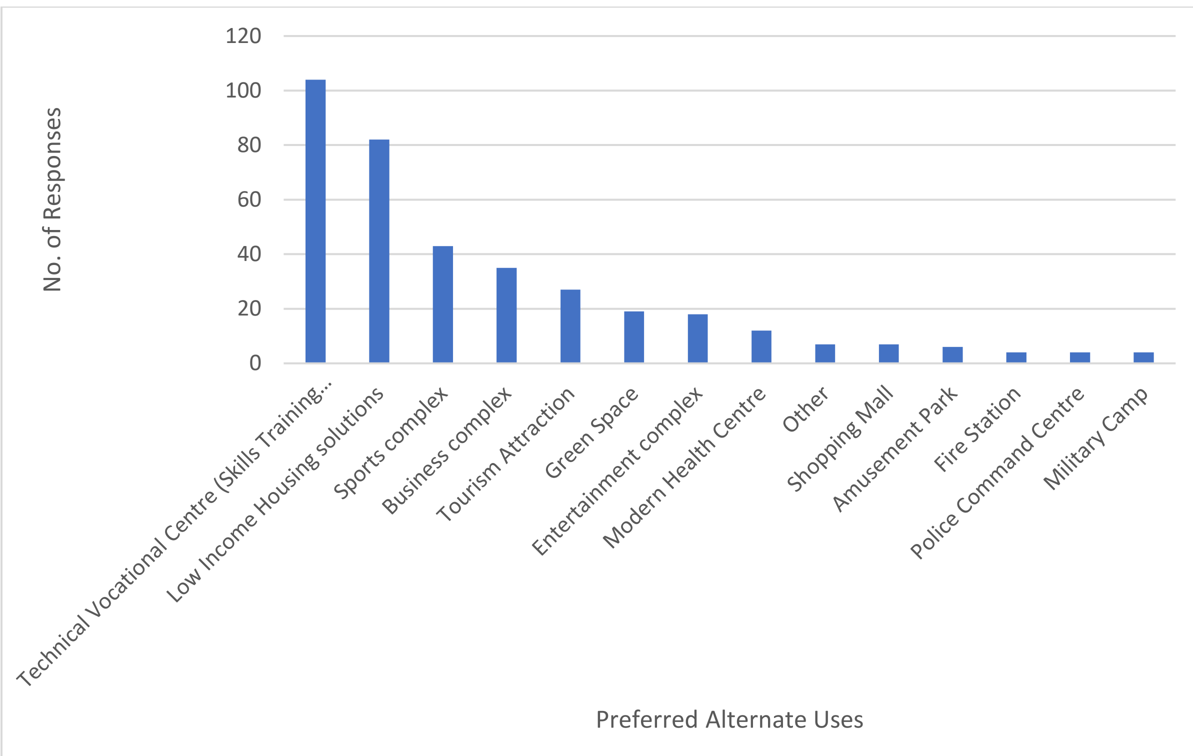



*Figure 6-45: The wider community preferred alternative uses. Source: Maresol Socio-economic Survey, 2025*

#### 6.2.2.5.1 Support for Project

- 93% of respondents (highly approve or approve)
- 95% believe the project should proceed as designed
- Main reasons for support:
  - Community development (35.6%)
  - Access to housing (15.9%)
  - Economic activity (16.5%)

#### 6.2.2.5.2 Concerns & Recommendations

- 49.5% concerned about impact on Rozelle Spring
- Preferred alternative land uses by minority:
  - Skills training center (27.6%)
  - Sports complex (11.4%)
  - Low-income housing (21.8%)
- There is a clear concern for environmental quality deteriorating with this development, with nearly a quarter of the respondents (23.4%) siting the four following issues as their main concerns:
  - Reduced air quality
  - Negative impact on the plant and animal life in the area
  - Soil erosion
  - Reduction in water supply

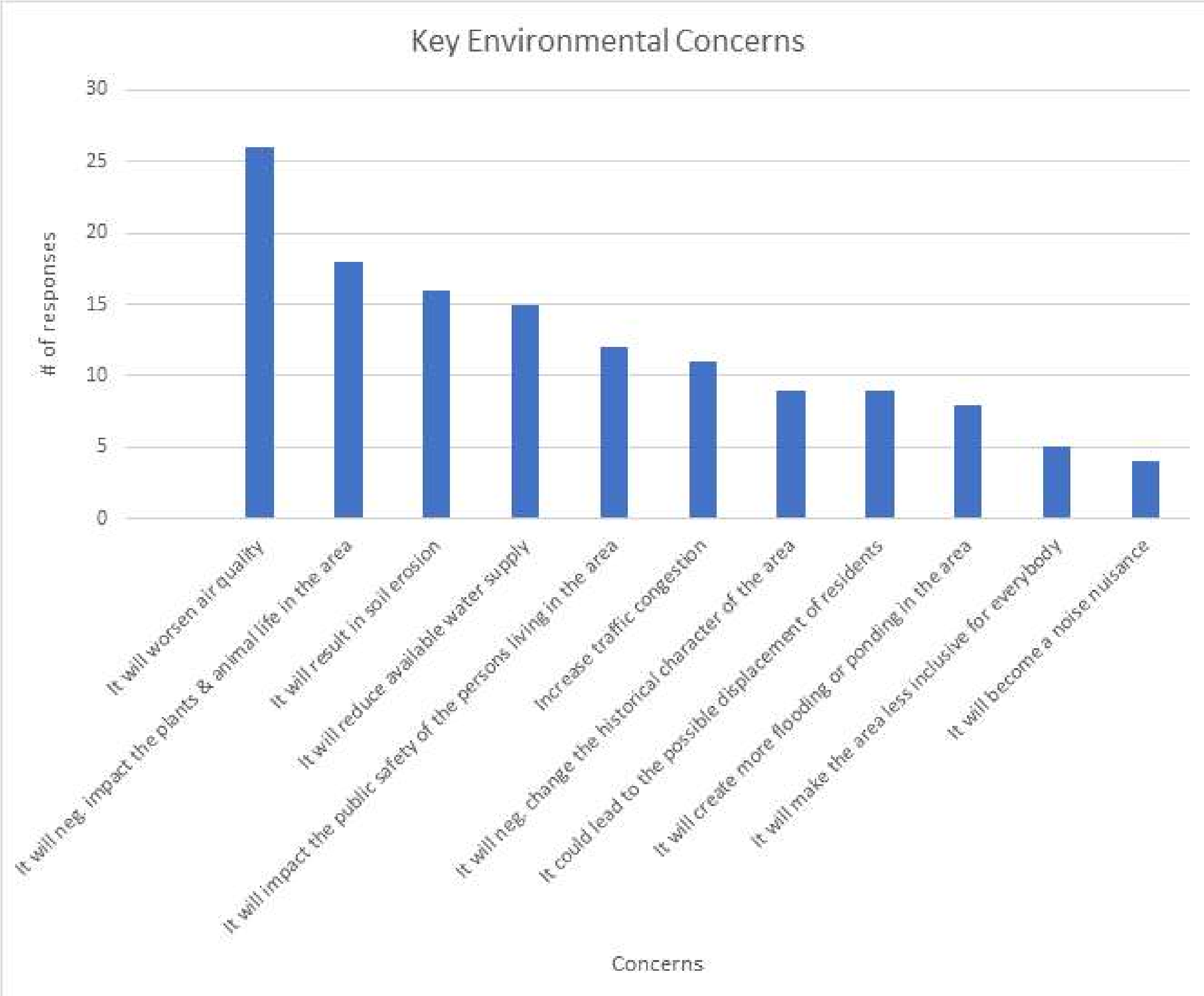



*Figure 6-46: Community's key environmental concerns. Source: Maresol Socio-economic Survey, 2025*

*Key Insight: 27.6% of respondents prefer a Technical/Vocational Centre as a better landuse, suggesting strong interest in skills development. The community's desire for vocational training facilities highlights a need to improve human capital. There is widespread optimism for the project, with expectations of improved economic and social outcomes.*

### 6.2.2.6 ENVIRONMENTAL AND RISK ASSESSMENT

#### 6.2.2.6.1 Environmental & Risk Assessment

- Natural hazards identified by the community as most likely threats to affect them: hurricanes (50.8%), storm surge (30.8%), flash flooding (21.8%)
- 27.4% of respondents reported experiencing flooding
- 88.6% do not view flooding as a serious barrier to development

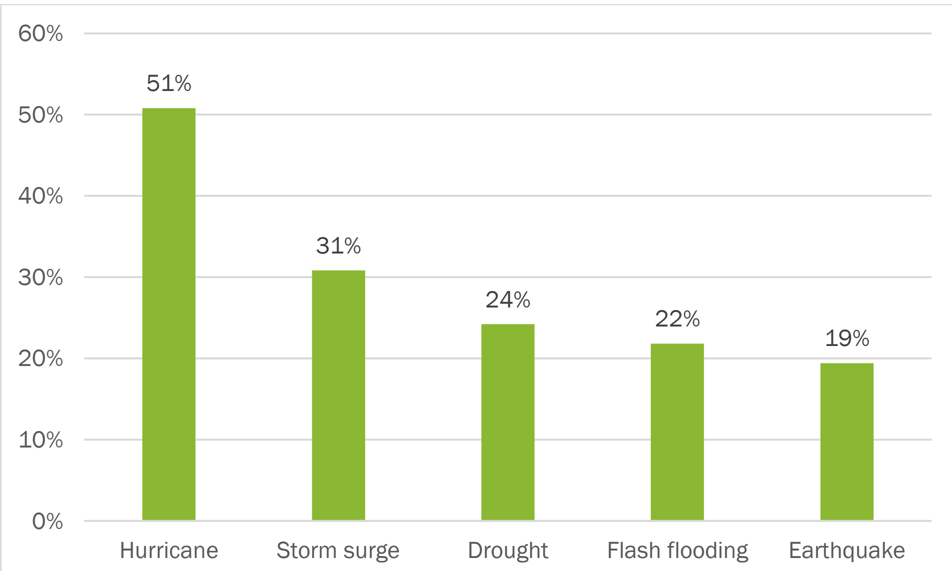



*Figure 6-47: Perceived Critical Natural Hazard. Source: Maresol Socio-Economic Survey, 2025*

#### 6.2.2.6.2 Anticipated Impacts

##### 6.2.2.6.2.1 Positive Impacts

- **Economic upliftment** through increased business activity and job creation
- **Community development** and modern infrastructure
- **Enhanced housing** options for residents
- **Youth empowerment** through social mobility and amenities

##### 6.2.2.6.2.2 Negative Impacts

- Risk to Rozelle Falls water source
- Environmental degradation (air quality, biodiversity)
- Increased pressure on underdeveloped infrastructure

### 6.2.2.7 6.2.2SUMMARY

The proposed Rozelle Estates development emerges at a pivotal moment for the communities of Rozelle and White Horses in St. Thomas, Jamaica. This Social Impact Assessment reveals a strong consensus among residents and local business operators that the development is both necessary and timely.

Over the past 15 years, the community has experienced notable, though uneven, change. While there has been progress in areas such as educational attainment and access to communication technology; especially internet and smartphone use, critical infrastructural concerns persist. Water access remains precarious for many households, with a substantial number relying on standpipes or experiencing frequent lock-offs. Sanitation infrastructure has improved slightly, but pit latrines are still in use by a notable segment of the population. Electricity access is consistent, but roads, drainage, and environmental risks continue to challenge everyday life, particularly during heavy rains and hurricane events.

Demographically, the community is aging. Compared to 2009, the mean age of residents is higher in 2025, suggesting possible outmigration of youth and the need for services that support both older adults and economic stability for working-age households. Despite improved education levels-particularly secondary and vocational training-economic activity continues to be dominated by low-income and informal employment. The majority of respondents earn less than J$100,000 monthly, underscoring the urgent need for sustainable job creation.

Business and community sentiment strongly favours the development. A striking 93% of residents support the project, and 85.7% of local business operators believe it will positively impact their operations. The community identifies economic opportunity, access to housing, and overall development as primary benefits. Simultaneously, they raise valid concerns about environmental degradation, particularly the potential impact on the Rozelle Spring, a key natural and cultural resource.

The project design demonstrates a commendable commitment to sustainability. With plans to preserve natural drainage, maintain open green spaces, and construct a centralized tertiary sewage treatment, it reflects an integrated approach to development. However, the effectiveness of these strategies will depend on proactive environmental management, inclusive planning, and ongoing community engagement.

## 6.3 BIOLOGICAL ENVIRONMENT

### 6.3.1 ECOSYSTEMS

The ecosystems found on the site include streams, riparian forest, coastal vegetation, terrestrial forests and shrub/grasslands. These were discussed in detail in the previous chapter (Chapter 5).

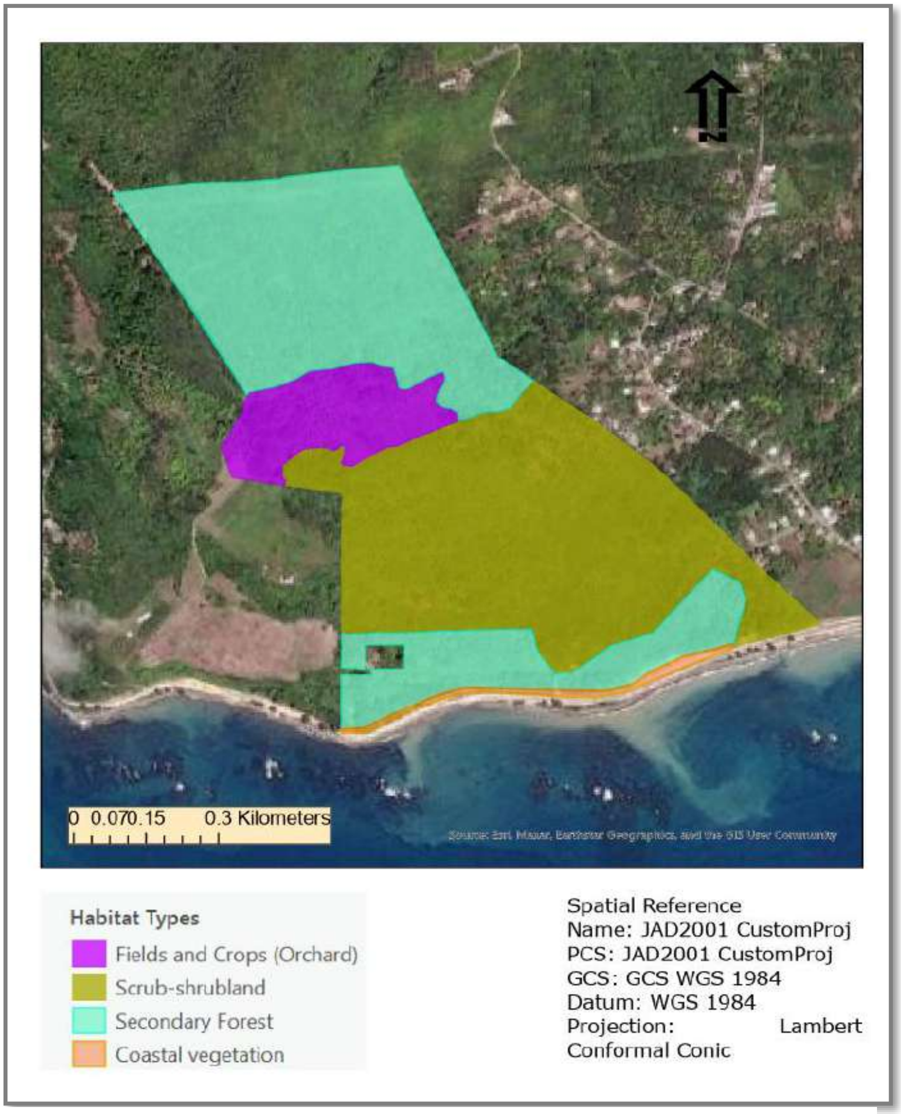



*Figure 6-48: Habitat distribution across the property for development*

The habitats identified across the proposed site were mainly of four types, namely field and crops, secondary forests, coastal vegetation and scrub/shrub lands. Figure 6-48 shows the distribution of the habitat types. The habitat described as fields and crops was mainly orchard, with patches of grasslands and ornamentals as the undergrowth. Additionally, small patches of secondary forests are scattered in the zone classified as 'fields and crops. The area seems to have historically been dominated by Dry Limestone Forest and Short Scrub Forest.

## 6.3.2 FLORA AND FAUNA ASSESSMENT

### 6.3.2.1 Methodology

The general flora assessment was done via a series of transects (100m x 5m each) within the boundaries of the development site. A total of nine (9) transects were created across the study area (Figure 6-49). All plant species encountered within each transect was recorded. For each species, the name, perceived dominance, and growth form was noted. The dominance/abundance was graded using the DAFOR scale. The DAFOR scale is a tool used in ecological surveys to estimate the relative abundance of a species (plant or animal) within a habitat. The common names of most of the species sighted were assigned in-situ. In the case of unknown species, voucher specimens were collected and identified at the University of the West Indies' (UWI) Herbarium. All plants were identified to the species level by examining morphological features such as leaf arrangement, leaf pattern, pattern of branching, and the morphology of floral and fruiting structure in conjunction with the use of the literature *Flowering Plants of Jamaica* (Adams 1972) and preserved reference specimens of the Herbarium.


*Figure 6-49: An aerial image showing the boundaries of the section of the property to be developed and the placement of the transects*

The general fauna assessment methodology involved two different approaches. Avifauna were assessed via the line transect method. This method entailed walking slowly along established routes and noting all the birds seen or heard in the area (Bibby 1998).

Birds observed for the first time while conducting other fauna surveys were added to the list as well. The amphibian and reptile surveys were conducted across the different microhabitat types including trees, stone piles, abandoned structures and other debris. The invertebrate assessment consisted of a series of walk-throughs within the project area.

Various microhabitats such as tree trunks, leaves, dry wood, and sticks were carefully examined. All specimens seen were identified, and a DAFOR ranking was assigned to reflect their relative dominance. Still images were captured for further study if necessary. Herpetofauna that could not be identified in the field were collected and identified using the reference literature such as: Amphibians and Reptiles of the Caribbean Islands keys (Caribbean 2015) and Amphibians and Reptiles of the West Indies (A. S. Henderson 1991). Insects observed in flight were recorded.

The arthropods encountered in the field were identified on the spot; however, arthropods that could not be identified onsite were later identified using Insects Keys (Triplehorn, Johnson and Borror 2005), the iNaturalist Application, and collections at the University of the West Indies where necessary.

*Table 6-29: Table showing the DAFOR scale and associated number of individuals used to assign the relative abundance of the species recorded during the assessment of the project area.*

| | Number of individuals observed |
|---|---|
| **D**ominant | ≥ 20 |
| **A**bundant | 15 – 19 |
| **F**requent | 10 – 14 |
| **O**ccasional | 5- 9 |
| **R**are | < 4 |

### 6.3.2.2 FINDINGS

On the ground observations of the vegetation profile and species composition agrees with the land cover assigned by the Forestry Department, for the most part; however, it should be noted that small patches of secondary forest are scattered in the zone classified as 'fields: Herbaceous crops, fallow, cultivated vegetables'.

The area seems to have been dominated by Dry Limestone Forest and Short Scrub Forest historically. This is evident by some of the species of plants that were encountered during the survey, as well as the limestone substrate that dominates.

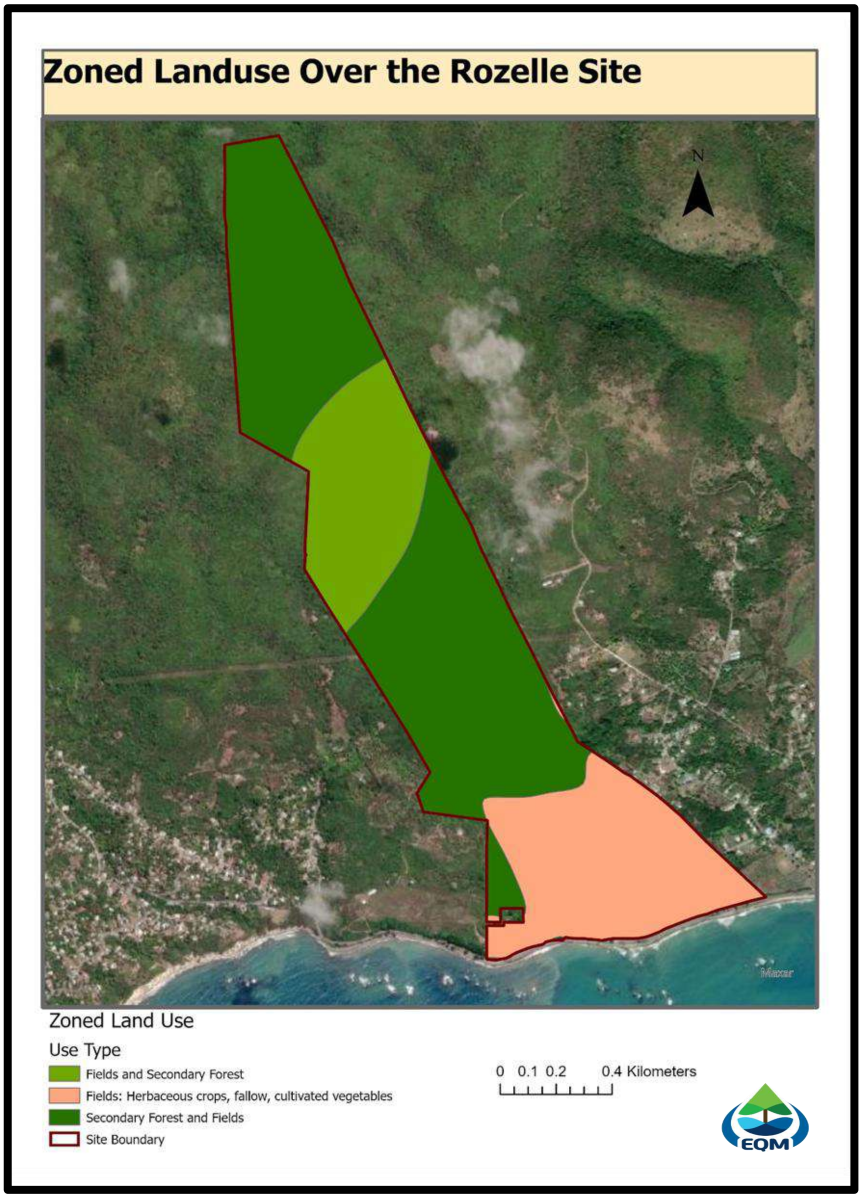



*Figure 6-50: A map showing land cover/landuse classification of the project area, as per the Forestry Department*

#### 6.3.2.2.1 Flora

Most of the plant species recorded during the survey can be classified as ornamentals, agricultural crops or plants associated with anthropogenic disturbances.

The study area is located on a property that has been heavily modified by human activity, and the natural vegetation has been significantly impacted. Several roads/trails are throughout the property. Current and remnant man-made structures also exists. Unsustainable practices such as logging of trees and charcoal burning were a common occurrence across the project area (Figure 6-61 to Figure 6-67). Other human activities observed include evidence of bird shooting and land clearance (probably for farming).

The plant diversity on the property was relatively high, with one hundred fifty-four (154) plant species from sixty-two (62) families recorded.

The vegetation encountered can be classified primarily as Secondary Forest (remnants of a Dry Limestone Forest) and open field and crops; along the main thoroughfare parallel to the southern boundary is dominated by Coastal Vegetation (Figure 6-52). The Rozelle Falls is also a feature on the property; the species within a small area along its source can be classified as Riverine Vegetation (Figure 6-51).

*Figure 6-51: Photograph of a patch of ca-tail Reed (Typha domingensis), observed within the small Riverine zone, along T7*

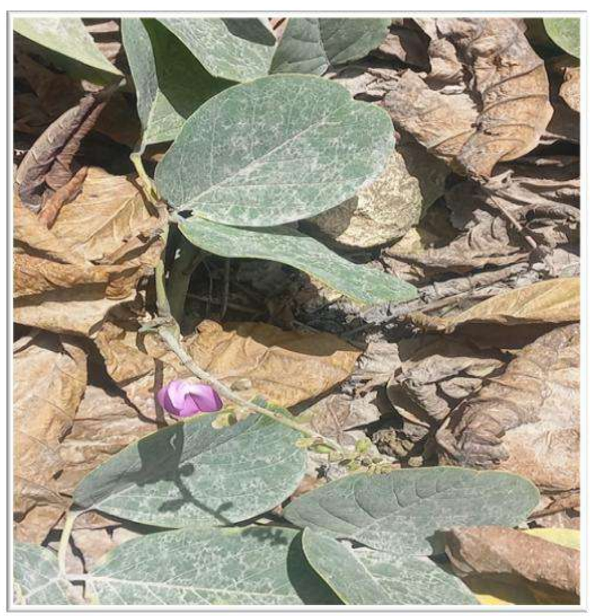


*Figure 6-52: Beach Morning Glory (Ipomoea pes-caprae) a commonly occurring coastal plant species*

Most of the trees encountered at the site were relatively small (<20 cm DBH), with the exception of a few Red Birch (*Bursera simaruba*), Guango (*Samanea saman*) and West Indian Almond (*Terminalia catappa*) trees. Most of the species encountered during the assessment are classified (Adams 1972) as being very common, commonly found in thickets and wastelands, or commonly found in secondary woodlands. These included ornamentals, agricultural crops or plants associated with anthropogenic disturbances. The distribution of the plant species encountered during this survey is even across Jamaica, especially in places with significant anthropogenic impacts.

Of the 154 plant species encountered within the study limits (Appendix 4), two (2) endemic plant species were observed; the Broadleaf (*Terminalia latifolia*) and God Bush (*Oryctanthus occidentalis*). *T. latifolia* is listed as Near Threatened (NT) by the International Union for Conservation of Nature (IUCN). None of the other plant species encountered during the study are deemed to have any special conservation status; neither was any species listed as rare in Jamaica. It should be noted that although the two endemic species were not frequently recorded species within the project boundary, they are both commonly occurring across Jamaica and widely distributed. The Black Lancewood plant was observed on the site as well. While the species is not an endemic or protected one, it is a species of interest as it has been documented to be the only host plant for the Jamaican Blue Swallowtail butterfly.

A total of three (3) plants classified as invasive alien species (IAS), were recorded during the assessment. These IAS included Lead Tree (*Leucaena leucocephala*), Guinea Grass (*Panicum maximum*), and Spotted African Orchid (*Oeceoclades maculata*).

*Figure 6-53 section of the mango orchard within the vicinity of T4.*

A Mango (Mangifera indica) Orchard (Figure 6-52) is located on the property, in the vicinity of T4. Agricultural plants were recorded across the general project area, however, this area (T4), was the largest section under agricultural use (orchard).

*Figure 6-54: A section of the secondary forest (in the vicinity of T8)*

#### 6.3.2.2.1.1 Large Tree Survey

An assessment of the large trees, defined as trees with diameter at breast height (DBH) of 30cm and greater, was carried out on the property for development.

##### 6.3.2.2.1.1.1 Methodology

For each tree encountered that fell into the category, the species, measured DBH reading, estimated height, and GPS coordinates of its location was recorded. Pink flagging tape was used to mark each such tree.

*Figure 6-55: A photograph of a tagged tree identified during the assessment of the development area.*


*Figure 6-56: An aerial image showing the location of large trees within the proposed development property boundary.*

### 6.3.2.2.1.1.2 Findings and Discussion

A total of one hundred seventy-three (173) large trees were identified, tagged and georeferenced, within the boundaries of the proposed development area.

The species diversity of the large tree assessment was relatively low (14 species), relative to the full complement of flora identified across the study site (154 species). The most frequently occurring species recorded in the large tree survey was the West Indian Almond (*Terminalia catappa*), with 75 individuals recorded; followed by Guango (*Samanea saman*), with 43 and then Red Birch (*Bursera simaruba*); 20 individuals.

The DBH of the trees measured were between 30.7 cm and 103.9 cm, however, the most frequently recorded DBH ranged between was 30.0cm – 49.9 cm. The species specimen that had the largest DBH recorded was the Guango (*Samanea saman*), measuring 103.9 cm.

The list of species of large trees identified is found in Appendix 4 (11.4.1).

### 6.3.2.2.1.2 Black Lancewood (*Oxandra lanceolata*) Survey

Due to the highlighted importance of the Black Lancewood plant, a special survey was conducted to determine its distribution throughout the entirety of the property. This section reflects the findings of the survey. The study limit encompassed the entirety of the parent property (the section for development and the northern remainder). The assessment was carried out between May 10 and May 25, 2025. The primary objectives of the survey were:

- Estimate the density of the Black Lancewood plant throughout sections of the property
- Determine the distribution of the Black Lancewood plant throughout sections of the property

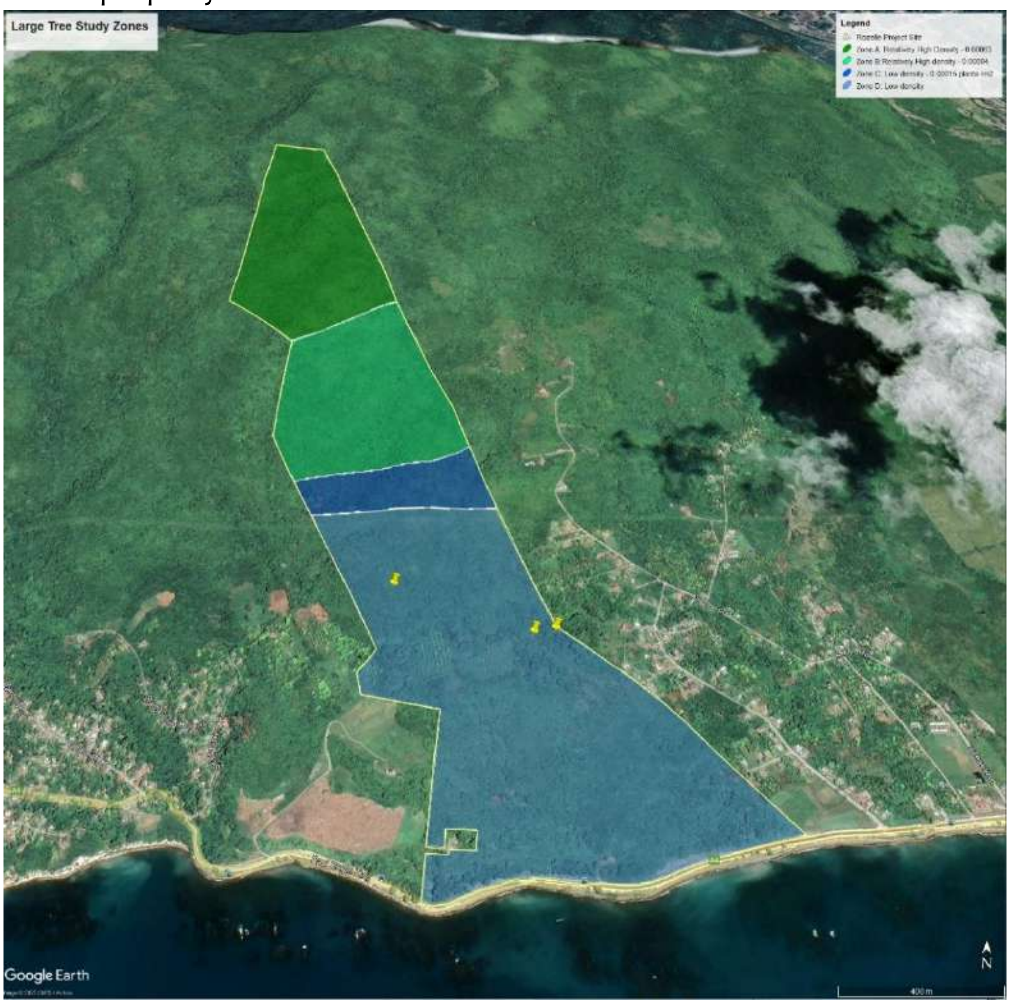



*Figure 6-57: An aerial image of the property showing the zones : Dark Green: Zone A, Light Green: Zone B, Dark Blue: Zone C, Light Blue, Zone D. Yellow Pins show the location of individual Black Lancewood plant observed within the section of the proposed for the development*

###### 6.2.1.1.1.1.2 Methodology

An initial reconnaissance was done to ascertain the general distribution of the Black Lancewood throughout the study area.

Using the information gathered in the reconnaissance, the study area was divided into four zones (Figure 6-57). A detailed walk-through survey of the project area was conducted in search of Black Lancewood plants. All representatives of this species were counted and recorded; seedlings, saplings and adult trees alike.

###### 6.2.1.1.1.1.3 Results/Observations

Black Lancewood plants were observed within the proposed area for development (lower section) as well as in the upper section of the property. The distribution and density of the species within this zone was highly variable.

###### *6.3.2.2.1.2.1.1 Zone A*

The density of the Black Lancewood plant was relatively high in Zone A; the distribution across this area was also relatively even across the space. A mixture of adult trees and juvenile plants were observed throughout this area.

*Figure 6-58: A photograph showing several Black Lancewood seedlings that were observed within Zone A of the property.*

###### 6.3.2.2.1.2.1.2 Zone B

Zone B had the highest density (0.0094 plants/m²) of the species of interest; the plants were distributed in a relatively even manner across this area. There was a healthy mixture of adult trees as well as seedlings and saplings throughout that section.

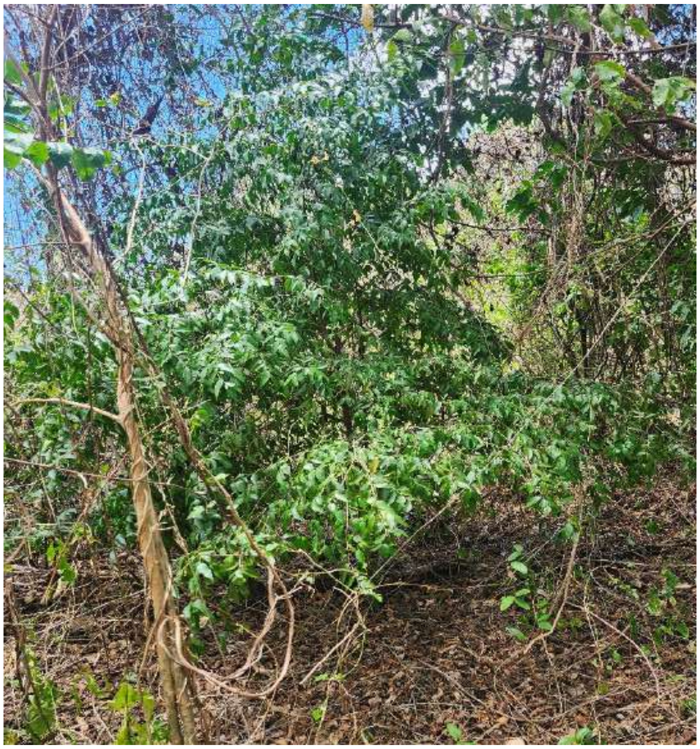


*Figure 6-59: A photograph showing one of several Black Lancewood trees observed within Zone B of the property.*

###### 6.3.2.2.1.2.1.3 Zone C

Zone C also had very low numbers of Black Lancewood, and very patchy distribution of the species across that space. The density of Black Lancewood in Zone C was approximately 0.00015 plants/m², with the majority of the plants seen being seedlings. Of the three zones assessed, Zone C had the lowest density of Black Lancewood present. The plants occurred in four small clusters across the zone.

###### 6.3.2.2.1.2.1.4 Zone D

Within the area that is slated for housing development, only three (3) individual plants were observed, all of which were seedlings.

###### 6.2.1.1.1.1.4 Discussion

The plants seem to occur more frequently in more vegetated areas of the property. The upper areas (Zones A and B), though also significantly disturbed, has a more robust forest structure than the lower sections of the property (Zones C and D). It was apparent that at some point in the distant past significant land clearance occurred in Zones A and B, for agriculture. This is evident by the detailed network of trails, agriculture infrastructure (cattle troughs and a micro dam) observed, and the fact that most of the forested areas are seemingly in an early stage of ecological succession (based on the species of plants present, as well as the dominance of smaller/less mature plants). It appeared, however, that current agricultural practices are primarily within the proposed development area, that is, Zone D, and to a lesser extent within Zone C. Zone D and Zone C are closer to the community (Rozelle district), and therefore more easily accessible. No current agricultural activities were observed in Blocks A and B.

*Figure 6-60¨A photograph showing remnant agricultural infrastructure, observed in Zone B of the parent property.*

It should be noted that via anecdotal information gathered from farmers from the adjoining community, it was uncovered that goat farmers from the area use the Black Lancewood plant as forage material for goats; particularly during dry periods, when other food sources for the goats are scarce or unavailable. The farmers stated that this involves the harvesting of the Black Lancewood plant and taking it to where the animals are housed.

Large scale deforestation practices such as logging of trees and charcoal burning were observed throughout the entire property; this was significantly more intense within the proposed area for housing development (Zone D). Approximately seven (7) active charcoal kilns (being packed or actively being burnt) were observed during the time of this assessment.

Figure 6-62: A photograph of a charcoal kiln that was observed being packed, with logs that were harvested within the project area.

In addition, another four (4) recently cleared kilns were observed within the proposed development area. Logging was observed in Zone C; however, no active kilns were observed. Active logging as well as kilns were seen in Zones A and B as well.

Figure 6-61: A photograph of an active charcoal kiln within the area that is slated for housing development.

*Figure 6-63: A photograph of a charcoal kiln within the area that is slated for housing development, which was being harvested at the time of the survey.*

Another major issue observed throughout the property was the frequent evidence of fires. Fire is seemingly used to clear land for agriculture in the lower sections of the property. However, however, the fires, based on the apparent frequency, may also originate from improperly managed charcoal kilns. An active fire was also observed during this survey. Several Black Lancewood plants damaged or destroyed by fire were observed throughout the study area during the assessment.

*Figure 6-64: A photograph of a section of Zone B on the property that was recently damaged by fire. Several plants, including, Black Lancewood, were destroyed or significantly damaged by the fire.*

*Figure 6-65: This image shows several Black Lancewood plants that were destroyed or damaged by fire in Zone B of the property.*

*Figure 6-66. Photo showing an area within the section of the property that is slated for housing development, that was recently logged and the set ablaze, probably for agricultural usage. In the rare of the frame is a makeshift hut being used by a farmer.*

*Figure 6-67: A photograph showing another area within the lands slated for housing development, which was recently logged and burnt, probably for agricultural usage.*

###### 6.2.1.1.1.1.5 Recommendations

Conserve Black Lancewood plants by doing the following:

- Zone B should be used for conservation purposes, based on the density and distribution of the Black Lancewood plants within this space. The only activities recommended in this zone would be low impact types, such as nature trail or bird watching. No activities that would require large scale land clearance would be recommended for this zone.
- Prior to land clearance, any existing Black Lancewood plants within the project area, proposed for housing development is be relocated. Ideally, any plants that are to be relocated should be relocated to Zone B.
- Zone C may be used as a transition zone between the housing development and the upper sections of the property. This area, based on the relatively low occurrence of the Black Lancewood, could be used for small scale, eco-friendly infrastructure and activities.
- The developer should develop a conservation management plan, that includes, but not limited to, general management of the forested areas in Zones A and B, the conservation of Black Lancewood plants, the management of invasive alien species on the property and the management of unsustainable practices such as plant harvesting/logging, charcoal burning and wildfires. Conservation management of this

area may assist with the conservation of the vegetated area, and the Black Lancewood occurrence, as this may limit/reduce the negative impacts of the unsustainable activities described above.

- Zone A could be used for small scale, eco-friendly activities such as nature walk, zip-line, e-biking and bird watching. No activities that would require large scale land clearance is recommended to take place within this zone.

#### 6.3.2.2.2 Avifauna (birds)

A total of thirty-four (34) species of birds were identified during the assessment (Table 6-31), including 31 residents and 2 migrants. Of the 31 residents, eight (8) are endemic to Jamaica. These are highlighted in Table 6-31 below.

The bird species composition on the property is typical of an area dominated by secondary forest/disturbed forest area. It should be noted that only one bird species associated with Wetlands/Riverine/Coastal areas, was recorded: the Little Blue Heron (Egretta caerulea).

Only 2 migrants were observed in the project area (Figure 6-68), the Gray Kingbird (Tyrannus dominicensis) and Black-whiskered Vireo (Vireo altiloquus), both of which are summer migrants. The assessment was done during the summer (July); hence no winter migrants were recorded. A bird survey conducted during the winter period, will more likely reflect a change in the species composition, as migrants from North America arrive during that period.

Only two of the bird species recorded have special designated status by the IUCN: the White-crowned Pigeon (Patagioenas leucocephala) and Jamaican Parakeet (Eupsittula nana) are both classified as near-threatened species.

*Table 6-30: The list of avifauna (birds) observed during the assessment of the project area*

| Common Name | Scientific Name | Range | IUCN | DAFOR Rank |
|---|---|---|---|---|
| American Kestrel | *Falco sparverius* | Resident | LC | R |
| Antillean Palm-Swift | *Tachornis phoenicobia* | Resident | LC | O |
| Bananaquit | *Coereba flaveola* | Resident | LC | D |
| Barn Owl | *Tyto alba* | Resident | LC | R |

| | | | | |
|---|---|---|---|---|
| Black-faced Grassquit | *Melanospiza bicolor* | Resident | LC | F |
| Black-whiskered Vireo | *Vireo altiloquus* | Migrant | LC | O |
| Caribbean Dove | *Leptotila jamaicensis* | Resident | LC | A |
| Cattle Egret | *Bubulcus ibis* | Resident | LC | D |
| Cave Swallow | *Petrochelidon fulva* | Resident | LC | O |
| Common Ground Dove | *Columbina passerina* | Resident | LC | D |
| Gray Kingbird | *Tyrannus dominicensis* | Migrant | LC | R |
| Greater Antillean Grackle | *Quiscalus niger* | Resident | LC | F |
| Jamaican Euphonia | *Euphonia jamaica* | Endemic | LC | R |
| Jamaican Mango | *Anthracothorax mango* | Endemic | LC | R |
| Jamaican Oriole | *Icterus leucopteryx* | Resident | LC | R |
| Little Blue Heron | *Egretta caerulea* | Resident | LC | R |
| Loggerhead Kingbird | *Tyrannus caudifasciatus* | Resident | LC | O |
| Northern Mockingbird | *Mimus polyglottos* | Resident | LC | F |

| | | | | |
|---|---|---|---|---|
| Jamaican Parakeet | *Eupsittula nana* | Endemic | NT | O |
| Jamaican Tody | *Todus todus* | Endemic | LC | R |
| Jamaican Woodpecker | *Melanerpes radiolatus* | Endemic | LC | R |
| Jamaican Vireo | *Vireo modestus* | Endemic | LC | R |
| Red-tailed Hawk | *Buteo jamaicensis* | Resident | LC | R |
| Sad Flycatcher | *Myiarchus barbirostris* | Resident | LC | O |
| Smooth-billed Ani | *Crotophaga ani* | Resident | LC | O |
| Red-billed Streamertail | *Trochilus polytmus* | Endemic | LC | O |
| Turkey Vulture | *Cathartes aura* | Resident | LC | O |
| Vervain Hummingbird | *Mellisuga minima* | Resident | LC | R |
| White-crowned Pigeon | *Patagioenas leucocephala* | Resident | NT | O |
| White-winged Dove | *Zenaida asiatica* | Resident | LC | A |
| Yellow-faced Grassquit | *Tiaris olivaceus* | Resident | LC | F |
| Yellow-shouldered Grassquit | *Loxipasser anoxanthus* | Endemic | LC | O |
| Zenaida Dove | *Zenaida aurita* | Resident | LC | A |

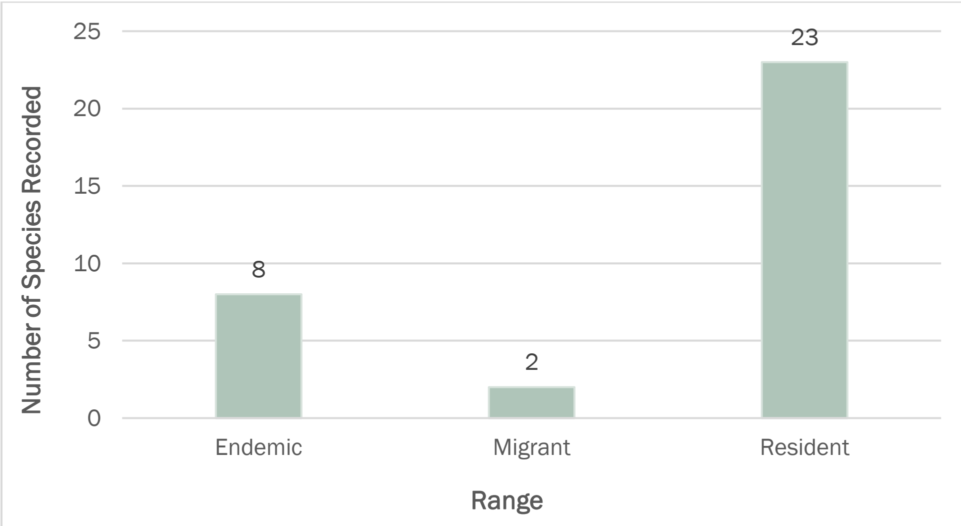



*Figure 6-68: A graph of the range of bird species recorded within the project area*

*Figure 6-69. Photo showing one of the many foot trails within the property boundary*

*Figure 6-70. Photo showing a small dwelling within the project boundary*

*Figure 6-71. Photo showing a charcoal kiln observed within the property for development (2023)*

### 6.3.2.2.3 Herpetology (amphibians and reptiles)

#### 6.3.2.2.3.1 Amphibians

A total of three (3) species of amphibians were recorded on the lands within the project area Table 6-33 all of which are introduced species: Cuban Flat-headed Frog (*Eleutherodactylus planirostris*), Lesser Antillean Frog (*Eleutherodactylus johnstonei*) and Cane Toad (*Rhinella marina*). None of the amphibian species encountered during this study has been deemed to have any special conservation status; neither was any species listed as rare in Jamaica.

#### 6.3.2.2.3.2 Reptiles

A total of six (6) reptilian species were recorded within the project area, all of which are endemic. The most frequently observed was the Jamaican Brown Anole (*Anolis lineatopus*). No Jamaican Boas (*Chilabothrus subflavus*) were observed during the survey. However, anectodal information from residents of the community was that these snakes have been sighted within the project area, particularly in the northern sections of the project boundary. It should be noted that *C. subflavus* is endemic to Jamaica and is a protected species and listed as Vulnerable (VU) by the IUCN.

*Table 6-31:The list of herpetofauna identified in the project area*

| Class | Scientific Name | Common Name | Range | IUCN Status | DAFOR Ranking |
|---|---|---|---|---|---|
| Amphibia | *Eleutherodactylus johnstonei* | Lesser Antillean Frog | Introduced | LC | A |
| | *Eleutherodactylus planirostris* | Cuban Flat-headed Frog | Introduced | LC | R |
| | *Rhinella marina* | Cane toad | Introduced | LC | O |
| Reptilia | *Anolis garmani* | Jamaican Giant Anole | Endemic | LC | R |
| | *Anolis lineatopus* | Jamaican Brown Anole | Endemic | LC | D |
| | *Anolis grahami* | Jamaican Turquoise Anole | Endemic | LC | R |
| | *Anolis valencienni* | Jamaica Twig Anole | Endemic | LC | R |
| | *Anolis opalinus* | Jamaican Opal-bellied Anole | Endemic | LC | O |
| Reptilia | *Chilabothrus subflavus** | Jamaican Boa | Endemic | VU | |

** Species not recorded during the survey; however, it was reported by residents as being in the project area.*

#### 6.3.2.2.4 Invertebrates

Nineteen (19) butterfly species were observed in the study area. Of the 19 species, 1 endemic species and 4 endemic subspecies were identified. See details in Table 6-33. None of the butterfly species identified during the survey has any special conservation needs.

The literature suggests that the general White Horses/Rozelle area is one of the localities across the island that hosts a population of the Blue Kite/ Swallowtail Butterfly (*Eurytides marcellinus*). This species is endemic to Jamaica and listed as Vulnerable (VU) by the IUCN. E. marcellinus is designated a protected species by Jamaican law. Neither the species, nor the main food source for its larvae; the Black lancewood (*Oxandra lanceolata*) (Society 2004) was identified during the assessment. However, due to the suspected likelihood of their occurrence, a series of site visit was done over the different hydrological seasons (wet and dry) to detect the presence of the butterfly species. The results are discussed in the subsequent section.

*Table 6-32: Table showing the butterfly species observed during the assessment of the area*

| **Family** | **Scientific Names** | **Common Names** | **Distribution** | **DAFOR Rank** |
|---|---|---|---|---|
| Hesperiidae | *Urbanus proteus* | Common tailed Skipper | Found throughout tropical and subtropical South America, south to Argentina and north into the Eastern United States and southern Ontario | R |
| Lycaenidae | *Hemiargus ceraunus* | The Hanno Blue | Widespread and very common | F |
| | *Leptotes cassius* | Cassius Blue | Caribbean, Central and northern South America, extends as far north as southern Texas and the tip of Florida, | R |
| Nymphalidae | *Anaea troglodyta portia* | Jamaican tropical leafwing | Endemic subspecies Jamaica | R |
| | *Anartia jatrophae* | White Peacock | Widespread and common. Southern US to Argentina | D |
| | *Dryas iulia delilah* | Julia | Endemic subspecies.; widespread, common | O |
| | *Euptoieta hegesia* | Mexican Fritillary | Central and Northern South America, | O |

| | | | | |
|---|---|---|---|---|
| | *Heliconius charithonia simulator* | Zebra Longeing | Endemic subspecies Jamaica | F |
| | *Junonia evarete* | Tropical Buckeye | Found in tropical and subtropical South America | A |
| | *Cuban Crescent* | Cuban Crescent | | R |
| Papilionidae | *Battus polydamas jamaicensis* | Polydamas Swallowtail | Endemic subspecies | F |
| | *Papilio andraemon* | Andraemon Swallowtail | Introduced from Cuba, 1940's, citrus pest. Greater Antilles | R |
| Pieridae | *Anteos maerula* | Yellow angled-sulphur | Widespread but not very common. Southern US to Peru | R |
| | *Ascia monuste* | Great Southern White; Antillean Great White | Widespread, common and pest of crucifers. Southern US to Argentina | F |
| | *Eurema nise* | Mimosa Yellow; Cramer's Little Sulphur | Widespread, common. Southern US to Argentina | F |
| | *Phoebis argante* | Giant Sulphur | Widespread, common. Southern US to Argentina | R |
| | *Phoebis sennae* | Cloudless Sulphur | Widespread and common. Southern US to Argentina | F |
| | *Pyrisitia lisa* | Little Yellow | Widespread, common. Southern US to Argentina | R |
| Satyrinae | *Calisto zangis* | Jamaican satyr | Endemic to Jamaica and the Guianas | R |
| Papilionidae | *Eurytides Marcellinus** | Blue Kite Swallowtail Butterfly/Jamaican Kite | Endemic to Jamaica. Listed as Vulnerable (VU) by the IUCN | |

Key

| | |
|---|---|
| Endemic Species | |
| Endemic sub-species | |
| Endemic Threatened (IUCN Listed) species | |

### 6.3.2.2.5 *Protographium Marcellinus* (Blue Swallowtail/Jamaican Kite/Blue-Kite Swallowtail)

*Protographium marcellinus*, the Blue Swallowtail Butterfly, or the Jamaican Kite Swallowtail Butterfly, is endemic to the island of Jamaica. The Jamaican Kite is a relatively small swallowtail with long, slender tails and stripes of black and blue-green along its wings (Society 2004) (Figure 6-71).

The larva of the species feed on the leaves of a single plant species, *Oxandra lanceolata*, (Black Lancewood, Lancewood). The adults feed on a wide variety of flowers. The availability of Black Lancewood is generally regarded as one of the limiting factors in the survival of the species populations.

The Blue Swallowtail Butterfly is now listed as a Vulnerable species by the IUCN and is regarded by NEPA as a species in need of urgent protection, hence, its efforts to prevent it from becoming endangered and even going to extinction. The major conservation concern is pressure on the breeding sites caused by human activities such as intensive agriculture, charcoal burning and housing development.

*Figure 6-71:Source: petchary.wordpress.com, (by Vaughn Turland)*

#### 6.3.2.2.5.1 Methods

Following extensive literature review on the species, a total of three field visits were conducted to the Rozelle area of St. Thomas, including the proposed development site on March 18, 2024, May 11, 2024, and June 9, 2024. Repeated visits were necessary as sightings of the adults of the species is known to be seasonal. The results of these visits are provided below.

###### 6.3.2.2.5.2 Results

March 18, 2024.

Three activities were carried out:

1. Observations were conducted on the occurrence of Black Lancewood (the larval food plant of the butterfly).

2. The presence/absence of adult butterflies were documented.

3. The leaves of the larval food plants were searched for eggs and larvae of the butterfly.

The land cover over the site in question is open dry forest and disturbed broadleaf forest (Figure 6-43). The area has been highly impacted by human activities over prolonged periods and the vegetation ranged from dense scrubland to patches of forests to disturbed/regenerating dry limestone forests.

Black Lancewood was not observed in the scrub vegetation. The scrub areas, having been previously cleared, were dominated by early colonizers and vines. It is possible that Black Lancewood seedlings occurred hidden under the dense vegetation, but despite intensive searching, none was identified.

Forests occurred as small patches between the scrub. Black Lancewood occurred in some of these patches, generally mature isolated trees and there may be seedlings whose growth has been suppressed by the shade of the canopy.

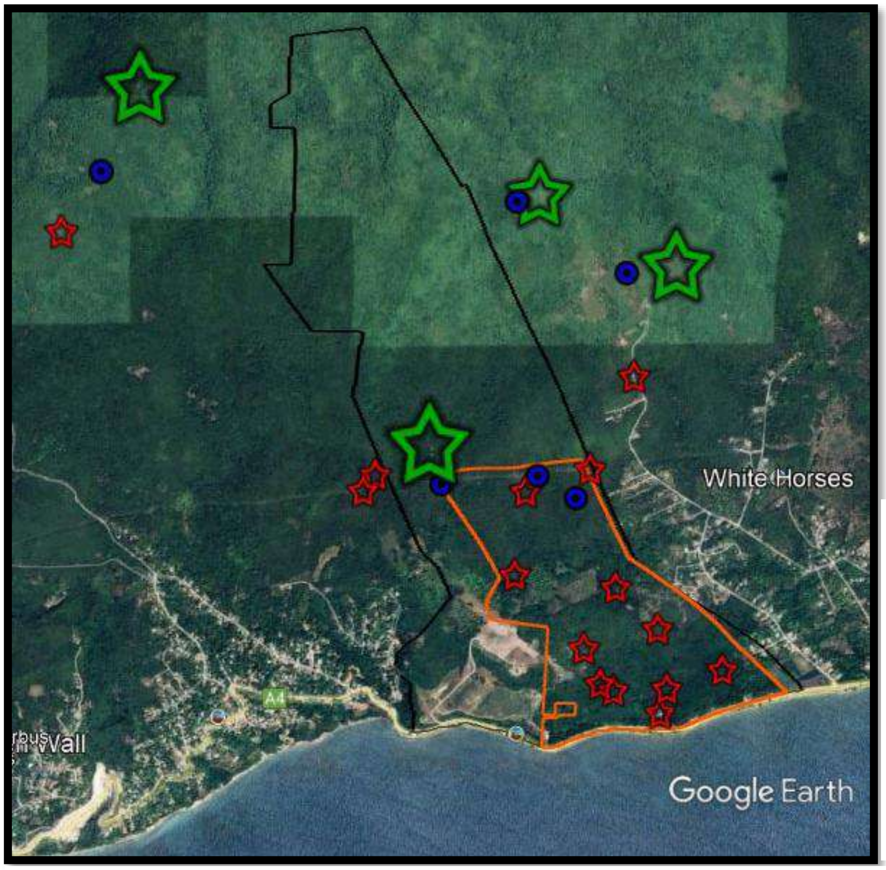
No adult butterfly was observed during the six-hour visit. Intensive search of the vegetation did not reveal any eggs or larvae.

May 11, 2024

The area was again visited but no life stage of the butterfly was observed.

June 9, 2024

A significant flight of adult Blue Swallowtail Butterfly was observed in progress. The flight was extensive across the Rozelle/White Horses area, mainly North of an imaginary line separating the upper half of the Developer’s property (Figure 6-72). The specimens appeared to be in perfect condition, indicating that they recently emerged from the pupal stage (as butterflies get older their wings begin to show wear and tear). No eggs or larvae were observed on the leaves of the Black Lancewood plants.




Blue Swallowtail sited

*Ox Andra lanceolata* – isolated plant

*Oxandra lanceolata* – clusters of plants

*Figure 6-72: A depiction of the Blue Swallowtail Butterfly survey results. The black outline shows the master property boundary while the orange polygon shows the boundaries of the section of the land to be developed for housing purposes.*

The Proposed Development site forms part of the larger Rozelle/White Horses breeding area of this species of butterfly. The lower region of the full property, i.e., the area designated for development, is mainly scrublands with few larval food plants occurring mainly as individual trees. However, in the upper regions of the property, i.e., the area not presently designated for development, food plants occur in patches of higher densities.


*Figure 6-73: Another closer view of Figure 6-61 showing the distribution of isolated Black Lancewood plants identified and where adult butterflies were observed*

Any development has the potential to reduce the already limited breeding area. The massive disturbances presently in the area are already having a negative impact. It is essential therefore, that any development there includes mitigation measures to augment the availability of Black Lancewood in forested areas.

#### 6.3.2.2.5.3 Discussion

The species has generally been uncommon compared to other swallowtail butterflies in Jamaica, although high numbers have occasionally been recorded (Lewis, 1954; Brown, 1972; Riley, 1975; Collins, 1985).

When numbers are very high, there might be migration across the island, and these migrants are usually males (Collins 1985) (Walker 1943) reported that large numbers swarmed over the Liguanea Plains in 1924, and thousands have been recorded to swarm through Kingston and St. Andrew in the 1940's and 1950's (Anon, 1945; Lewis, 1951; 1954). The breeding site of these individuals was Rozelle/White Horses, St. Thomas. However, such flights have not been recorded since. In more recent times single adults and occasionally small numbers have been recorded in various parishes including Kingston, St Andrew, St Catherine, Trelawny and St Ann.

Adults lay eggs on the leaves of Black Lancewood; and this is the only plant on which the larvae have been known to feed. The mature larvae pupate in the soil and adult butterflies emerge the following year, generally after the rains of March/April and occasionally in June. There is synchronized emergence of the adults, and this is when the butterflies are seen. These flights of adults can be spectacular. After about a week they disappear, by which time they would have laid eggs, and the life cycle of the next generation begins.

Adams (1972) lists Black Lancewood as "occasional in woodlands on limestone mostly in central and western parishes, altitude 25 – 1400 feet." Discussions with farmers across the island indicated that in some areas it might be common enough to be commercially useful for charcoal and other uses.

Rozelle/White Horses, is regarded as the chief breeding site of the Blue Swallowtail. A number of additional breeding sites have been identified. These include Lancewood Valley, Southern Clarendon; Round Hill, Southern Manchester; Rio Bueno, Northern Trelawny; and Crown Lands, Southern Trelawny. However, the Rozelle population is still regarded as the chief breeding population.

###### 6.3.2.2.5.4 Conservation concerns

*Protographium marcellinus* is now regarded as a vulnerable species (Collins 1985) the major conservation problem being pressure on the few breeding sites identified to date.

Several authors have called for conservation measures to be put in place for this species. The number of sightings, and frequency of swarming has dwindled over the years, consequently, (Turner and Turland, 2022) postulated that the Blue Swallowtail is the species of swallowtail in Jamaica that is most likely to go extinct.

While the larval food-plant, Black Lancewood, is widespread, the breeding sites of the Blue Swallowtail are very restricted; that is, other environmental conditions are essential. There has been no intensive research on the ecology of the species, hence, the exact environmental conditions necessary for its successful breeding is still unknown. However, one characteristic of the breeding sites is that the food plant occurs in high density; that is, eggs/larvae have not been observed on isolated plants.

The species is also vulnerable because of the nature of its life cycle. Other species of butterflies in Jamaica breed all year round. The Blue Swallowtail has only one annual brood, often in low numbers, and is therefore extremely vulnerable. Failure of any developmental stage of the lifecycle (egg, larva, pupa) in a single year may be detrimental to the species' survival. The diapausing pupae, (for six to ten months), are vulnerable. The window of emergence of the adults is very limited and is dependent on the secondary rainfall period.

The utilization of the known breeding areas by humans for agriculture, charcoal burning, and housing, greatly fragment the habitat, often leaving Black Lancewood plants isolated. Sites are often left as scrublands and regenerating forests, but Black Lancewood is a late colonizer, and it will take several decades or even centuries to be present in high densities.

In summary the species is vulnerable due to:

- One larval food plant.
- Only five known breeding sites nationally.
- Pupae vulnerable for six or more months while they diapause in the soil.
- Adult emergence from the soil is dependent on the secondary rainfall period.
- Density of larval food plant is essential; individual plants are not suitable for oviposition.

Similarly to the Black Lancewood plant, Zone B described above may be used for conservation of the butterfly species.

#### 6.3.2.2.5.5 *Oxandra lanceolata*, (Black Lancewood, Lancewood)

As mentioned above, the larval stage of the *Protographium Marcellinus*, feeds primarily on the *Oxandra lanceolata* (Black lancewood) tree. *Oxandra lanceolata* is an evergreen shrub or tree that can grow around 2 - 20 metres tall. The trunk can grow up to 10-30cm in diameter and can be unbranched for up to 4 metres (Acevedo-Rodríguez 2012).

The *Oxandra lanceolata* thrives in wet tropical biomes and specific regions of Central and South Mexico, and the Caribbean (Cuba, Jamaia, Haiti, Dominican Republic, and Puerto Rico) (Acevedo-Rodríguez 2012). It thrives in limestone stone at elevations of up to 451m or 701m.

#### 6.3.2.2.5.6 Arthropods (butterflies)

With regards to arthropods (non-butterfly species), a total of 24 species were recorded (Table 6-31) these included spiders (3 species), termites (1 species), ants (2 species) and ticks (1 species).

*Figure 6-74: A photograph of a termite nest, observed within the project area.*

*Table 6-33: The arthropods (non-butterfly observed during the assessment*

| Order | Family | Scientific Names | Common Name | Range Jamaican Distribution | DAFOR Rank |
|---|---|---|---|---|---|
| Araneae | Araneidae | *Gasteracantha cancriformis* | Black Crab spider | Native, Common | F |
| | Araneidae | *Trichonephila clavipes* | Banana spiders | Native, Common | O |
| | Tetragnathidae | *Leucauge argyra* | Orbweavers | Native, Common | R |
| Blattodea | Termitidae | *Nasutitermes costalis* | Termites, Duck ants Widespread. | Native, Common | F |
| Coleoptera | Cerambycidae | *Oxymerus aculeatus* | | Native, Common | O |
| Diptera | Muscidae | *Musca domestica* | Housefly | Native, Common | R |
| Hemiptera | Pentatomidae | *Ascra sp.* | Stink bug | | O |
| | Reduviidae | *Zelus longipes* | Milkweed Assassin Bug | Native, Common | R |
| Hompotera | Cicadidae | *Odopoea sp.* | Cicada | Native, Common | R |
| Hymenoptera | Apidae | *Apis mellifera* | | Native, Common | F |
| | Formicidae | *Pheidole sp.* | Black ants | Native, Common | F |
| | Formicidae | *Camponotus sp.* | Carpenter and Sugar Ants | Native, Common | R |
| | Formicidae | *Camponotus hannani* | Red Ants | Native, Common | F |
| | Vespidae | *Polistes crinitus* | Caribbean Paper Wasp | Native, Common | O |
| | Xylocopinae | *Xylocopa mordax* | | Native, Common | O |
| Ixodida | Ixodidae | *Rhipicephalus microplus* | Cattle tick | Native, Common | R |
| Odonata | Libellulidae | *Orthemis macrostigma* | Red Dragonfly or Tropical King Skimmers | Native, Common | F |

| | | | | | |
|---|---|---|---|---|---|
| | Libellulidae | *Enallagma coecum* | Antillean Bluet | Native, Common | O |
| | Libellulidae | *Erythrodiplax umbrata* | Band-winged Dragonlet | Native, Common | R |
| Orthoptera | Acrididae | *Abracris flavolineata* | | Native, Common | F |
| | Acrididae | *Schistocerca serialis* | Short-horned Grasshoppers | Native, Common | F |
| | Acrididae | *Schistocerca serialis* | Large grasshopper | | R |
| | Gryllidae | | Cricket | Unknown | O |
| Spirobolida | Rhinocricidae | *Anadenobolus monilicornis* | Yellow-banded millipede | Native, Common | O |

### 6.3.2.2.6 Mammals

A total of seven (7) mammalian species were positively identified during the survey (Table 6-34), most of which are domesticated. None of the mammals recorded are endemic to Jamaica. Two of these species are considered IAS: Small Indian Mongoose (*Harpists javanicus*) and Brown/Norway Rat (*Rattus norvegicus*).

*Table 6-34: Table showing the mammal species observed within the project area*

| **Common Name** | **Scientific Name** | **Family** |
|---|---|---|
| Cow | *Bos taurus* | Bovidae |
| Dog | *Canis familiaris* | Canidae |
| Donkey | *Equus asinus* | Equidae |
| Goat | *Capra aegagrus hircus* | Bovidae |
| Small Indian Mongoose | *Herpestes javanicus* | Herpestidae |
| Cat | *Felis catus* | Felidae |
| Brown/Norway Rat | *Rattus norvegicus* | Muridae |

There were signs of at least 1 bat species' presence; the Jamaican Fruit Bat (*Artibeus jamaicensis)*, a frugivore. The actual species was not observed, however, the characteristic eating of West Indian Almond (*Terminalia catappa*) fruits and their sporadic dispersal of the fruits around the property was observed. Given that the project area is within zone dominated by limestone, there is a possibility caves might be close by (no caves were observed during the survey). It is therefore possible that bats are roosting in nearby areas and could be utilizing the grounds of the property for foraging.

## 6.4 TRAFFIC IMPACT ASSESSMENT (TIA)

A traffic Impact assessment (TIA) was conducted for the development, from which recommendations were offered and included in a revised design for the access onto the property. These adjustments also satisfied the National Works Agency's requests. The design includes a single intersection for the development.

The following were the key finds:

- The demand flow rate was determined for the morning and evening peak as 627 pc/h and 570 pc/h, respectively. The existing corridor operates at LOS "A".
- With one intersection and no intersection expansion, the capacity of the north movement in relation to 10-year traffic volumes with the development fully occupied is such that the level of service is "B" for the morning peak hour and reduced to "C" for the evening peak hour. 3.
- The intersection expansion does not affect the overall LOS for the north approach using one intersection. However, splitting the traffic between 2 intersections and expanding the road improves the LOS for the evening peak hour to "B" instead of "C"; it remains the same for the morning peak but with a reduced overall average delay.

See attached independent study.

# 6.5 HAZARD ASSESSMENT

## 6.5.1 STORM SURGE AND EXTREME EVENTS

This section was previously covered under section 6.1.11.

## 6.5.2 SEISMIC ASESSMENT

Jamaica is located in the north-central Caribbean on the Gonave microplate that moves a rate of 13 mm/yr. Its motion is bounded by the Oriente Fracture Zone to the North, the Cayman Spreading Center to the West, the Enriquillo Plantain Garden and the Walton Fault zones to the South. Earthquakes affecting Jamaica typically originate from the sources listed in Figure 6-61. The proximity of the site to the very active Enrique Plantain Garden fault makes it susceptible to seismic hazard.

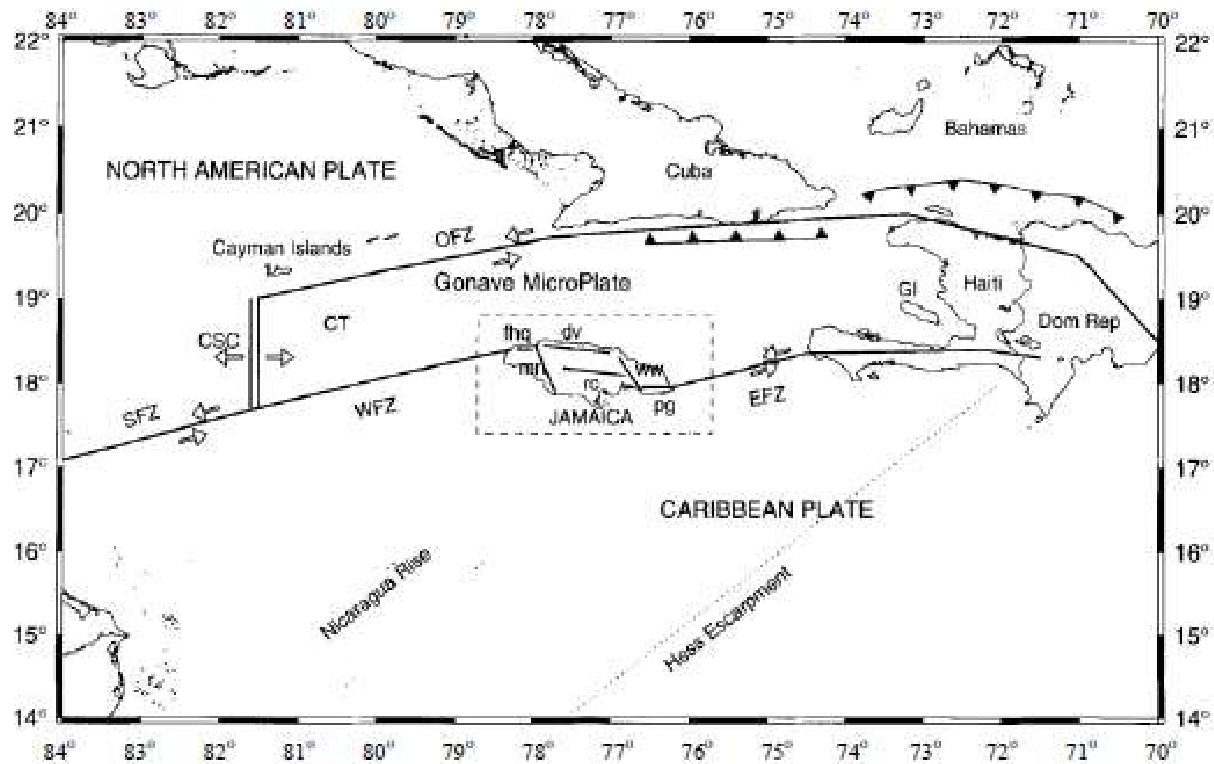



*Figure 6-75: Jamaica region tectonics: SFZ—Swan fracture zone; CSC—Cayman Spreading Center; CT—Cayman Trench; OFZ—Oriente fracture zone; WWF—Walton fault zone; EFZ—Enriquillo fault zone; Dom Rep—Dominican republic; GI—Gonave Island; fhq—Fat hog quarters fault; dv—Duanvale fault; ww—Wagwater fault; pg—Plantain garden fault; mn—Montepelier—Newmarket fault zone; rc—Rio Minho-Crawle river fault. (Source, Salazar et al (2013))*

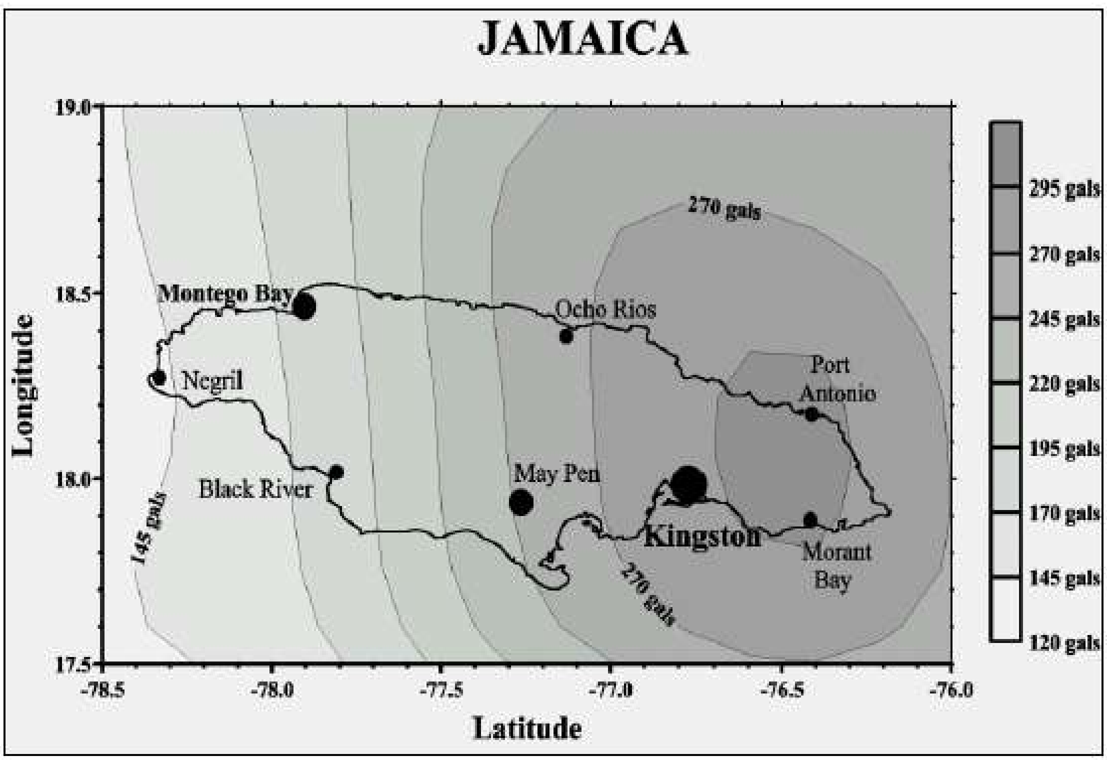
Seismic hazard studies and mapping for the island have been undertaken in several instances to include Pereira and Gay (1978) and Shepherd and Aspinall (1980), OAS (1999) and Salazar et al (2013). The OAS maps are most referenced and are comparable to the 2013 studies that were undertaken by personnel from the Seismic Research Centre, The University of the West Indies (UWI), St. Augustine, Trinidad and Tobago and from the Earthquake Unit, The University of the West Indies (UWI), Mona, Kingston, Jamaica.

The OAS study was limited to only one return period event being analyzed for peak ground acceleration (PGA), the 475-year return period (or 10% chance of exceedance in any 50 year), whereas the 2013 study analyzed PGA for475 year as well as 0.2s and 1.0s spectral acceleration the 2475-, and 4975-year return scenarios.

PGA with RP = 475 is a widely used parameter to express the results of Probabilistic Seismic Hazard Analysis (PSHA), while the computing of the spectral acceleration at periods of 0.2 s and 1.0 s and RP = 2,475 and 4,975 years is consistent with the more recent versions of the International Building Codes.

Both studies have the predicted PGA values among the highest in Jamaica. The OAS study has the PGA values above the 0.295g range whereas the 2013 UWI study has it varying between 0.263g and 0.281g, see Figure 6-76.

a



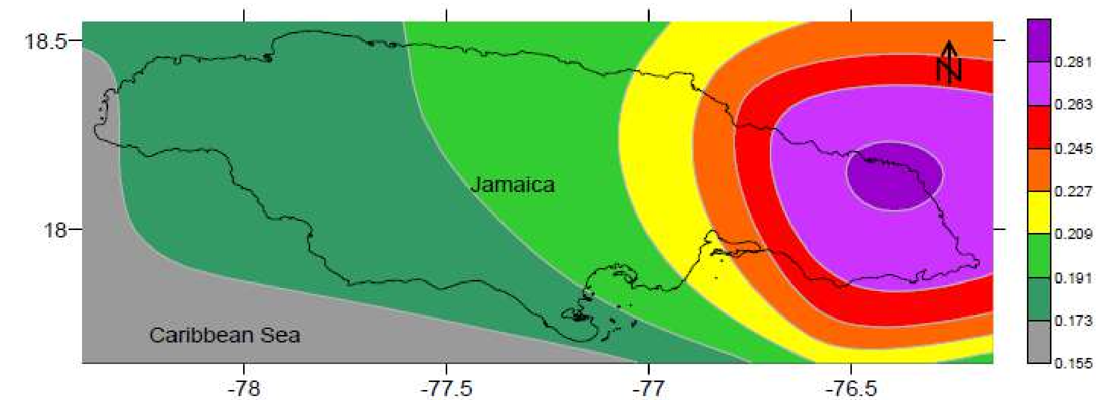
| | |
|---|---|
| b |  |



*Figure 6-76 Seismic Hazard Maps of Jamaica showing predicted Peak Horizontal Ground Acceleration for 475-year RP scenario: (a) Source (OAS 1999); (b) Source Salazar et al, 2013.*

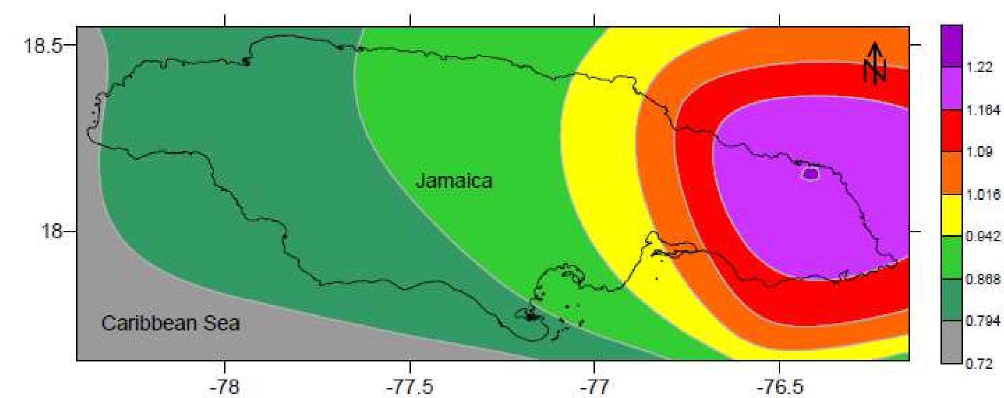
Similarly, the spectral acceleration values predicted for Saint Thomas and the project area are among the higher ranges in Jamaica, see Table 6-357 and Table 6-368.

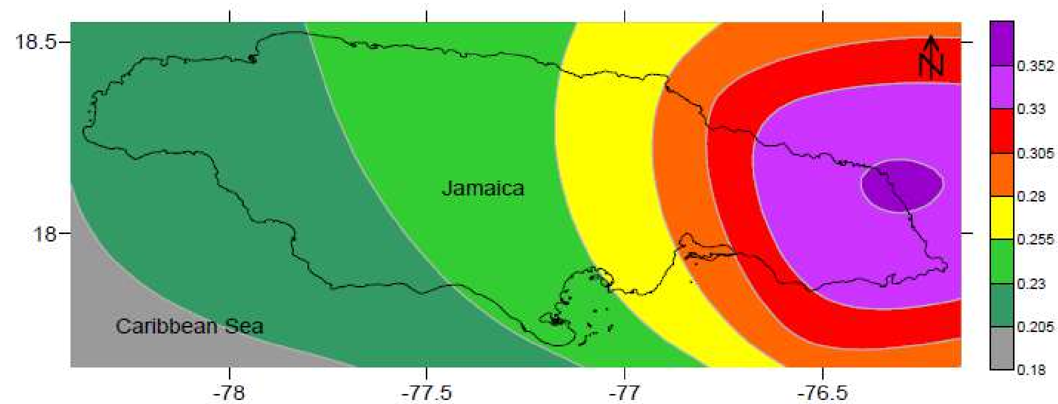
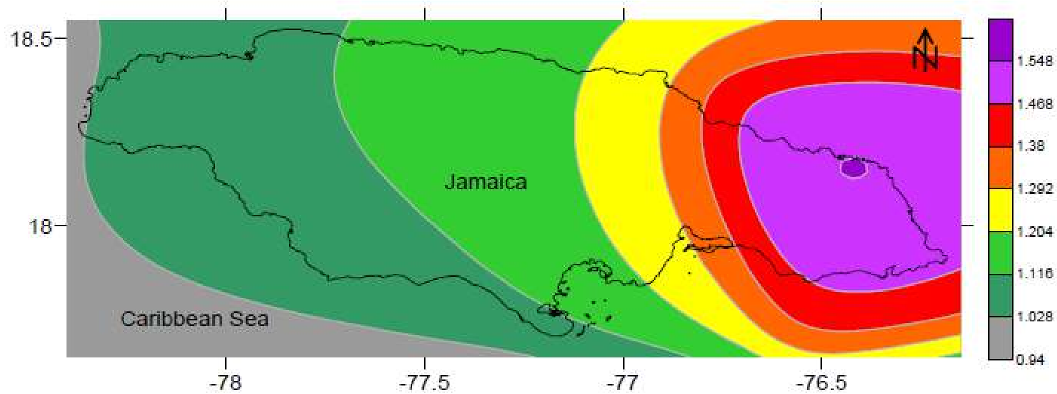
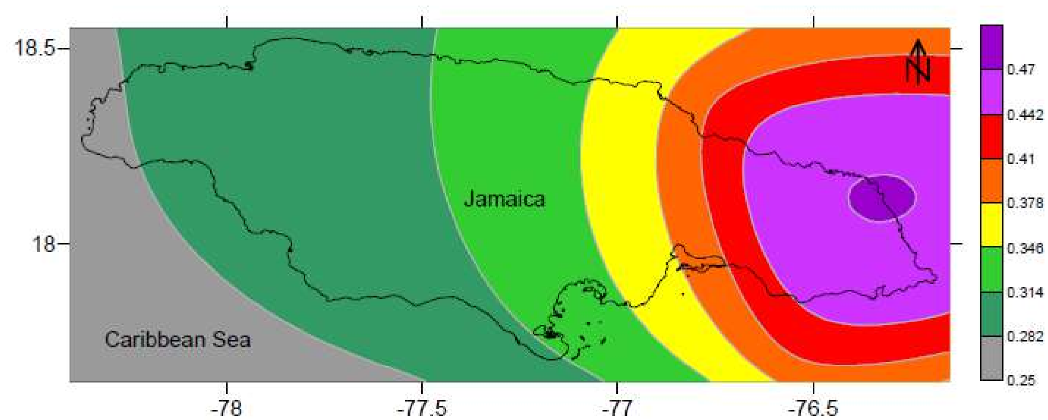
*Table 6-35 Spectral acceleration predictions for 2475- and 4975-year return periods*

| ***Return Period*** | **Spectral Acceleration (g)** | |
|---|---|---|
| | 0.2 | 1.0 |
| 2475 | 1.16 - 1.22 | 0.33 - 0.35 |
| 4975 | 1.46 - 1.54 | 0.44 - 0.47 |

The IBC has design guidelines and typical values to be used for the site classes where applicable. Where available, the geotechnical studies done onsite should be used as guides for the site-specific spectral accelerations for structural designs.

*Table 6-36 Seismic Hazard Maps of Jamaica showing predicted 0.2s and 1.0s spectral acceleration the 2475, and 4975 (Salazar et al (2013))*

| | | |
|---|---|---|
| RP = 2475 | 0.2 s |  |

| | | |
|---|---|---|
| RP = 2475 | 1.0s |   |
| RP = 4975 | 0.2 s |   |
| RP = 4975 | 1.0s |   |

## 6.5.3 TSUNAMI

### 6.5.3.1 BACKGROUND

Rozelle, St Thomas lies on the southern coast of Jamaica and is exposed to tele-tsunamis generated offshore of the northern coast of Central America. Whereas these events are not commonplace, the location and the development by extension is exposed and susceptible.

Jamaica has had at least four earthquakes since 1600 that could be considered as major events and which generated tsunamis at various points around the island, two of which are known to have impacts on sections of St Thomas (Taber 1920). These were in 1692 and in 1907. The impacts at the project location have not been documented.

*Table 6-37 Summary of Tsunamis known to affect Jamaica*

| Year | Tsunami affected Location(s) | EQ Focal Depth | Maximum Estimated water surface Elevation (m) | Comments |
|---|---|---|---|---|
| 1688 | Port Royal | | | |
| 1692 | Port Royal, Yallahs, St Ann's Bay | 7.7 | 1.8 | |
| 1766 | North Coast of Jamaica | | | Earthquake in Cuba |
| 1781 | Savanna La Mar | | 3 | |
| 1787 | | | | Possibly Montego Bay |
| 1812 | | | | Disturbed sea following EQ |
| 1881 | Kingston, North coast | | 0.46 | |
| 1907 | South Coast (Yallahs) and Eastern sections of North Coast | 6.5 | 2.4 | |

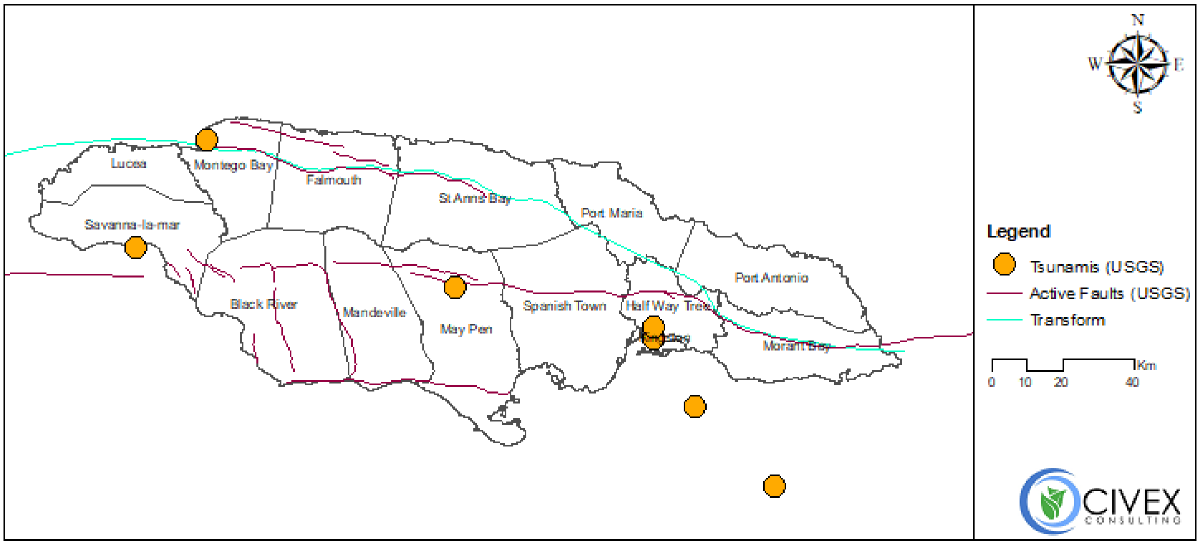



*Figure 6-77:USGS recorded locations and sources for Tsunamis known to have affected Jamaica*

### 6.5.3.2 TSUNAMIC GENERATION

There are three types of faulting that can generate an earthquake, strike-slip, normal dip-slip and reverse dip-slip. The normal and reverse dip-slip types have been said to be tsunamigenic (M. M. Hasan 2015). Figure 2.6 shows the three slip types. Within the seismic community, the symbols used normally to represent slips at the faults are called focal mechanisms (Lees 2000) and are shown in Figure 6-64. They are intended to be graphical summaries of the strike, dip, and slip directions defined below.

*Figure 6-78:Normal Dip-Slip (left), Reverse Dip-Slip (middle) and Strike-Slip (right). Source: Hasan, Rahman, and Mahamud (2015)*

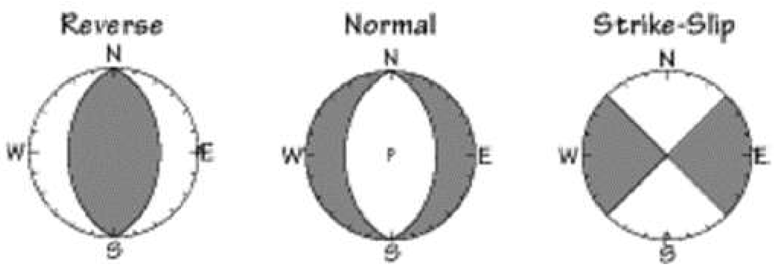



*Figure 6-79: Symbols (beach balls) used to represent the three key fault types or focal mechanisms.*

The most likely tsunami sources to impact the project site are the offshore faults (due to convergent tectonic plate margin) located north of Panama. The Panama tectonic plate is a south-western extension of the Caribbean plate surrounded by five tectonic plates: the South American plate, Caribbean plate, Cocos plate, and Nazca plate, and by the Chortis tectonic block (Buchs 2010). The plate had once been a piece of volcanic arc that split off from the rest of the Caribbean plate between the late Tertiary and early Quaternary and is currently moving in a northward direction, (Fisher, et al. 1994). This Caribbean-Panama plate boundary is convergent and is a source of a few notable earthquakes. It appears the Caribbean Plate subducting is below the Panama microplate, forming a strike slip plate boundary where it is a possible source of a tele-tsunami that could impact the southern Jamaican coastline.

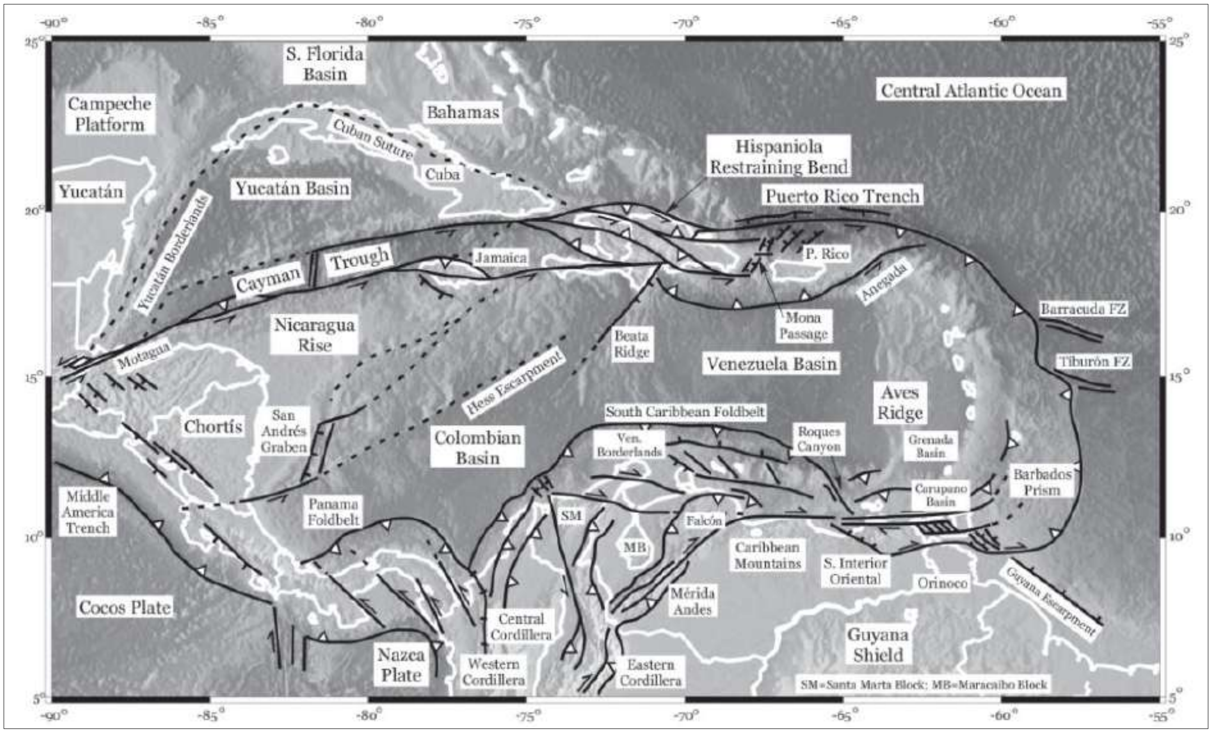



*Figure 6-80:Plate-boundary map and bathymetry of the circum-Caribbean region, showing key tectonic features. Notice The Caribbean Plate Subducting below Panama microplate.*

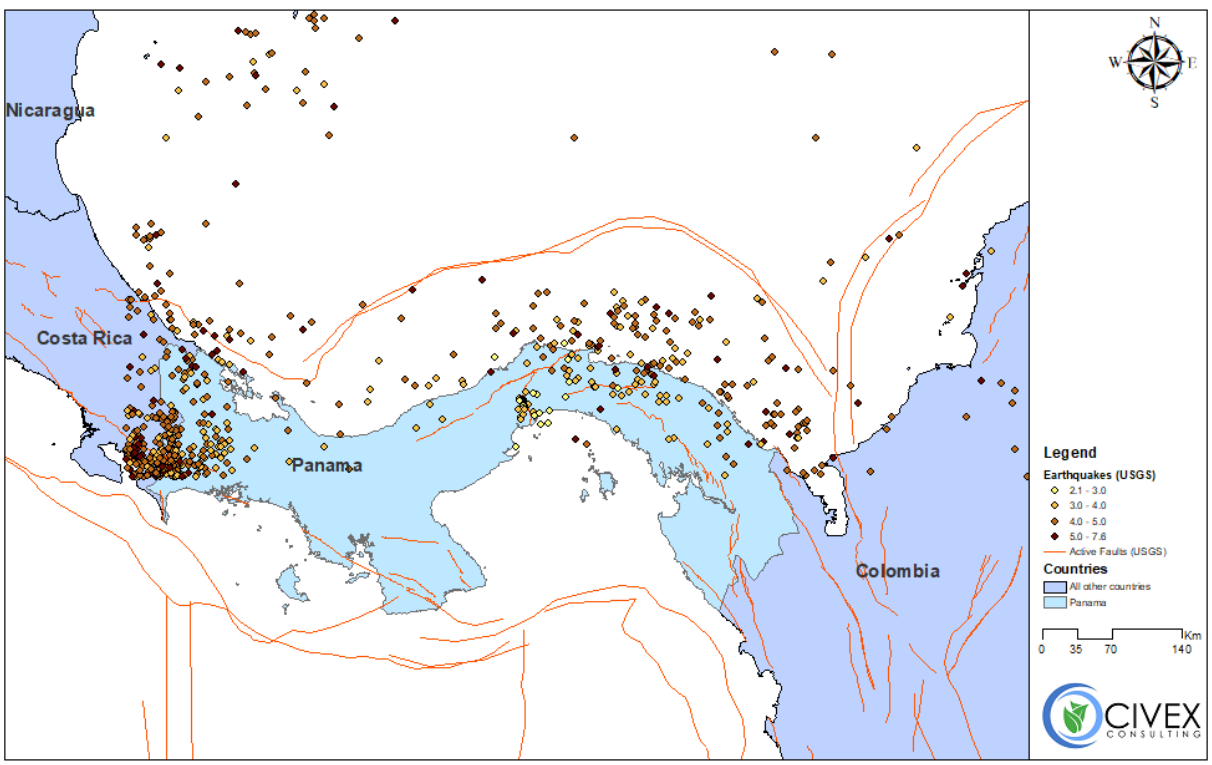



*Figure 6-81:Historical earthquakes in the vicinity of Panama (1914-2023) extracted from USGS database*

There are three key assumptions that are generally made in modelling Tsunami waves. These are long waves (shallow water waves) because their lengths are generally significantly larger than the water depth in which they are generated and propagated; there is an instantaneous vertical deformation of the seafloor; and displacement of the seafloor in the horizontal plane are negligible, meaning they do not influence the wave amplitude (Tanioka 1996b). The elastic crust half plane model proposed by Okada (1985), following a review of the available tsunami generation methods, is now the model of choice of most modelers as it is simple and gives reasonably good estimations in a variety of fault conditions (Luger 2010). This model is widely used by numerous authors in research and design work to simulate initial water surface displacement due to crustal displacement at faults caused by submarine earthquakes (Payande 2015). It is an analytical model that calculates the strains and displacement at the free surface if the fault geometry (depth, length, dip, width) and orientation (strike) are known (Okada 1985) These inputs can be found in some earthquake catalogues including the National Geophysical Data Center (NGDC) for a high percentage of the more recent earthquakes. The relative ease with which the inputs can be determined coupled with its simplicity has made this model the most favoured in the modelling community.

#### 6.5.3.3 Wave Propagation

Following the water surface displacement caused by seafloor disturbance, gravity acts as a restoring force to reduce the surface displacement to zero; (Lin 2008). This creates a series of waves that radiate or propagate away from the disturbance. The wave type is classified by the ratio of the water depth to the wavelength as shallow, intermediate or deep-water waves. Tsunami waves have long periods (5min to 60min) and or wavelengths relative to the ocean depths are classified as shallow water waves; (Reeve 2004). The magnitudes of the water depth to wavelength ratio for determining the wave type are summarized in Table 6-49 below.

*Table 6-38: Wave classification based on wave period, wave length and wave depth*

| relative depth $H/\lambda$ | wave type | wave celerity | wavelength ( $\lambda$ ) |
|---|---|---|---|
| $H/\lambda < 0.05$ | shallow water wave | $\sqrt{gH}$ | $\sqrt{gH}T$ |
| $0.05 < H/\lambda < 0.5$ | intermediate depth wave | $\sqrt{\frac{g\lambda}{2\pi}\tanh\left(2\pi\frac{H}{\lambda}\right)}$ | $\frac{gT^2}{2\pi}\tanh\left(2\pi\frac{H}{\lambda}\right)$ |
| $H/\lambda > 0.5$ | deep water wave | $\sqrt{\frac{g\lambda}{2\pi}}$ | $\frac{gT^2}{2\pi}$ |

This process is generally simulated by only one of three general classes of models; they include 3D Navier-Stokes models, Bossiness H2D Models and H2D Shallow water Equations (Horrillo 2014).

## 6.5.3.4 METHOD

### 6.5.3.4.1 Tsunami Simulation/Modelling

Tsunami modelling for this project was limited to wave generation and propagation as indicated in the scope and no run-up calculations or estimations were considered. The Okada formulation for estimating the displacement of the seafloor is included in the Mike 21 suite of programs. It is therefore easy to move from the generation of the water surface elevation to wave propagation analysis stage. The literature review indicated the SWE wave models preferred for tsunami modelling because the flow is assumed to be uniform across the depth of the water, as well as the effect of dispersion is neglected. These features make the SWE's simpler to implement and use. The SWE model is used in the flexible mesh version of hydrodynamic model used in Mike 21.

#### 6.5.3.4.2 Modelling Setup and Scenarios

##### 6.5.3.4.2.1 Model Setup

The first step in setting up the models was to construct the finite element mesh for the project area. The element sizing criteria had elements inside harbour, at the entrance to the harbour and deeper waters south of the harbour having maximum element areas of 10,000, 50,000 and 100,000,000 square metres respectively. The elements used were all the triangular type. The selected boundary on the seaward side was set to an open boundary. A digital bathymetric model was created by inserting the bathymetric and shoreline points and calculating the elevations between points using the linear interpolation method in MIKE 21. The resulting mesh is shown in Figure 6-68.

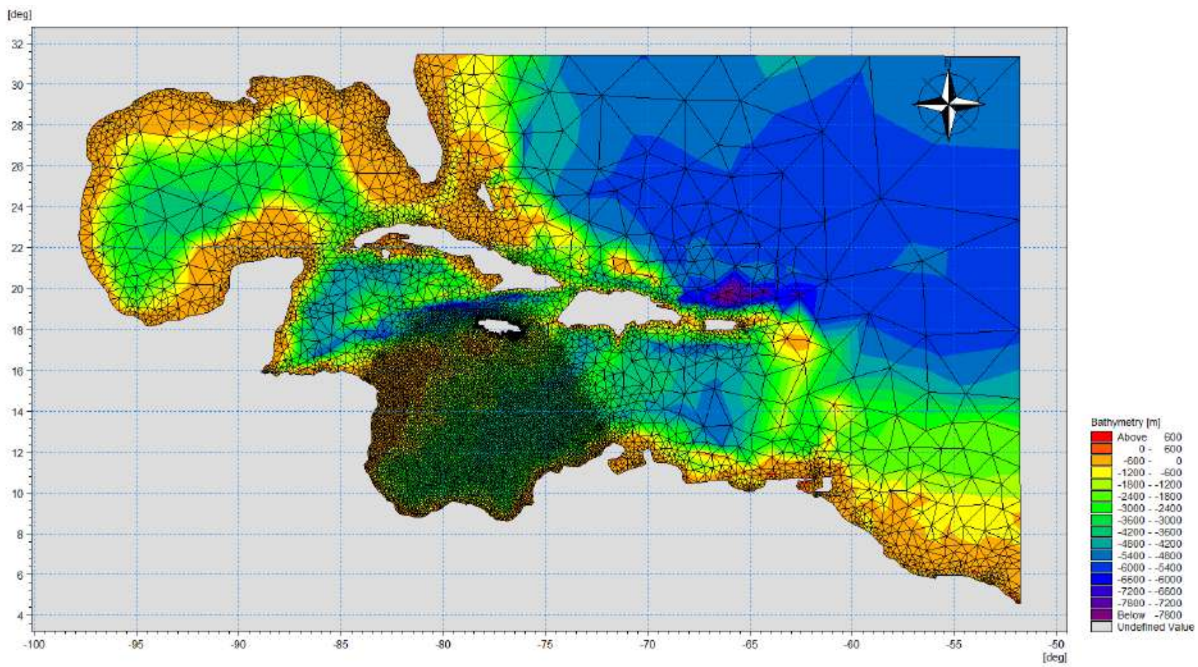



*Figure 6-82: Bathymetric model of the Caribbean*

##### 6.5.3.4.2.2 Boundary Conditions and Manning Coefficient

The manning coefficient was selected for the bed resistance and was set to varying across the domain. The seaward boundaries had manning values 0.5(s/m) 1/3 and set water levels of zero to allow for the easy dissipation of the waves. All other locations across the domain had manning coefficient of 22(s/m) 1/3. It was important to use much lower values at the boundaries to avoid a piling up of water on the boundaries. This is because the model is unable to move the water away quickly from the boundaries to avoid it affecting other areas of the model.

#### 6.5.3.4.2.3 Earthquake Parameters

A total of seven scenarios were modelled, each based on 6.5, 7.0, 7.5 8.0 and 8.5Mw earthquakes. The largest earthquakes measured within 150km north of the northern Panama shoreline and south of the identified fault/plate Panama/Caribbean plate margin is approximately 7.6Mw. Tsunamis are not likely to be generated for earthquake magnitudes less than 6.5Mw. Four scenarios were investigated for a single location that has the greatest likelihood for generating a tsunami.

*Table 6-39: Earthquake parameters*

| Parameter | Values | | | | |
|---|---|---|---|---|---|
| | Scenario 1 | Scenario 2 | Scenario 3 | Scenario 4 | Scenario 5 |
| Dip Angle (°) | 72 | 72 | 72 | 72 | 72 |
| Slip Angle (°) | -32 | -32 | -32 | -32 | -32 |
| Strike Angle (°) | 96 | 96 | 96 | 96 | 96 |
| Depth (km) | 10 | 10 | 10 | 10 | 10 |
| Latitude (°) | 8.960 | 8.960 | 8.960 | 8.960 | 8.960 |
| Longitude (°) | -79.53 | -79.53 | -79.53 | -79.53 | -79.53 |
| Mw | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 |

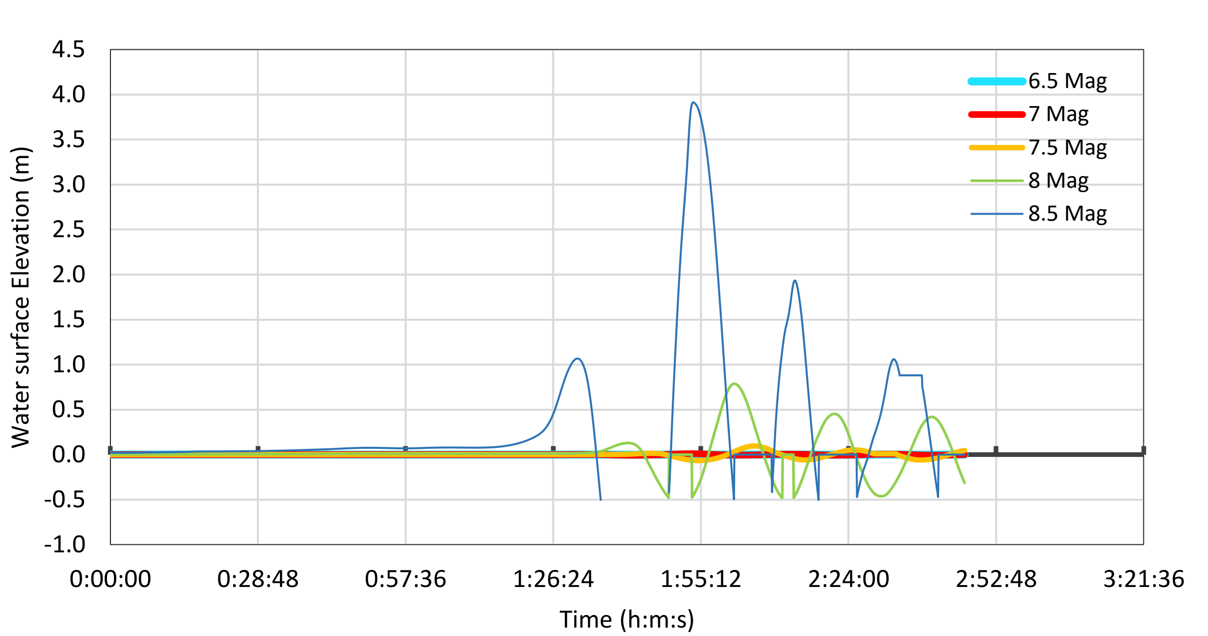
### 6.5.3.5 RESULTS AND DISCUSSION

The results of the simulation indicate a tsunami could be generated by the faults north of Panama and can impact the project site. The estimated time of impact is approximately one hour and thirty minutes after the earthquake event. Tsunamis generated by earthquakes having magnitudes less than 7.5 to 8.0Mw are likely to have negligible increase in eater levels at the project site. The USGS online inventory having over 100 years of measured earthquake data at the Panama-Caribbean plate margin has no earthquake exceeding 7.6Mw. The joint probability of higher magnitude event occurring with shallow focus is extremely low.

The site topography is also above the highest predicted tsunami elevation. It can be concluded that the site has low susceptibility to tsunamis generated from the north of Panama.

*Table 6-40: Earthquake magnitude against wate elevation:*

| Earthquake Magnitude (Mw) | 6.5 | 7.0 | 7.5 | 8.0 | 8.5 |
|---|---|---|---|---|---|
| Maximum Water Surface Elevation (m) | 0.001 | 0.010 | 0.096 | 0.787 | 3.914 |



# 7. ANALYSIS OF POTENTIAL ENVIRONMENTAL IMPACTS

## 7.1 IMPACT IDENTIFICATION AND ANALYSIS AND MITIGATION STRATEGIES

The natural features of the landscape as discussed in the previous chapters, lends to the possibility of environmental impacts from the development, particularly from the pre-construction and construction phases. The proximity of the proposed development site to the nearby community, also suggests that the human facet of the environment (people and their livelihood) is also likely to be impacted. The anticipated impacts to all facets of the environment are presented below, as well as practical measures for mitigation for the anticipated negative impacts.

This section identifies the potential impacts that have been considered for the pre-construction, construction, operational and decommissioning phases. Physical, Biological/Ecological and Social attributes have been considered in the analysis. The impacts identified include direct and indirect impacts, as well as cumulative impacts. The recommended mitigation strategies are designed to be practical and realistic, based on the peculiarities of the site to house the proposed development.

In order to assess potential impacts, sensitive receptors have been identified to inform the analysis. Various receptors, outlined below, were taken into consideration. It should be noted that the potential impacts identified in this section are not exhaustive but includes those that are most likely. Potential receptors include:

- Ecosystems; floral and faunal biota
- Protected, rare and endemic species of flora and fauna
- Water resources ( springs, streams and gullies (including Rozelle Falls
- The marine environment down-gradient of the development site
- People (workers, residents, visitors)
- Local businesses
- Drainage system
- Sewage system
- Communities
- Footpaths and roads
- Heritage site (Rozelle Falls)
- School, churches and other public buildings

### 7.1.1 PRE-CONSTRUCTION AND CONSTRUCTION PHASE

This section outlines the potential impacts associated with pre-construction and construction activities. Activities include site clearance, excavation, levelling of the proposed site, internal road construction and the laying of utility lines (power, water, wastewater, and telecommunications), construction of houses, and erection of supporting project components such as a site office, and a perimeter fence.

#### 7.1.1.1 PHYSICAL IMPACTS

##### 7.1.1.1.1 Hydrology and Drainage

During the construction phase, various activities can cause significant environmental and infrastructural impacts if not properly mitigated. Disruption of surface water and changes in hydrologic regime is possible with the pre-construction and construction activities of this proposed development. This can stem from improper storage of construction material or refuse, along with the removal of existing natural drains without appropriate alternatives. It has the potential to increase runoff which may cause flooding onsite or downstream. Other potential impacts as a result are as follows:

###### 7.1.1.1.1.1 Flooding

Construction activities often increase impervious areas and disrupt natural drainage patterns, leading to enhanced stormwater runoff. Without adequate management, this can result in:

- Downstream flooding of the banks of Chocolate Gully due to increased volumes of runoff.
- On-site ponding and flooding, which can delay construction and create unsafe working conditions.
- Prolonged road closures or disruptions caused by water pooling on access routes.

###### 7.1.1.1.1.2 Blocking of the Rozelle Falls source

Parts of the site intersect with overland flow paths that naturally feed Rozelle Falls. Construction in these areas can obstruct the flow of water, temporarily reducing the water reaching the Falls, which is vital for maintaining its natural ecosystem and aesthetic value.

###### 7.1.1.1.1.3 Siltation of the Caribbean Sea

Disturbed soil can be transported as sediment into nearby water bodies, including the Caribbean Sea. This results in water quality degradation, impacts on marine ecosystems, and the deposition of silt in aquatic habitats, which can alter their natural balance.

**Mitigation**

###### 7.1.1.1.1.4 Flooding

- Design a temporary onsite stormwater system prior to the start of construction
- Regrade section of development site and design stormwater system to NWA standards
- Phase construction to manage stormwater flows
- Employ ecohydrological solutions such as sustainable drainage systems (SuDS) alternatives for major drainage infrastructure. These can include water quality/vegetative swales and detention ponds where appropriate.

*Figure 7-1: An example of a SuD. Source: https://www.bgs.ac.uk.*

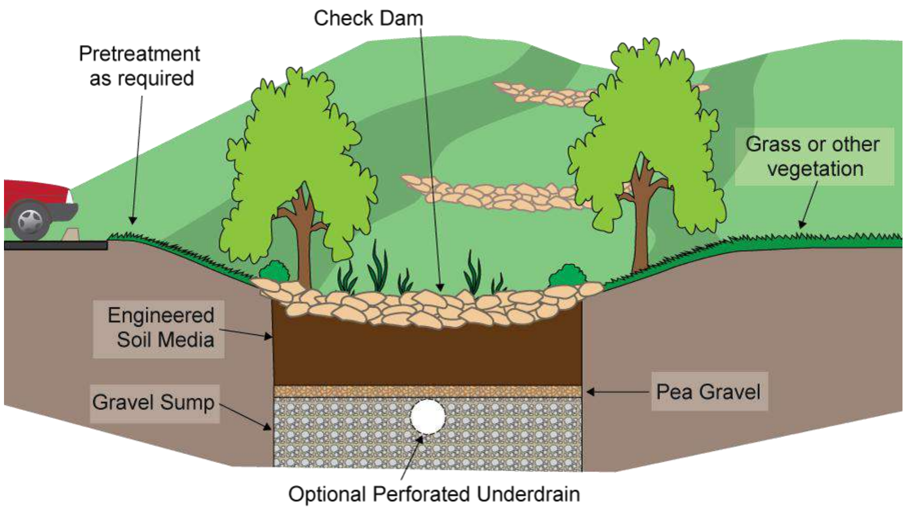



*Figure 7-2: An example of a designed grass swale with underdrain. Source: https://www.fairfaxcounty.gov*

*Figure 7-3: A vegetated swale used for a roadside runoff application. Source: www.stormwater.com*

### 7.1.1.1.1.5 Blocking of the Rozelle Falls source

Install alternate underground storage, staging this section first in construction during the dry season.

###### 7.1.1.1.1.6 Siltation of the Caribbean Sea

- Use Sediment ponds
- Emergency Silt screens to deploy at discharge points
- Phase construction to manage stormwater flows.

##### 7.1.1.1.2 Soil Stability and Quality

- Clearing and grading of the site exposes bare soil to rainfall and wind, causing topsoil erosion. This process destabilizes slopes, increases sedimentation in water bodies, and may reduce soil fertility, affecting re-vegetation efforts post-construction.
- Improper disposal of construction waste, oils, or chemicals can contaminate soil, degrading the quality, especially downgradient of the construction yard where equipment, fuel, chemicals are to be housed.

**Mitigation**

- Clear land and construct in stages
- Build silt fences
- Temporary sedimentation forebays
- Include check dams in construction site drains

##### 7.1.1.1.3 Water Quality

###### 7.1.1.1.3.1 Freshwater

If the planned pre-construction and construction activities are not managed properly, these activities can result in increased sediment run-off to the nearby water systems and other drainage channels that empty along the coastline. Land clearance and improper storage of fine earth material near to drains and or stream are activities that can potentially negatively impact the quality of the water in the river, channels and along the coastline.

###### 7.1.1.1.3.2 Marine

Improperly treated or disposed of sewage and improperly stored and used chemicals can also potentially contaminate adjacent marine environment. Clearing and grading the site can lead to build-up of silt in the nearby marine water columns.

**Mitigation**

- To reduce soil exposure during construction, pave or plant vegetation on exposed grounds as soon as possible and where possible, areas outside building and access footprint should be left vegetated. Stockpiles of materials should have a berm and should be covered.

- Natural drainage should not be blocked without suitably engineered alternatives and excavated material should be stored away from drains, gullies, swales or the path of natural drainage.
- Use sediment traps/turbidity barriers where necessary to avoid sedimentation of the nearby marine waters. Sufficient sanitary conveniences are available for workers and contractors.
- Implement waste management protocols and designate containment areas for hazardous materials.
- Install and maintain oil water separators and grease traps around fuel storage and containment areas, refueling facilities and parking areas.

#### 7.1.1.1.4 Air Quality

Construction activities have the potential to introduce temporary increases in particulate emissions in and around the construction site.

The following construction activities can contribute to air quality deterioration due to increased particulate matter:

- Clearing and excavation of the land
- Transportation, storage, and handling of construction material (e.g., fine earth material)
- Improper storage and transportation of cleared/excavated earth materials on site
- Increased traffic and construction vehicles in the area
- Improperly maintained vehicles
- Fugitive dust from unpaved roadways
- Use of diesel generators

The impact to air quality is expected to be predominant during the pre-construction and construction phases of the development.

**Mitigation**

- Develop and implement an Environmental Management and Monitoring Plan which should address air quality, to include Vehicle Maintenance Plan.
- Develop and implement an onsite Waste Management Plan to reduce the likelihood of workers resorting to burning to get rid of unwanted material. Ensure the site is monitored periodically to ensure compliance with the practices highlighted in this Plan.

#### 7.1.1.1.5 Noise pollution

Construction activities, including heavy equipment operations, machinery use, and increased vehicular traffic, generate elevated noise levels within the sphere of influence. This can disturb nearby residents and workers, reducing the quality of life and potentially leading to health issues like stress and hearing loss.

It is anticipated that the highest noise levels will be experienced during the pre-construction and construction phases.

**Mitigation**

- Conduct noise generating activities during regular working hours to minimize noise nuisance at night-time.
- Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area.
- All heavy-duty equipment and noise generating machinery should be equipped with mufflers to minimize noise emission levels and not be allowed to idle unnecessarily.
- The contractor should ensure that all heavy machinery being used on site are properly used and maintained to the manufacturer's specifications and possess current fitness certificates from the relevant authorities.
- Prioritize equipment with a low noise rating. If not possible, use noise dampeners. This equipment should be placed in areas downwind of sensitive receptors.

#### 7.1.1.1.6 Solid Waste

- During construction, non-hazardous solid waste may be generated from activities such as site clearance (debris), packaging for construction materials (pallets, cardboard, plastics etc.) and generally generated by workers on site. To a lesser degree, construction activities may also generate hazardous waste e.g., concrete additives, paint, and varnish containing organic solvents. The proper disposal of these materials according to regulation and best practices must be adhered to.
- Given nearby communities depend on Rozelle Falls and the Community Pipe for water and recreation, as well as the marine environment below, special care must be taken to ensure the surface water features on the property and the marine environment are not adversely impacted.

**Mitigation**

- Develop and implement an Environmental Management and Monitoring Plan, to include Solid Waste. Periodic monitoring should be instituted to ensure that the Plan is being adhered to

- Solid waste generation and handling will be monitored during the site preparation and construction phases. This will involve all aspects of management, including collection, handling, transportation, and disposal of all types of solid waste. Different containers will be provided for temporary storage of sorted waste materials to facilitate recycling where possible. A trip ticket system will be implemented to track the offsite transportation of waste materials to the nearest approved dumpsite.

Monitoring of solid waste will take the below form:

###### 7.1.1.1.6.7 Waste Inventory and Disposal

- Inspections will be carried out routinely to ensure adequate waste receptacles are provided for solid waste collection onsite.
- Inspections of solid waste generated from site clearance and construction activities to be loaded onto trucks to ensure appropriate sorting and handling of the different waste types occurs to encourage recycling. Assessment of the records of the quantity of solid waste generated and records of actual waste disposed of will also be done.
- All receptacles and bins will be checked to ensure they are secure and covered where appropriate, including food waste bins.

###### 7.1.1.1.6.8 Burning onsite

No burning will be allowed on the site. All waste will be contained and moved to an appropriate dumpsite.

#### 7.1.1.2 HUMAN IMPACTS

This residential development of Rozelle Estate has the potential to create a variety of impacts in all project phases. These potential impacts can be either positive or negative depending on the receptors involved and other parameters such as magnitude and duration of impacts.

##### 7.1.1.2.1 Culture and Heritage

The natural landscape provides some cultural benefits to the residents living within the White Horses community as well as passers-by. Continued access to the Falls is an expressed concern.

The Developers have expressed appreciation for the preservation and protection of the Falls, as well as all Taino artefacts and historic pieces identified by the JNHT.

##### 7.1.1.2.2 Socioeconomic

It is anticipated that this project will potentially have a significant positive impact on areas such as the economy and employment.

This development will potentially result in the direct and indirect employment of workers to support the pre-construction and construction phases of the project. Direct employment is projected at approximately 300 tradesmen and labourers during the pre-construction and construction phase. This employment is a positive, to last the timeline of the development, until constriction is completed, and the units are handed over.

Indirect employment will also likely result in the support of other businesses such as taxi's that will transport workers to and from the site and the trucking services that may be employed, to name a few.

##### 7.1.1.2.3 Workers Health and Safety

Accidents, falls, and potential loss of life can occur from operating machinery. It is important that investments are made with respect to the necessary personal protective equipment, and the training of their correct usage, and ongoing monitoring of said usage, and appropriate management plans be implemented to prevent these potential issues.

##### 7.1.1.2.4 Community Health and Safety

*The risks for accidents, falls, bruises*, and potential loss of life can extend beyond the workers to the wider community if the construction site is not properly managed with restricted access and appropriate signage and lighting. These mitigation measures are necessary investments to prevent potential hazards which can be irreversible in the case of loss of life.

#### 7.1.1.2.5 Small-scale Commercial Business

The increased population from construction workers will have a multiplier effect on the immediate vicinity as local proprietors are likely to be engaged to supply refreshments, lunches etc. to workers on site. This is a potential positive impact on the community as the workers contribute to the thriving of small-scale businesses in the immediate project area. In addition to the establishment of new shops and small-scale businesses, existing businesses such as local hardware stores, grocers and bars will also likely receive an increased benefit from purchases to support the pre-construction and construction phases of the project.

**Mitigation**

##### 7.1.1.2.5.1 Culture and Heritage

Protect and preserve Rozelle Falls. The design for the development leaves a significant vegetative buffer for the protection of the stream sourcing the Falls and the associated riparian vegetation.

Where Taino artefacts and historical pieces are concerned, the Developers should allow the JNHT to conduct their standard 'watch' to ensure that these are carefully relocated or avoided during site clearance and construction activities.

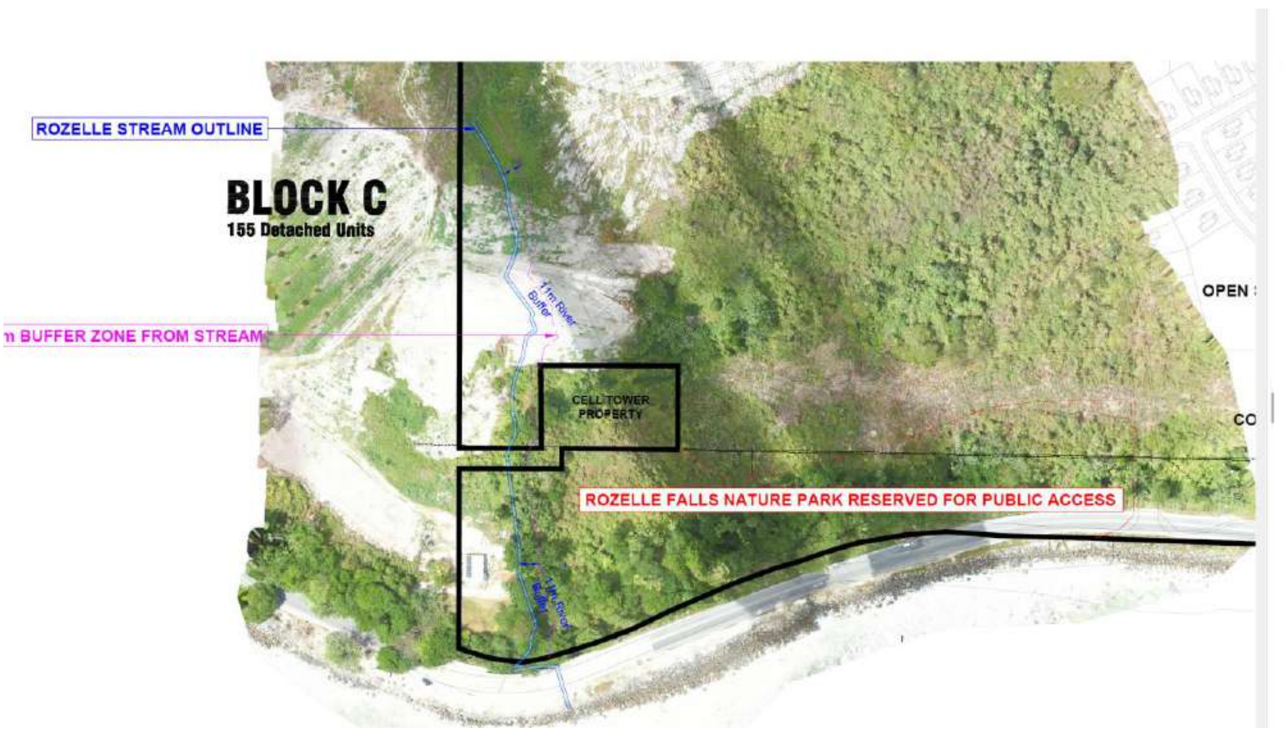



*Figure 7-4: A close up of an aerial image over the southwestern limit of the property, where the Falls occurs. Note a 11m buffer is to be retained along the stream outlined for protection of the stream and its riparian vegetation.*

###### 7.1.1.2.5.2 Socioeconomic

No mitigation required since the impacts are positive.

###### 7.1.1.2.5.3 Workers Health and Safety

- Ensure security protocols are established and implemented and adhered to on site.
- Establish an onsite emergency medical response team.
- Provide and enforce wearing of appropriate PPE gear.
- Have frequent sensitisation on sessions with employees (especially with new batches of workers) on safety requirements and practices.
- Conduct audits of work site to ensure compliance is adhered to.
- Incidents should be logged so that they can be reviewed, and safety measures can be updated accordingly.
- Ensure that proper signage is placed in areas where proper PPE is

###### 7.1.1.2.5.4 Community Health and Safety

Ensure proper security measure are in place to control access to the site.

### 7.1.1.3 BIOLOGICAL/ECOLOGICAL IMPACTS

The ecological environment on site is anticipated to be disturbed from land clearing and other activities during the pre-construction and construction period.

At the ecosystem level, the stream, riparian areas and secondary forest stand to be impacted by the different activities during land clearance and construction.

Potential impacts from the development on species biodiversity include fauna displacement, noise affecting birds, loss of some flora. The development poses an indirect risk to the Blue Swallowtail Butterfly population in the area. The pre-construction activities will see the clearing of lands occupying the footprint of the development. This will likely result in the removal of the plant that the larval stage feeds on.

Two (2) endemic plant species were recorded across the study area during the flora assessment; the Broadleaf (*Terminalia latifolia*) and God Bush (*Oryctanthus occidentalis*) and one (1) *T. latifolia* is listed as Near Threatened (NT) by the International Union for Conservation of Nature (IUCN). The Black Lancewood tree, although not of special conservation needs, will be required in favourable quantities to sustain Blue Swallowtail Butterfly.

Eight (8) endemic birds were recorded within the project area. Special care will have to be given to ensure nesting sites aren't disturbed and noisy activities where possible are conducted outside of the mating season. The habitats for these species will be disrupted during the construction phase and they may relocate into the surrounding areas.

**Mitigation**

#### 7.1.1.3.1 Blue Swallowtail Butterfly and Black Lancewood Tree

##### 7.1.1.3.1.1 Establish a Swallowtail Butterfly Conservation Initiative

Develop a Swallowtail Conservation Plan to include the following:

The development to proceed with minimal disturbance of the surrounding vegetation. The main management parties of the development such as Environmental Manager and Developers be tasked with the responsibility for educating the workforce attached to the development about the butterfly and their role in protecting it.

1. Mechanism found to ensure protection of surrounding areas where the species occur in the long-term. This should include the establishment of a Butterfly Sanctuary in the upper areas of the property not slated for development.

2. A Community Conservation Approach be adapted in which the butterfly becomes the emblem of the development, and the residents become involved in protecting the

species. This modern approach to conservation has been proven to be effective in Jamaica (Garraway et al 2017).

3. Establishment of a nursery for Black Lancewood seedling at a suitable location outside the development footprint. Planting these plants to produce dense patches suitable for oviposition by the butterflies, (planting of seedlings is a concept already explored by NEPA).

4. A Foundation/Trust Fund may be established to facilitate the conservation of the species. This can be used as seed-funding to attract other funds (both local and international). This will facilitate actions such as:

    i. Monitoring of the species; perhaps annual butterfly counts when there is a flight of adults, in which other interested parties may take part. This will provide educational opportunities for the wider public.

    ii. Develop stakeholder engagement activities providing opportunities for capacity development and community engagement, thereby improve conservation awareness in general.

    iii. The conservation project may be rooted in one or more institution such as University of the West Indies, a college in St Thomas, or an environmental NGO in St Thomas. Forming a partnership of this nature with the UWI should be seamless as there is already an active programme on butterflies in the Department of Life Sciences.

##### 7.1.1.3.1.2 Other flora and Fauna Species

- In instances where Jamaica Boas (*Chilabothrus subflavus*) are observed during the pre-construction (land preparation or construction phases of the project), the matter should be immediately reported to the Project Manager and the NEPA, so the animal can be safely relocated.

- All staff working on the project should be educated about the potential of encountering this species, and that they should not be harmed or killed, as it is a protected animal under Jamaican Law.

- The planting of native trees throughout the housing development once construction is completed is encouraged, where possible, throughout the project area to bolster habitat for fauna.

- Where possible, large trees (< 30cm DBH) that are currently within the project area and can be preserved should be incorporated in the development.

- Efforts should be made to reduce noise pollution during the land clearance and construction phases of the development.

- The clearance of vegetation along the streambanks/gullies and natural gullies should not be allowed; it is recommended that a minimum of 5 m buffer zone from the streambanks. Preserving the riverine vegetation will aid in maintaining the integrity of the streambank, as well as the habitat for fauna dependent on the characteristic vegetation and micro-climate.

#### 7.1.1.4 NATURAL HAZARDS

Hazards such as hurricanes, tropical storms and earthquakes can occur during the pre-construction and construction phase. Natural hazards mentioned can potentially result in loss of assets, injury to persons, disruption to pre-construction and construction stage activities and loss of life if not managed. This can potentially have a major negative impact but can be mitigated through having emergency response procedures on site for contractors to follow and a disaster risk management plan in place.

**Mitigation**

##### 7.1.1.4.1 Storm Surges/Flooding

- Natural drainage areas should not be blocked unless a suitable engineered alternative has been developed and implemented.

- All drains on-site should be maintained. Signage should be placed on site and sensitization should be done to ensure that these areas are kept free of debris.

Monitoring should be done (to ensure that drains are free from debris.

##### 7.1.1.4.2 Earthquakes and Seismic Risk

Ensure design follows the code for earthquake design.

- Develop a Warning System for contacting all on-site personnel when strong weather alerts are issued
- Develop and Emergency Response Plan and sensitize staff

#### 7.1.1.5 CUMULATIVE IMPACTS

Cumulative impacts, as it pertains to air, noise and water associated with the project identified include:

- Traffic congestion along the main Rozelle White Horses thoroughfare is anticipated to be a concern for residents. With the expected growth in the community there may be additional need for road investments. This may result in increased noise nuisance and particulate matter production in the area as more people will have to get to and from the proposed development site.
- With the expected development there will be a significant reduction in the amount of undisturbed secondary forest which will have knock on effects to the fauna, including avifauna in the area.
- The hydrology and drainage will be altered by the permanent changes to the landscape and although the land is situated on an aquiclude, runoff from the site will contain contaminant from human occupation and place downstream water bodies, both fresh and marine, at risk for pollution.

**Mitigation**

The mitigation measures above should adequately address the cumulative impacts if each recommendation is executed.

## 7.1.2 POST CONSTRUCTION PHASE

As the site transitions to its operational phase, changes in landuse and the introduction of impervious surfaces may create lasting environmental impacts. Below are the detailed descriptions of potential impacts.

### 7.1.2.1 PHYSICAL IMPACTS

#### 7.1.2.1.1 Hydrology and Drainage

##### 7.1.2.1.1.1 Flooding

Increased impervious surfaces reduce the site's natural infiltration capacity, leading to higher runoff volumes. This can result in localized ponding on-site, especially in areas with inadequate drainage infrastructure.

##### 7.1.2.1.1.2 Drying of Rozelle Falls

Alterations to the natural drainage system during development can disrupt the overland flow paths that supply water to Rozelle Falls. Reduced water flow to the Falls could impact its ecological and cultural significance, as well as its aesthetic appeal.

##### 7.1.2.1.1.3 Water Quality Degradation

Runoff from developed areas can carry pollutants, such as oils, grease, and fertilizers, into nearby water bodies. This contamination poses risks to aquatic ecosystems, affecting water clarity, oxygen levels, and the health of marine and freshwater species.

##### 7.1.2.1.1.4 Groundwater Recharge Reduction

The introduction of impervious surfaces, such as roads and buildings, reduces the amount of water that infiltrates into the ground. This can lower groundwater levels over time, affecting the availability of freshwater resources and the overall hydrological balance.

### 7.1.2.2 BIOLOGICAL

#### 7.1.2.2.1 Biodiversity Loss

Habitat fragmentation from construction activities and changes to water flow can lead to significant losses in local flora and fauna. Species that rely on uninterrupted habitats may face challenges in survival and migration, further disrupting the local ecosystem.

### Mitigation

#### 7.1.2.2.1.1 Flood and Drainage Management

- Ensure during construction to design temporary stormwater management system for runoff mitigation as well as grade construction zone as needed to direct water to the designated drainage areas.
- For post-construction ensure drainage systems are enhanced to divert runoff to the detention ponds and Caribbean Sea to reduce flooding downstream.
- Regrade areas prone to ponding and install bio-retention areas, vegetative swales, and sediment traps.

#### 7.1.2.2.1.2 Drying of Rozelle Falls

Design underground storage to maintain Falls

#### 7.1.2.2.1.3 Water Quality Degradation

Use bio-retention areas, vegetative swales, and sediment traps to filter runoff before discharge.

#### 7.1.2.2.1.4 Groundwater Recharge Reduction

Incorporate permeable pavements and infiltration basins in the development.

#### 7.1.2.2.1.5 Biodiversity Preservation

Restore habitats through replanting and preserving natural wildlife corridors.

Monitor water flow patterns to mitigate habitat disruption.

## General Mitigation

*Enhancement of Detention Pond Designs*

- Increase capacity of DP-3 in catchment 2 to sufficiently manage calculated inflow volumes in that area.
- Regularly assess and maintain all detention ponds to ensure optimal functionality during more extreme storm events.

*Improvement of Drainage Systems*

- Implement minor systems to divert runoff away from the edges of Catchment 1 (west-point) and Catchment 3 (east-point) and simultaneously contain and direct the runoff already onsite via the proposed drainage system to their respective outlets.
- Install additional drainage structures along vulnerable areas, especially along the main road near to Duhaney Pen
- Realign gully (Chocolate gully) which occupies the eastern portion of the site so that the flow path is not directly impacting the site.
- Consider incorporating additional subsurface storage areas in conjunction with subsurface gravel drainage systems, a cut-off drain, and a detention pond to effectively manage runoff in the natural areas (open spaces) along the north-western site boundary, directing it towards Rozelle Falls.

*Erosion and Sediment Control*

- Implement erosion control measures such as vegetative buffers, silt fences, and sediment traps along the more sloped terrains of the site and near the drainage outlets.
- Regularly monitor sediment deposition in gullies and implement maintenance schedules to prevent reduced capacity.

*Long-term Monitoring and Adaptation*

- Establish a comprehensive Hydrological Monitoring Program to track hydrological changes, assess the effectiveness of implemented measures, and make necessary adjustments overtime.
- Collaborate with relevant agencies to update criteria and mitigation strategies based on evolving climate and landuse conditions.

*Rozelle Falls Protection/Maintenance*

- Incorporate underground systems to maintain flow paths and prevent drying of the Falls.
- Ensure pollutant isolation to safeguard the quality of the water to the Falls.

### *Investigation of Ponding Source*

Consider conducting a detailed investigation to locate sources of the ponding area in catchment 2.

The identified impacts and recommended mitigation measures are summarized in the table below.

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| **Physical** | Hydrology & Drainage | Blocking of the Rozelle Falls source | Install alternative underground storage, staging this section first in construction during the dry season |
| | | Increased runoff causes flooding lower regions and the roadway | ▪ Design a temporary onsite stormwater system prior to the start of construction<br>▪ Regrade sections of development site and design stormwater system to NWA standards<br>▪ Phase construction to manage stormwater flows<br>▪ Conduct phased removal of vegetation, during each phase of the development<br>▪ Ensure areas of bare soil are re-vegetated as soon as is practical<br>▪ Select sustainable drainage system (SuDS) alternatives for major drainage infrastructure. Examples include water quality/vegetation swales and detention ponds where appropriate.<br>▪ Use grasscrete/grassblock, interlocking blocks or other permeable paving to facilitate percolation and biological |
| | Soil | Destabilized slopes resulting in soil erosion and reduced soil fertility, affecting re-vegetation efforts post-construction | ▪ Clear land of vegetation in stages<br>▪ Build silt fences<br>▪ Install temporary sedimentation forebays |
| | | Chemical spills cause soil contamination in the vicinity of the construction yard | ▪ Store chemicals in appropriate container<br>▪ Install bund around chemical storage housing |
| | Freshwater Quality | Siltation and increased turbidity of freshwater sources | ▪ Develop Environmental Management and Monitoring Plan, to include management of solid waste, and conduct periodic audits should ensure adherence.<br>▪ Install temporary sedimentation forebays<br>▪ Use sediment traps/turbidity barriers where necessary to avoid sedimentation of the nearby marine waters |

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | Marine Water Quality | | ▪ Cover or hoard all stockpiles of soil and other aggregate material with appropriate material not in use to prevent escape to waterways and exposure to rain<br>▪ Seal the footing of such hoarding to avoid seepage of surface run-off, or;<br>▪ Create entrenchment around mounds of materials to ensure stability of materials<br>▪ Establish and maintain vegetative cover along bare soils and steep erodible slopes<br>▪ Construct catchpits along drains running parallel to slopes to intercept surface run-off flowing out of the construction site.<br>▪ The detention ponds should capture the bulk of any runoff loads not previously intercepted up-gradient via the means described above |
| | Air Quality | Increased particulate emissions in and around the construction site | ▪ Develop and implement an Environmental Management and Monitoring Plan which should address air quality, to include regular vehicular servicing and maintenance<br>▪ Develop and implement an onsite Waste Management Plan to reduce the likelihood of workers resorting to burning to get rid of unwanted material. Ensure the site is monitored periodically to ensure compliance with the practices highlighted in this Plan. |
| | Noise | Elevated noise levels within the sphere of influence affecting residents, schools and churches, as well as construction workers | ▪ Conduct noise generating activities during regular working hours to minimize noise nuisance at night-time.<br>▪ Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area.<br>▪ All heavy-duty equipment and noise generating machinery should be equipped with mufflers to minimize noise emission levels and not be allowed to idle unnecessarily.<br>▪ All heavy machinery being used on site will be properly used and maintained to the manufacturer's specifications and possess current fitness certificates from the relevant authorities. |

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | | | ▪ Prioritize equipment with a low noise rating. If not possible, use noise dampeners. This equipment should be placed in areas downwind of sensitive receptors. |
| ***Human*** | Culture and Heritage | The general White Horses community don't have access to Rozelle Falls | Design dual entrance to the Falls so that both residents of the development and the general public have access to the Falls |
| | | The Falls is destroyed during site clearance and construction activities | ▪ Preserve riparian vegetation along the stream sourcing the Falls and fence the area to prevent equipment or workers from entering the area during construction phase in the vicinity.<br>▪ Erect appropriate signage in conspicuous areas |
| | | Taino sites and artefacts were uncovered during the JNHT's investigation which can be lost during site preparation activities. | Inform JNHT of the different phases and stages of the project and accommodate archaeological watching briefs. |
| | Socio-economic | Improved local economy from increase in employment and businesses | |
| | Worker and Community Health and Safety | Accidents, falls, and potential loss of life from operating machinery | ▪ Establish protocols for the necessary personal protective equipment, and the training of their correct usage, and ongoing monitoring of said usage<br>▪ Appoint Health and Safety personnel on the site |
| | | Increased Vehicular Traffic cause delays at intersection of site access road and the main road (based on increased traffic loading and increase in heavy machinery) leading to increased congestion in the area | ▪ Implement traffic management protocols to prevent congestions<br>▪ Laise with the local traffic authorities to assist with traffic management |

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| **Biological** | Habitat | Loss of habitat for species of flora and fauna, including endemics, as lands are cleared and topsoil removed prior to construction | ▪ Tag endemic trees that are in close proximity to areas that will be cleared to ensure they are preserved.<br>▪ The planting of native trees throughout the property as a part of landscaping when the development is completed, is encouraged where possible. This will bolster the habitat for fauna. |
| | Ecosystem | Edge Effect: Edges of fragmented land becomes exposed to a new microclimate which may cause stress to flora and fauna that are not adapted to the new conditions<br>Stream integrity is compromised from garbage, sedimentation and removal of riparian vegetation | ▪ Maintain a buffer zone of at least 10m from streams and gullies; no development should be allowed in this buffer area<br>▪ Where possible, some of the larger trees within the property should be retained. This will help to maintain some of the habitat for fauna within the areas.<br>▪ Distributing solid waste receptacles at designated areas across the site, erect warning and information signs in conspicuous locations informing employees of garbage receptacle placements and warning of penalties for not complying with instruction |
| | Species | Blue Swallowtail Butterfly and Black Lancewood Tree | Develop a Swallowtail and Black Lancewood Conservation Plan, to include the following:<br>▪ Establishment of a Butterfly Sanctuary in a section of the land North of the project site boundary (Zone B)<br>▪ Establishment of a nursery for Black Lancewood seedling at a suitable location outside the development footprint, for transplanting later to the conservation site<br>▪ Prior to commencement of work, remove all individuals where feasible and relocate to predetermined conservation zone<br>▪ Monitoring of the species in the form of annual butterfly counts when there is a flight of adults |

| PRE-CONSTRUCTION PHASE -SITE CLEARANCE AND PREPARATION | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | | Other Species | ▪ Preserve large trees (≥ 30cm DBH) on the development property that are outside the development footprint and plant native trees throughout the housing development once construction is completed. |

| CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| **Physical** | Hydrology & Drainage | Blocking of the Rozelle Falls source | Same as per pre-construction |
| | | Flooding | ▪ Regrade sections of development site and design sustainable stormwater system to NWA standards<br>▪ Phase construction to manage stormwater flows<br>▪ Select sustainable drainage system (SuDS) alternatives for major drainage infrastructure, such as water quality/vegetation swales and detention ponds where appropriate.<br>▪ Design and construct rain gardens for common areas such as the nature park and recreational spaces<br>▪ Use permeable options such as grasscrete/grassblock or interlocking blocks for individual yard access<br>▪ Consider conducting a detailed investigation to locate sources for ponding area in catchment 2. |
| | Soil | Destabilized slopes resulting in soil erosion and reduced soil fertility, affecting re-vegetation efforts post-construction | Same as per pre-construction |
| | | Contaminated soil in the vicinity of the construction yard | Same as per pre-construction |

| CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | Freshwater Quality | Siltation and increased turbidity of freshwater and marine waters | Same as per pre-construction |
| | | Increase in nutrients and bacterial content causing eutrophication and contamination | ▪ Provide proper lavatory access to workers<br>▪ Develop Environmental Management and Monitoring Plan, to include monthly audits with water quality monitoring being a part of the monitoring regime<br>▪ Materials to be used during construction phase should not be stored near or riverbanks, or in the path of natural drainage<br>▪ Audit for compliance to Waste Management Plan (solid and chemical waste) |
| | Marine Water Quality | | Same as per pre-construction |
| | Air Quality | Fugitive dust emissions are generated in and around the construction site | ▪ Develop and implement an Environmental Management and Monitoring Plan which addresses air quality, to include regular vehicular servicing and maintenance<br>▪ Develop and implement an onsite Waste Management Plan to reduce the likelihood of workers resorting to burning to get rid of unwanted material. Ensure the site is monitored periodically to ensure compliance with the practices highlighted in this Plan.<br>▪ Wet areas where applicable to reduce the generation of fugitive dust.<br>▪ Cover fine earth material with appropriately sized covers during transportation. |
| | | Vehicle Emissions cause poor air quality | |
| | | Burning of Solid Waste causes increased airborne particulates, affecting site personnel and the larger district | |
| | Noise | Elevated noise levels within the sphere of influence affecting residents, schools and churches, as well as construction workers | ▪ Conduct noise generating activities during regular working hours to minimize noise nuisance at night-time.<br>▪ Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area. |

| CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | | | ▪ All heavy-duty equipment and noise generating machinery should be equipped with mufflers to minimize noise emission levels and not be allowed to idle unnecessarily.<br>▪ The contractor should ensure that all heavy machinery being used on site are properly used and maintained to the manufacturer's specifications and possess current fitness certificates from the relevant authorities.<br>▪ Prioritize equipment with a low noise rating. If not possible, use noise dampeners. This equipment should be placed in areas downwind of sensitive receptors. |
| ***Human*** | Culture and Heritage | The general White Horses community don't have access to Rozelle Falls | Design dual entrance to the Falls so that both residents of the development and the general public have access to the Falls |
| | | The Falls is destroyed during site clearance and construction activities | Preserve riparian vegetation along the stream sourcing the Falls and fence the area to prevent equipment or workers from entering the area during construction phase in the vicinity. |
| | | Taino sites and artefacts were uncovered during the JNHT's investigation which can be lost during site preparation activities. | Inform JNHT of different phases of the project and accommodate archaeological watching briefs. |
| | Socio-economic | Improved local economy from increase in employment and businesses | |
| | Worker and Community Health and Safety | Accidents, falls, and potential loss of life from operating machinery | ▪ Establish protocol for the necessary personal protective equipment, and the training of their correct usage, and ongoing monitoring of said usage<br>▪ Appoint Health and Safety personnel on the site |
| | | Prolonged exposure to noise levels above recommended limits without the appropriate PPE resulting in adverse health impacts. | ▪ Position stationary noise sources in downwind position and away from sensitive noise receptors and other sources of noise in the area.<br>▪ Erect noise barriers as needed.<br>▪ Implement soft-start procedures where possible when using |

| CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| | | | construction equipment.<br>▪ Staff should be equipped and trained in the use of required personal protective equipment (PPE).<br>▪ Phase clearance activities. |
| | Ecosystem | Edge Effect: Edges of fragmented land becomes exposed to a new microclimate which may cause stress to flora and fauna that are not adapted to the new conditions | ▪ Maintain a vegetative buffer zone of at least 10m from streams and gullies; no development will be allowed within this buffer zone.<br>▪ Where possible, some of the larger trees within the property should be retained. This will help to maintain some habitat for fauna within the areas |
| | Species | Blue Swallowtail Butterfly and Black Lancewood Tree | ▪ Monitoring of the species in the form of annual butterfly counts when there is a flight of adults<br>▪ Establish nursery for Black Lancewood Tree and transplant when appropriate, to the established conservation area. |
| | | Other Species | ▪ Preserve large trees (≥30cm DBH) on the development property that are outside the development footprint<br>▪ Plant native trees throughout the housing development once construction is completed. |
| **Natural Hazards** | | Storm Surges/Flooding | ▪ Develop a Warning System for alerting all on-site personnel when strong weather alerts are issued<br>▪ Develop and Emergency Response Plan and sensitize staff |
| | | Earthquakes and Seismic Risk | ▪ Ensure building design adheres to the code for earthquake safety<br>▪ Develop an Emergency Response Plan and conduct regular drills<br>▪ Conduct post event inspections to ensure worker safety and structural integrity |
| | | Hurricanes | ▪ Develop an Emergency Response Plan<br>▪ Install a warning /public address system for alerting employees when strong weather alerts are issued<br>▪ Conduct site inspection after storm to ensure worker and structural safety |

| POST - CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| **Physical** | Hydrology & Drainage | No Rozelle Falls- The stream dries up | Design underground storage to maintain flow to the Falls |
| | | Flooding | ▪ Enhance drainage systems to divert runoff to the detention ponds and Caribbean Sea to reduce flooding downstream.<br>▪ Install additional drainage structures along vulnerable areas, especially along the main road near to Duhaney Pen<br>▪ Realign the Chocolate gully's eastern stem so that the flow path is not directly impacting the site.<br>▪ Implement minor systems to divert runoff away from the edges of Catchment 1 (west-point) and Catchment 3 (east-point) and simultaneously contain and direct the runoff already onsite via the proposed drainage system to their respective outlets.<br>▪ Re-vegetate areas of bare soil are as soon as is practical |
| | | Hydrological regime altered | ▪ Implement long term (3-year) Hydrological Monitoring Programme to monitor hydrological changes, assess the effectiveness of implemented measures, and make necessary adjustments overtime.<br>▪ Collaborate with relevant agencies to update criteria and mitigation strategies based on evolving climate and landuse conditions. |
| | | Groundwater recharge is reduced | ▪ Incorporate permeable pavements and infiltration basins in the development<br>▪ Encourage rain gardening to homeowners<br>▪ Consider incorporating additional subsurface storage areas in conjunction with subsurface gravel drainage systems, such as cut-off drains, additional detention pond to effectively manage runoff in the green areas (open spaces) along the north-western site boundary, directing flow towards Rozelle Falls. |

| POST - CONSTRUCTION PHASE | | | |
|---|---|---|---|
| **CATEGORY** | | **POTENTIAL IMPACT** | **RECOMMENDED MITIGATION MEASURES** |
| ***Human*** | Culture and Heritage | The Rozelle Falls quality becomes degraded over time | Implement Long Term Protection /Maintenance<br>▪ Monitoring flow and stream water quality over the medium to long term to ensure there is no negative impact from the development<br>▪ Implement monitoring program in dialogue with the relevant authorities (WRA, EHU) to ensure sustainability of monitoring programme |
| **Biological** | Habitat | Reduced Biodiversity from construction activities | ▪ Restore habitats through replanting native species throughout the development during landscaping activities<br>▪ Preserve natural wildlife corridors. |
| | Ecosystem | Edge Effect: Edges of fragmented land becomes exposed to a new microclimate which may cause stress to flora and fauna that are not adapted to the new conditions | ▪ Maintain a buffer zone of at least 10m from streams and gullies; no development should be allowed in this buffer area to aid in preserving this natural feature. |
| | Species | Blue Swallowtail Butterfly and Black Lancewood Tree | Develop a Blue Swallowtail Butterfly Conservation Plan, to include the following:<br>▪ Monitoring of the species; perhaps annual butterfly counts when there is a flight of adults, in which other interested parties may<br>▪ Monitor Black Lancewood plant to ensure acclimatization in new environment<br>▪ The nature park reserve being proposed provides a space where species of interest, including the Black Lancewood plant, can be planted between secondary forest patches and degraded areas. |

# 8. PROJECT ALTERNATIVES

The total acreage of the property is 417 acres. The acreage being considered for development, after factoring the various considerations such as slopes, forest density, access, etc., is 187 acres. The options available to the Developer include construction of single, multi family, or townhouse arrangements. Town homes would provide the best use of the land and a higher return on investment (ROI), than all the other options. The construction of apartments is not an attractive option because the availability of large tracts of land makes this infeasible considering the character of the existing landscape. Such high-density developments are not an attractive option to homeowners in areas where detached homes are prevalent.

The provision of low-income housing while not providing the best ROI, is a decision that satisfies the multiple considerations. It provides a means of guaranteed wholesale delivery of the units and the demand of the income groups in that geography. Therefore, the development provides predominantly detached multifamily homes.

This section presents the alternative project ideas that were identified and analyzed as alternatives for the housing development project discussed. Identification of alternative projects provides the Authority (NEPA) with alternative projects to weigh the main proposal against in terms of environmental benefits; considering all facets of the environment (built, natural and social).

The following are the project alternatives that were contemplated:

## 8.1 ALTERNATIVE 1-THE "NO ACTION" ALTERNATIVE

This alternative sees the project site staying as is; mostly in ruinate, with sections of it being used for orchard farming, bee keeping and animal grazing.

The ***advantages*** of this alternative include:

### Physical

- The Rozelle Falls remain as is
- No potential environmental (soil and water) degradation from siltation, chemicals, solid waste, etc.
- No nuisance from construction related activities
- No potential degradation of the water resources and the marine environment

### Social

The Rozelle Falls feature would remain as is, eliminating the community's concerns that they could potentially lose access to it.

### Biological

- The secondary forest patches and riparian areas are maintained;

- Faunal species will not be disrupted and will not relocate to other sections of the parent property

The ***disadvantages*** of the No-Action Alternative include:

### Physical

The streams within and around the property remain unstudied and their reliable yield and seasonal water quality remains undetermined over time.

### Social

- Any risk the quality of the streams, including Rozelle Falls, poses to residents and patrons remain unknown and therefore unactioned.

- The opportunity to improve community awareness and capacity building concerning the Black Lancewood plant and the Blue Swallowtail Butterfly is lost

- No additional economic benefits to the community and economy

- No increased employment and creation of indirect and induced job opportunities
- No increased housing options for people in the region

### Biological

- There is no intervention in preserving the Black Lancewood plant in the area and its numbers are reduced further with each land-clearance activity that takes place on the property.
- The population and survival of the Blue Swallowtail Butterfly is left to chance as its larval food source becomes depleted over time due to anthropogenic practices on and around the project boundary
- The land degradation continues as the property remains unoccupied and is too large to patrol. Therefore, along with the reduction of the species listed above, there is loss of fertile topsoil and water quality is reduced due to soil erosion

## 8.2 ALTERNATIVE 2-THE HOUSING DEVELOPMENT AS PROPOSED HEREIN

New Rozelle Properties Limited development proposal comprises a housing development to include eight hundred ninety-five (895) residential units and associated commercial and institutional lots, open (green and recreational) spaces, social services and utilities.

The Master Plan includes 895 residential housing units on approximately 187 acres of land. The portion of the parent property to be used for the development is 187 acres, less than half of the parent property (46%).

The ***advantages*** of having the development as proposed include:

### Physical

*Water resources management:* The streams concerning the development are currently not being monitored by the government. The streams' reliable yield and seasonal water quality remains unknown. The project brings awareness to the authorities and its environmental monitoring programme incorporates water quality monitoring, providing useful water resources data, particularly for the WRA.

### Social

- Rozelle Falls is an emblem for the community and its value is promoted through community sensitization, including under a conservation initiative and signs posted demarcating its vegetative buffer, providing a sense of reassurance and importance to the community.
- Additional economic benefits to the community and economy
- Increased employment and creation of indirect job opportunities
- The survey outcome shows that the community would like to see a technical vocational /skills training centre in the community. The development as designed makes reservations for this purpose.

### Biological

- There is a conservation initiative for the Black Lancewood plant, where a nursery is established, and long-term monitoring of the species survival is done

- The Blue Swallowtail Butterfly becomes another emblem of the community and population becomes sustainable, if not increased over time, as its food source improves, and the community at large takes steps to protect it under the same conservation programme.
- Most of the plant species recorded in the survey can be classified as ornamentals, agricultural crops or plants associated with anthropogenic disturbances. The project provides an opportunity to make deliberate attempts at enhancing the number of any species of interest via deliberate planting.
- The nature park reserve being proposed provides a space to plant species of interest between secondary forest patches

The ***disadvantages*** of this option include:

### Physical

- Potential environmental (soil, air and water) negative impact from siltation, chemicals, solid waste, fugitive dust, etc.
- Nuisances from construction related activities including noise and vibration
- Potential degradation of the marine environment

### Biological

- The number of Black Lancewood plants on the portion of property for development will decrease, which could potentially affect the Swallowtail Butterfly numbers over the long term.
- The riverine environment supporting the Falls will be at risk from the development and workers on the development site.

## 8.3 ALTERNATIVE 3- A HOUSING DEVELOPMENT PROJECT WHERE THE UNITS ARE APARTMENTS

NRPL develops the property for residential purposes, but designs apartment complexes only. This would occupy approximately 1/3 of the property being proposed for development, but with a denser design.

The ***advantages*** of having an apartment complex development type include:

**Social**

- Additional economic benefits to the community and economy
- Increased employment and creation of direct and indirect job opportunities
- The survey outcome shows that the community would like to see a technical vocational training/ skills training centre in the community. The development could be designed to accommodate this at a section of the property

**Biological**

- Perhaps not a conservation initiative required, but more so establishment of a nursery and some sensitization of the community to avoid damaging the nursery.
- The Blue Swallowtail Butterfly population is less threatened as more of the vegetation is retained

The ***disadvantages*** of this option include:

**Physical**

- Potential environmental (soil, air and water) negative impact from siltation, chemicals, solid waste, etc.
- Nuisances from construction related activities including noise and vibration
- Potential degradation of the marine environment

**Social**

- An opportunity to increase the number of low-income housing solutions for people in the region lost

- The high density-type development would not fit with the local character of the area, which could be unappealing for those persons

### Biological

- There is no intervention for preserving the Black Lancewood plant in the area and its numbers are reduced further with each land-clearance activity that takes place in the upper regions of the remainder of the property.
- There is greater risk to ecosystems as the development would be intensified in the flatter areas, which are closer to the marine environment, hence the residence time of runoff would be lessened and infiltration rates decreased, increasing the likelihood of siltation and eutrophication in the marine environment.

## 8.4 ALTERNATIVE 4- A TOURISM DEVELOPMENT -COTTAGES, USING THE FULL AREAL EXTENT OF THE PARENT PROPERTY

NRPL develops the property for the tourism market, constructing cottages, dispersed over the full breath and length of the parent property, for aesthetic appeal.

The ***advantages*** of having a cottage development:

**Social**

- Rozelle Falls is an emblem for the facility and a selling point for the development of regionally and internationally as a tourism destination.
- Additional economic benefits to the community and economy
- Increased employment and creation of direct and indirect job opportunities

**Biological**

- Awareness of the Blue Swallowtail Butterfly is increased.

The ***disadvantages*** of this option include:

**Physical**

- Potential environmental (soil, air and water) negative impact from siltation, chemicals, solid waste, during construction and phase.
- Nuisances from construction related activities including noise and vibration

**Social**

- Employment opportunities reduced
- An opportunity to increase the number of low-income housing solutions for people in the area is lost.
- The development is a commercial one, catering primarily to tourists
- Access to the development is restricted. The survey outcome shows that the residents would like to see a technical vocational training/ skills training centre in the community. This development would not allow access for the wider community.

### Biological

- There is no intervention for preserving the Black Lancewood plant in the area.
- The Blue Swallowtail Butterfly is left to chance in terms of its sustainability

# 9. CONCLUSIONS

The development proposed will contribute to the national goal for providing affordable housing solutions. The design incorporates nature-based solutions for protection of soil and water quality and includes protection of valuable ecosystems.

The major environmental considerations concerning the development include impacts to Rozelle Falls, the sustainability of the Blue Swallowtail Butterfly, and increased runoff causing flooding and impaired water quality, both in freshwater sources and the marine environment.

## CONCERNS

### *Rozelle Falls*

There are two primary concerns concerning the Falls; one is that the development will prevent the general community of White Horses and Rozelle residents in particular from enjoying the Falls. The second is that the development will result in the destruction of the Falls, either by removing its source (stream) or destroying the riparian vegetation along its stream, causing impaired water quality.

The Falls will be maintained as an emblem associated with the development. The Developers have postulated the Falls being a selling point for the project and have had dialogue with the Ministry of Tourism about promoting and preserving it. The Falls will be retained in its current state and a vegetative buffer maintained to protect streambank integrity and water quality.

The stream source for Rozelle Falls will be protected via a riparian forest buffer, which will see a vegetative buffer of at least 10m wide along the length of the stream being preserved and protected from impact, both during construction related activities and post construction. The riparian forest buffer will be cemented via a covenant for the development's splinter titles.

### *Blue Swallowtail Butterfly*

The issue concerning the Blue Swallowtail Butterfly is the long-term sustainability of the food source for its larval stage, the Black Lancewood plant. Herein proposed is a conservation area/zone on a section of the upper half of the parent property, where a nursery will be located under an initiative to increase the density of the plants for the butterfly. Secondly, a Butterfly sanctuary is proposed, under the auspices of a joint management programme between the UWI-Mona and the community.

*Increased Runoff and Flooding*

To prevent runoff from the site being a potential source of impact to freshwater sources and the marine environment, the development design has incorporated nature-based designs, particularly for grey water and drainage management. Sustainable drainage systems (SuDS) will be implemented in the form of detention ponds, vegetated swales, and filter trenches to infiltrate runoff. There will be entrenchment around the areas used for storage and stockpiling of material, and on-site waste management

Where individual onsite drainage is concerned, grasscrete, interlocking blocks, or other permeable paving will be employed, to facilitate percolation and biological purification of runoff; thereby reducing overland flow and sedimentation.

*OPPORTUNITIES*

*Community Support*

The community survey has expressed is ready for transformative development. Despite historical infrastructure deficits and continued economic fragility, there is strong optimism that the Rozelle Estates development will usher in a new era of opportunity. However, for this potential to be realized equitably and sustainably, the project must remain sensitive to environmental concerns, incorporate mechanisms for community feedback, and include tangible commitments to local hiring, skills development, and water resource preservation.

*Species Conservation Opportunity*

The project provides an otherwise far-fetched opportunity to protect a national endangered and IUCN-listed vulnerable species; the Jamaican Kite/Blue Swallowtail Butterfly (*Protographium marcellinus*). Where under normal circumstances the species would be at risk of its food source being completely eradicated due to land clearing for agriculture proposes, the study has lead to a detailed investigation geotagging its distribution and the extent of habitation in the area. Resulting from this information, the Developer, in partnership with the local stakeholders and other partners, can take deliberate steps to conserve the species by enhancing its habitat situation in the locality. Had this not been done the local community could unknowingly clear the land of the plants serving as the Butterfly's larval food source, eliminating the chances for survival of an endemic species.

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# 11. APPENDICES

## 11.1 APPENDIX 1-EIA TERMS OF REFERENCE



**TERMS OF REFERENCE
FOR AN
ENVIRONMENTAL IMPACT ASSSESSMENT**

EQM

*REF: STT24EIA04: APRIL2024*

**For
Subdivision and Housing Development
At Rozelle, St. Thomas**

By New Rozelle Properties Limited
Prepared by Ecosystems Quality Management Consulting (EQM)

*Assessment and Quality Management of Water, Wetlands and Watersheds*

## Table of Contents

## Foreword

Herein provided is a draft term of reference (TOR) for the Environmental Impact Assessment to be prepared for the New Rozelle Housing Development, to be located in Rozelle in the parish of Saint Thomas. An EIA seeks to provide a description of the components of the project and the project site and a discussion of the potential impacts of the proposed project, as well as the impact of the environment on the proposed development. It also outlines mitigation measures necessary to reduce the negative impacts of the project.

The EIA will be prepared using scientific methods and a participatory approach involving key stakeholders. Should the TOR herein be accepted by the National Environment and Planning Agency, NEPA, the EIA will be executed as outline herein.

The draft TOR is as follows:

## 1. Executive Summary

The executive summary will provide a comprehensive overview of the proposed development, the objectives for the proposed project, a description of the physical setting of the site, including natural resources, justification for the project etc. In addition, it will provide the major findings of the EIA, including main impacts and the recommended mitigation measures and alternatives, analyses and conclusions.

## 2. Introduction

The introduction will provide a background and seek to explain the need for and the context of the project and the REA. It will also provide a delineation and justification of the boundary of the study area, general methodology, assumptions and constraints of the study. A scope of work will also be provided here.

## 3. Policy, Legal and Administrative Framework

The relevant legislation and standards governing environmental quality, the protection and management of sensitive ecosystems, endangered species, culture and heritage, public health and safety and landuse planning and control will be discussed.

## 4. Methodology and Approach

This section will discuss the methodologies and approaches for conducting the study including collection and analysis of data, stakeholder perception and consultation, dates upon which in-situ data was collected, calibration methodology, etc.

## 5. Project Description

This will provide a description of the proposed subdivision and housing project and will present the following:

- Project background
- A location map at a scale of 1:12,500 (or an appropriate scale)
- The total area of the site
- A site layout plan showing the various components and design elements of the proposed development.
- An outline and discussion of the different elements of the development, inclusive of a breakdown of the total number and type of houses, total area to be utilized, the proposed phases, amenities to serve the proposed development such as parks, and green areas, etc.
- Details of infrastructure development such as design plans for all components of the development, including the proposed wastewater treatment and disposal system, will be clearly outlined.
- Plans for providing utilities such as potable water and electricity supply, roads and other services, will be presented in detail.
- Details of equipment and machinery to be involved, how these will be mobilized and areas to be used for storage of machinery and material will be indicated.
- Details of workforce, including proposals for mobilization and accommodation will be indicated.

- A project implementation schedule of the different phases of the project will be clearly defined, the relevant time schedules provided and phased diagrams and appropriate visual aids included in the EIA report.
- Details of proposed access(es) to the site to be used for pre-construction, construction and operational phases will be discussed.

### 5.1 Wastewater Treatment Plant WWTP)

The developers propose to construct an onsite wastewater treatment system to serve the development. A detailed description of the Wastewater Treatment Plant (WWTP) will be provided, including (but not limited to):

- Treatment system and design criteria
- Maintenance and Operation Plan
- Septage and Sludge Management Plan
- Projected daily flows (average and peak)
- Effluent discharge details (including projected water quality)
- Treatment processes
- WWTP components

### 5.2 Solid Waste Management

A Waste Management Plan, which clearly outlines expected types and quantities of wastes during the site clearance and construction phases, general waste arising from material consumption of the workforce, as well as the expected waste during the operational phase. Details will also be provided for any central disposal area(s) being considered to serve the proposed development.

## 6. Site Description

A description of the site will be provided showing its location in relation to other residential areas and generally in the locality. The study area will be demarcated and referenced, using 1, 2 and 5km radii where appropriate to show the types of resources located in the area and the magnitude of the associated impacts. A map of the area showing the different landforms, topography, and ecosystems will be provided in addition to a narrative description of the specific development site. The below elements will be discussed to provide visualization of its characteristics.

- Land cover /landuse mapping
- Ecosystem mapping

## 7. Description of the Environment

Potential Impacts and solutions recommended will be developed with the background context of the pertinent Jamaica government policies and laws related natural resource management, conservation and fresh and coastal water quality guidelines.

### 7.1 Physical Environment

The study will provide a detailed description of the physical environment making up the site. This will include a description of the following elements:

- Land use/Land Cover
- Climate
- Relief/Topography
- Soils
- Ambient Air
- Ambient Noise
- Services and amenities
- Geology & Hydrogeology

#### 7.1.1 Hydrogeology/ Hydrology and Water Resources

All existing natural drainage channels will be mapped and presented. Also proposed is a description of the hydrogeology of the site within 2 and 5km radii, including the natural drainage patterns, description of the hydrogeological unit (aquiclude), groundwater and proposed man-made drainage/flow paths.

A drainage analysis will be conducted. The objective of this analysis is to identify the hydrological risks associated with the development, such as flood risks, and present design options for hydraulic solutions. This study will consider the entire drainage basin or watershed in which the development is to be located. This study will identify options for the management of water traversing and located within and in close proximity to the property, including the source of the Rozelle Falls. A stormwater design and management plan to manage discharge of excessive volumes of stormwater into the receiving marine environment, will be formulated with the goal of reducing potential impacts on the receiving Caribbean Sea.

##### *7.1.1.1 Flood analysis*

Statistical analysis will be performed to determine the 10-, 20-, 50- and 100-year return periods.

##### *7.1.2.1 Aquatic Features*

All freshwater aquatic features identified on the proposed site will be discussed. These potentially include ponds, streams, gullies identified on the property. The marine environment within proximity of the development will also be described.

##### *7.1.3.1 Water Access and Water Quality*

Access to potable water and water quality on the site will be discussed. The below parameters are proposed for analysis:

| | | | |
|---|---|---|---|
| Freshwater sites | pH | Marine sites | pH |
| | Phosphates | | nitrates |
| | Chloride | | phosphates |
| | Nitrate | | TSS, |
| | BOD | | Residual Chlorine |
| | Conductivity | | BOD |
| | Total Coliform | | Faecal Coliform |
| | TDS | | Total Coliform |

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### 7.2 Human Environment

#### 7.2.1 Heritage

An assessment of artifacts, archaeological, and cultural features of the site will be done in collaboration with the Jamaica National Heritage Trust (JNHT).

#### 7.2.2 Socioeconomic Environment

This section of the report will discuss the demography, current and potential landuse patterns, existing infrastructure and utility and social amenities within a 5km radius of the site.

### 7.3 Biological Environment

#### 7.3.1 Ecosystems

All ecosystem types identified on the property will be described in detail. The ecosystems identified will be described in terms of type, community structure, species dominance, species dependence, habitats/niche specificity and diversity. Possible biological loss or habitat fragmentation will also be addressed.

#### 7.3.2 Flora and Fauna Assessment

A detailed qualitative and quantitative assessment terrestrial habitats in and around the proposed project site will be done. This will include flora and fauna surveys, description of vegetation types and habitats, inclusive of a list of identified species, commentary on ecological health, sensitive and endemic species, function and value in the project area, threats, and conservation issues.

A species list will be generated, which will highlight rare, endemic, threatened, protected, endangered, and invasive species. Those that are known economically/nationally important species will also be highlighted. Migratory species will also be considered.

Specific data that will be presented include:

- Vegetation profile
- Species lists for each community
- A habitat map of the area

### 7.4 Traffic Impact Assessment

A traffic impact study will be presented, which examine the potential impact of the traffic during the construction and post construction stages, on the existing and future main road traffic.

### 7.5 Hazards Assessment

There are two types of potential hazards that will be discussed:

- those hazards that the project may be subjected to, primarily natural hazards; and
- hazards that the project may pose to the surrounding environment

7.6 Existing Pollution and Nuisances

All nuisance and existing pollution sources will be identified and discussed. The community survey will also unearth any historical pollution and nuisance that prior affected the communities in proximity to the development site.

## 8. Analysis of Potential Environmental and Socio-economic Impacts

Here the likely impacts of the project on the different facets of the environment, methods adopted for assessing the impacts, such as empirical methods and model studies, will be discussed. Relevant best environmental practises, conservation practices, and planned environmental monitoring and management, including post approval environmental monitoring, will be discussed. Any existing temporary, seasonal or lasting impacts within the study radius that may affect the project at any of the different phases of the development will also be presented.

A review of internationally published literature and a team of experts will be relied upon to develop a list of anticipated environmental concerns associated with the proposed development, and will include potential impacts on the physical, biological and human environment. A system impact rating will be presented outlining:

- Impact Intensity (degree of change),
- Impact Extent (potentially affected area), and
- Impact Duration (length of time that impact will be experienced).

8.1 Terrestrial Environment

Anticipated impacts on the surrounding environment will be discussed. Areas such as:

- Land use, on infrastructure including drains, road network, social amenities, ecosystems, the marine environment and any other sensitive environment or place.
- Impact on the natural drainage system and potential soil erosion
- The possibility of pollution incidence due to improper handling of wastes and substances such as chemicals during site clearance and construction
- Possible impacts of the wastewater treatment plant on the terrestrial environment

8.2 Aquatic Environment

Here the potential impacts of site clearance, construction and operational phases of the development on surfacewater, groundwater and the marine environment will be discussed. Some anticipated potential impacts are:

8.1.1 Freshwater

- Water pollution from construction activities
- Impact of withdrawal on surface or groundwater resources; including potential impact of the development on the level of flow at the Rozelle Falls
- Impact of wastewater generation
- Water contamination

8.2.2 Marine

- Potential increase in turbidity and smothering of micro-organisms/buoyant species
- Nutrification of the nearshore environment from runoff generation

8.3 Atmospheric Environment/Air

Here the anticipated impacts on air quality, mainly during the site clearance and construction phases of the project will be presented. Existing features and operations in proximity to the study area will be examined to assess how they could potentially impact the development and what impacts the development could exert on them. It is anticipated that there will be:

- Potential sources of dust
- Fugitive dust emissions impact on people, flora and fauna
- Potentially hazardous substances that may become airborne

8.4 Biological Environment

A discussion will be provided on how the project activities will affect biodiversity on the site and within a predetermined radius. The impacts during site clearance and construction phases will be presented. Anticipated potential impacts include:

8.4.1 Pre and post construction vegetation site clearance

- Impact of construction on biodiversity (flora and fauna)
- Aquatic (freshwater and marine) ecosystems biodiversity
- Impact on species of special consideration, for example, rare or endemic species
- Impact on migratory species

8.5 Ambient Noise

Impact of the project relating to construction and operation and noise levels in the area. Anticipated impacts:

- Noise from specific machinery used during site clearance and cutting and compaction of access roads
- Noise due to demolition and construction activities
- Operation of diesel generator
- Impact of noise on biodiversity

8.6 Socio-economic Environment

A description of the predicted impacts of the development on the people of the nearby communities; that is, their livelihood, culture and environment. This will be assessed against the background of landuse, housing and social amenities, such as utilities and transportation. The Rozelle Falls is anticipated to be a key factor of discussion here given the community will have an impact on the Falls, while the development has the potential to impact the Falls and is source.

8.7 Solid Waste

Solid waste from site clearance and construction activities relating to all components of the development such as hoarding, creation of access roads, the sewage treatment facility, etc., will be presented. The different waste streams anticipated include:

- Vegetative waste from site clearance
- Topsoil from cutting of new access roads
- Hazardous waste such as gas oil and cleaning agents
- Demolition waste

Aspects such as sanitary facilities, burning and bunding will be addressed here.

## 9. Recommended Mitigation Measures

For each adverse impact identified, mitigation measures will be discussed detailing the method for execution; for instance, identification and discussion of mitigating measures which may include purchase of special equipment, or conducting physical work such as for noise abatement and reduction, including installation of noise barriers and measures for minimising vibration due to construction activities. Other methods may be administrative such as pouring concrete during favourable weather or timing heavy duty equipment movement during off peak traffic hours.

## 10. Identification and Analysis of Project Alternatives

Alternatives to the proposed development including a no-action alternative will be examined. These will be analysed in relation to the physical, biological and socio-economic considerations related to the site. These alternatives will take into consideration historical activities that have taken place on the site and the associated impact on the environment, as well as the methods proposed for each phase of the development.

## 11. Environmental Monitoring and Management Plan

The Environmental Monitoring Plan will consist of a description of the parameters to be monitored and an outline of the monitoring regime, including monitoring network, frequency and parties responsible for the monitoring.

## 12. Conclusions and Recommendations

## 13. List of References

## 14. Appendices

The appendices will contain (but is not limited) to the below items:

- Terms of Reference
- Study Team
- Results of Community Consultation
- Analytical Certificates
- In-situ data sheets
- Perception Survey Questionnaires
- Photographs/maps

## 11.2 APPENDIX 2- STUDY TEAM

This Environmental Impact Assessment study was done with contributions from other professionals and sub-contracted consulting firms. The study team comprised of:

| | |
|---|---|
| Jamaica National Heritage Trust (JNHT) | Heritage Assessment- Archaeological Impact Assessment |
| Maresol Research Solutions | Socio-Economic Impact Assessment |
| Interplan Planning Consultants | Development Planning and Designs |
| CIVEX Consulting Limited | Drainage and Hazard Analysis, and Traffic Impact Assessment |
| Air Quality Measurement Systems Limited (AQMS) | Air Quality and Noise Assessment |
| Dr. Eric Garraway and team | Ecological Assessment |
| Ecosystems Quality Management Limited (EQM) | Project Lead, Water Resources, Ecosystems Assessment, and GIS |

## 11.3 APPENDIX 3 – SOCIO-ECONOMIC SURVEY INSTRUMENTS

Socio-Economic Survey Instrument

a. ***Socioeconomic Survey Instrument for Rozelle Estates, White Horses, St. Thomas Environmental Impact Assessment***

MARESOL Research Solutions (MARESOL) has been contracted by EQM through New Rozelle Properties Limited (NRPL) to conduct a Socio-Economic Assessment for a Proposed Housing and Subdivision Project in Rozelle, White Horses, St. Thomas. A critical component of this assessment is conducting a survey to determine the socioeconomic environment of the general White Horses community and its surrounding areas. This assessment includes the administration of questionnaires to (i) Assess the community's awareness of the proposed development (ii) Determine both the public positive and negative perceptions of the project regarding the potential impacts as it relates to social, aesthetic, and historical values on the project area and its environs (iii)Determine the demographics and existing infrastructure (i.e., transportation, electricity, water, telecommunications etc.) of White Horses and the surrounding communities. We would really appreciate your participation in answering this survey to help us understand public perception of the proposed development in the area. Your personal information will remain confidential, and you have the authority to withdraw from the survey at any time. This survey will take approximately twenty minutes. Thank you in advance for your time and participation.

**Name of Data Collector:**

**Date/Time:**

**SECTION 1 – DEMOGRAPHICS**

1. Community Name:

☐ White Horses

☐ Rozelle

☐ Other

2. Please specify the name of the community if you selected other. ____________

3. What is your gender?

☐ Male

☐ Female

☐ Prefer not to say

4. What is your age? ____________

5. How many people reside in your household? ____________

6. How many children under the age of 18 live in your home? ____________

7. How many adults over the age of 65 live in your home? ____________

**SECTION 2: PERCEPTIONS (Explain and show Concept Drawing)**

New Rozelle Properties Limited proposes to construct a residential community in Rozelle, St Thomas. The proposal is to build an affordable housing community for middle income earners. This development includes 895 residential units along with supporting services

8. Did you have any prior knowledge about the housing project before today?

☐ Yes

☐ No

9. Do you approve of the project concept?

- ☐ Highly Approve
- ☐ Approve
- ☐ Highly Disapprove
- ☐ Disapprove
- ☐ Neutral

10. How do you think that your community views the project?

- ☐ Highly Approve
- ☐ Approve
- ☐ Neutral
- ☐ Disapprove
- ☐ Highly Disapprove

11. In your opinion do you think that this project is?

- ☐ Very Necessary
- ☐ Necessary

- ☐ Neutral
- ☐ Unnecessary
- ☐ Highly Unnecessary

12. If you do not think that this project is necessary, please select reasons for your response from the following options
    - ☐ I have no problems with the project
    - ☐ Waste of money
    - ☐ Developer has misplaced priorities
    - ☐ Removes green space
    - ☐ Design is not attractive
    - ☐ Other

13. If the option is not provided, please provide another reason________________________________________

14. What do you think would be a better use of the space? Please select ONE (1) option from the listing below
    - ☐ Sports complex
    - ☐ Entertainment complex
    - ☐ Business complex
    - ☐ Green Space
    - ☐ Technical Vocational Centre (Skills Training Centre)
    - ☐ Police Command Centre

- ☐ Fire Station
- ☐ Low Income Housing Solutions
- ☐ Bus Park
- ☐ Military Camp
- ☐ Shopping Mall
- ☐ Modern Health Centre
- ☐ Amusement Park
- ☐ Tourism Attraction
- ☐ Other

15. If you selected other for a better use of space, please specify. ______________________

16. What is the main reason you would want to see this development happen?

- ☐ Associated amenities
- ☐ Housing solutions are scare in area
- ☐ The community needs to be developed
- ☐ It will attract more business
- ☐ I need a home
- ☐ Other

17. If you selected other, what is the main reason you would like to see this development happen? ________________

18. Based on your personal preferences should this project proceed as designed?

- ☐ Yes
- ☐ No

19. If you selected NO, please select from below ONE (1) option which was most concerning

- ☐ Artistic design
- ☐ Land use for the proposed housing development
- ☐ Other

20. If your concern was not listed, please provide an explanation.

**SECTION 3 – ENVIRONMENTAL CONCERNS**

21. Have you experienced flooding in this community?

- ☐ Yes
- ☐ No

22. How often does flooding happen in your community?

- ☐ Yearly
- ☐ Monthly
- ☐ Weekly
- ☐ Every time during heavy rainfall

23. How would you rate the level of flooding in your community?

☐ Very Bad

☐ Bad

☐ Neutral

☐ Not bad

24. Do you see flooding as a serious problem for the development of the area?

☐ Yes

☐ No

25. What are the likely natural hazards to affect the area? (Please select all that apply)

☐ Storm surge

☐ Earthquake

☐ Hurricane

☐ Flash flooding

☐ Drought

26. Are you concerned about how much this development will impact the Rozelle Spring?

☐ Yes

☐ No

27. Do you have any other environmental concerns for the community in relation to this development being implemented?

☐ Yes

☐ No

28. If you selected yes, select from the following the ONE issue for which you have the most concerns arising from this proposed development.

- ☐ It will worsen air quality
- ☐ It will become a noise nuisance
- ☐ It will reduce available water supply
- ☐ Increase traffic congestion
- ☐ It will create more flooding or ponding in the area
- ☐ It will result in soil erosion
- ☐ It will negatively impact the plants and animal life in the area
- ☐ It will destroy the Great House
- ☐ It will negatively change the historical character and memories of the area
- ☐ It will make the area less inclusive for everybody
- ☐ It will impact the public safety of the persons living in the project area and the surrounding environs
- ☐ It could lead to the possible displacement of residents

**SECTION 4 – SOCIO-ECONOMIC**

29. Are you the head of household?

☐ Yes

☐ No

30. Is the head of household currently employed?

☐ Yes

☐ No

31. What is their/your (main) current income generating activity? Please select one option from the list below

☐ Tourism related activities

☐ Bauxite mining

☐ Farming

☐ Commerce or retail activities

☐ Other

32. What is your/the head of the household's highest level of educational achievement?

☐ Primary

☐ Secondary

☐ Vocational

☐ Tertiary

33. How many members of your household currently attend:

| | |
|---|---|
| basic school | |
| primary school | |
| secondary school | |
| tertiary institution | |

34. How many members of your household have no academic qualifications at all?

35. What is your employment status?

- ☐ Employed (Full-time)
- ☐ Employed (Part-time)
- ☐ Unemployed
- ☐ Retired

36. What is your monthly salary range?

- ☐ $100,000 or less
- ☐ $100,001 to $200,000
- ☐ $200,001 to $300,000
- ☐ $300,001 or greater

37. What is your usual mode of transportation

☐ Motor vehicle

☐ Public transportation

☐ Motor bike

☐ Bicycle

☐ Other

38. How long have you lived in the community?

☐ 1 year or less

☐ 2 to 5 years

☐ 6 to 9 years

☐ 10 to 15 years

☐ 16 years or more

39. Do you have a disability?

☐ Yes

☐ No

40. If you have a disability, please state the type of disability you have (Please select all that apply)

☐ Sight

☐ Hearing

☐ Speech

☐ Physical

☐ Slowness of learning

☐ Other please specify__________________

41. Were you born with this disability?

☐ Yes

☐ No

**SECTION 5 – SERVICES**

42. Do you or anyone in your household have a phone?

☐ Yes

☐ No

43. What type of phone is used in your household? (Please select all that apply)

☐ Landline

☐ Cell phone

☐ Smart cell phone (one that can access the internet)

44. Does your community have public internet access?

☐ Yes

☐ No

☐ Don't know

45. Does your household have internet access?

☐ Yes

☐ No

☐ Don't know

46. How does your household access the internet?

☐ Via smart cell phone

☐ Via community WiFi

☐ Via household broadband (modem)

47. What is your household's main source of drinking water?

| | | | |
|---|---|---|---|
| ▯ Indoor piped water | ▯ Outdoor piped water | ▯ Standpipe | ▯ Well or spring |
| ▯ Rainwater (tank) | ▯ Trucked water (NWC) | ▯ Trucked water | (private) |

▯ Bottled ▯ River water (Salt River)

48. How frequently do you experience water lock-offs?

☐ Weekly

☐ Monthly

☐ Every few months

☐ Yearly

☐ Primarily during droughts

☐ Primarily during rainstorms

☐ Have not experienced a water lock-off

49. How is water stored when there is a lock-off?

▯ Tanks (concrete) ▯ Tanks (plastic) ▯ Bottles ▯ Buckets ▯ Other, please specify

▯ Do not store

50. Is the provision of water service adequate?

▯ Yes ▯No ▯ Sometimes ▯ I don't know

51. Historically, have there been other sources of water supply to the community? Please select all that apply.

- ☐ Rural Water Supply
- ☐ Parish council trucking
- ☐ Bauxite companies
- ☐ Other wells/springs

52. Do you utilize the Rozelle Spring for any purpose?

- ☐ Yes
- ☐ No

53. If you answered yes to using Rozelle Spring, for what purposes? Select all that apply.

- ☐ Laundry
- ☐ Recreation
- ☐ Fishing
- ☐ Irrigation
- ☐ Domestic purposes

54. How does your household dispose of garbage (Please select all that apply)?

- ☐ Regular public collection system
- ☐ Irregular public collection system
- ☐ Burn
- ☐ Bury
- ☐ Dump in backyard
- ☐ Community skip
- ☐ Dump elsewhere
- ☐ Other, please specify______________

55. Is the provision of garbage collection service adequate?

☐ Yes ☐No ☐ Sometimes ☐ I don't know

56. What kind of sewage connections are used?

☐ Toilet linked to a central sewer network

☐ Toilet linked to an on-site disposal system

☐ Pit toilet

☐ Septic Tank

☐ Other, please specify_____________________

57. Are the toilet facilities used only by your household, or do other households use the same facilities?

☐Shared ☐ Household use only

58. Is the provision of garbage collection service adequate?

☐Yes ☐No ☐ Sometimes ☐ I don't know

THANK YOU!

Appendix B – Business Survey Instrument

## b. *Business Survey Instrument for Rozelle Estates, White Horses, St. Thomas Environmental Impact Assessment*

MARESOL Research Solutions (MARESOL) has been contracted by EQM through New Rozelle Properties Limited (NRPL) to conduct a Socio-Economic Assessment for a Proposed Housing and Subdivision Project in Rozelle St. Thomas. A critical component of this assessment is conducting a survey of the businesses in the area to determine the socioeconomic environment of Rozelle and its surrounding areas. This questionnaire seeks to assess: (i) the community's awareness of the proposed development (ii) the perceptions of the project (iii) the demographics of the area and (iv) existing infrastructure and services (i.e., transportation, electricity, water, telecommunications etc.) of Rozelle and the surrounding communities. We would really appreciate your participation in answering this survey to help us understand public perception of the proposed development in the area. Your personal information will remain confidential, and you have the authority to withdraw from the survey at any time.

This survey will take approximately five minutes. Thank you in advance for your time and participation.

Enter a date and time

Name of Data Collector

1. Are you a business owner/manager

☐ Yes

☐ No

2. What type of business? ____________________

3. Age ____________________

4. Gender

☐ Male

☐ Female

☐ Prefer not to say

New Rozelle Properties Limited proposes to construct a residential community in Rozelle, St Thomas. The proposal is to build an affordable housing community for middle income earners. This development includes 895 residential units along with supporting services such as commercial units, park facilities, landscape reserve and required infrastructure.

5. Are you aware of the proposed project?

☐ Yes

☐ No

6. Do you approve of this project?

☐ Yes

☐ No

☐ Not sure

7. Based on what you have learnt; what type of impact do you see the project having on your business?

☐ A positive impact

☐ A negative impact

☐ Not sure

8. If you answered positive impact, please indicate the reasoning. ____________

9. Do you think that this project would be approved of by the other business owners in the surrounding area?

☐ Yes

☐ No

☐ Not sure

10. Please indicate your reasoning for your opinion. ____________

11. Do you perceive that local business community views this project as being:

☐ Necessary

☐ Unnecessary

☐ Not sure

12. What alternative use of the area do you think local business operators would prefer for the intended project site if any? (Check ALL that apply)

☐ None

☐ Complex/Attraction

☐ Other

13. If you selected Complex/Attraction what type of complex or attraction would you prefer?

☐ Entertainment complex

☐ Shopping complex

☐ Tourism attraction

☐ Modern Health Clinic

☐ Business complex

☐ Children's play area complex

☐ Green space

☐ Sports complex

☐ Technical Vocational Center

☐ Police station

☐ Modern Market

☐ Bus Park

☐ School

☐ Military camp

☐ Other

# 11.4 APPENDIX 4- PLANT SPECIES LIST

*List of floral species identified along transects in the assessed area using a classification ranking to show prevalence and relative abundance of each plant species encountered.*

| Family | Scientific Name | Common Name | Range | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Fabaceae | Abrus precatorius | Johncrow Bead | Common, in thickets, hedgerows and on fences, mostly in rather dry areas | | | | | O | | | F | |
| Mimosaceae | Acacia macracantha | Park Nut | Common locally, in secondary thickets on arid limestone | F | A | O | R | R | O | | O | A |
| Amaranthaceae | Achyranthes indica | Devil's Horsewhip | Common as a weed of cultivation and disturbed waste places | | | O | | O | | | | |
| Pteridaceae | Adiantum concinnum | | | | | | | | | R | | |
| Pteridaceae | Adiantum pyramidale | | | | | | | | | R | | |
| Apocynaceae | Allamanda cathartica | Yellow Allamanda | Climbing ornamental shrub | O | | O | | | | | | |
| Amaranthaceae | Alternanthera ficoidea | Crab Wiss | Common as a weed of roadsides, rough pastures and waste places, often in low damp localities or in shade | | | | | O | O | | | |
| Fabaceae | *Alysicarpus vaginalis* | Medina | Frequent, in sandy waste places, | | | | | | O | | | |

| Family | Scientific Name | Common Name | Range | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | cultivations and rough pastures | | | | | | | | | |
| Bignoniaceae | *Amphilophium crucigerum* | Monkey Comb | Locally common, on trees near streams and in gullies | | | | R | R | | | O | |
| Poaceae | *Andropogon pertusus* | Andropogan | Abundant in the drier more disturbed areas | | | | | | R | | | |
| Annonaceae | *Annona muricata* | Sour Sop | Commonly cultivated | R | | | R | | | | | |
| Annonaceae | *Annona reticulata* | Custard Apple | Cultivated and escaped into waste places near habitations | | | | | | R | | | |
| Annonaceae | *Annona squamosa* | Sweet Sop | Commonly cultivated, escaping near habitations and along roadsides and pasture margins | | O | | | R | R | | O | |
| Araceae | *Anthurium grandifolium* | Wild Coco | Very common in woodlands and on sheltered banks, sometimes epiphytic | | | | | O | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polygalaceae | *Antigonon leptopus* | Coralita | Common in cultivation and escaping on fences and hedges | R | | | | | | | | |
| Moraceae | *Artocarpus altilis* | Breadfruit | Common in cultivation, but mostly at lower elevations | | | | R | R | | | | |
| Moraceae | *Artocarpus heterophyllus* | Jackfruit | Frequently planted but sometimes found in remote areas | | | | R | | | | | |
| Poaceae | *Arundo donax* | Giant Reed | Locally abundant, gregarious along sheltered or open streambanks and riverbanks | | | | | | | R | | |
| Caesalpiniaceae | *Bauhinia divaricata* | Bull Hoof | Common in thickets and open woodlands on limestone, mostly in rather dry or well-drained areas | | O | | | | | | F | |
| Asteraceae | *Bidens pilosa* | Spanish Needle | A common weed of roadsides and waste places | A | O | F | | | A | O | | D |
| Sapindaceae | *Blighia sapida* | Ackee | Commonly cultivated and naturalized | R | | | R | | | | | R |
| Nyctaginaceae | *Boerhavia coccinea* | Hog Weed | Common, as a weed of rough disturbed pastures, waste places and sand dunes | O | O | | | | | O | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Burseraceae | *Bursera simaruba* | Red Birch | Common in woodland on limestone | R | O | | | F | O | | F | O |
| Annonaceace | *Oxandra lanceolata* | Black lancewood | Occasional in woodlands on limestone, mostly in the central and western parishes | | | | | R | | | R | |
| Commelinaceae | *Callisia repens* | | Locally common on sheltered rocky banks | | | | | O | F | O | | |
| Capparaceae | *Capparis flexuosa* | Bottle-cod Root | Common in thickets, mainly in arid parts of the south coast and on the cays, occasionally inland | | | | | | | | R | |
| Scrophulariaceae | *Capraria biflora* | Goat Weed | Common in disturbed ground, and along roadsides | | R | O | | | F | | O | |
| Vitaceae | *Cissus sicyoides* | Soldier Wiss | Very common, on trees, walls, fences and in thickets | | F | | | A | A | | F | |
| Caricaceae | *Carica papaya* | Papaya | Common in cultivation, hardly naturalized | | | | | | R | | | |
| Caesalpiniaceae | *Cassia emarginata* | Senna Tree | Rather common, mostly in coastal areas on limestone | A | A | F | | | O | | F | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Moraceae | *Cecropia peltata* | Trumpet Tree | Common, especially on recently cleared forested land | | O | F | | | O | F | | |
| Meliaceae | *Cedrela odorata* | West Indian Cedar | Common in places where propbably planted, especially in pastures and along roadsides | | | | R | | | | | |
| Bombacaceae | *Ceiba pentandra* | Silk Cotton Tree | Occasional, perhaps mostly planted | | | R | | | | | | |
| Menispermaceae | *Cissampelos pareira* | Velvet Leaf | Very common in thickets, woodland margins and on fences | F | | | | | R | | | |
| Vitaceae | *Cissus sicyoides* | Soldier Wiss | Very common, on trees, walls, fences and in thickets | | F | | | A | A | | F | |
| Rutaceae | *Citrus aurantifolia* | Lime | Commonly cultivated | | | | R | | | | | |
| Ranunculaceae | *Clematis dioica* | Wild Clematis | Common in thickets and woodland margins in limestone areas | O | | | | | | | | |
| Polygonaceae | *Coccoloba diversifolia* | Pigeon Plum | Occasional in open woodlands on limestone, mainly in the eastern and central parishes | | | | | | | | R | |
| Arecaceae | *Cocos nucifera* | Coconut | Commonly cultivated | R | | | R | | R | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commelinaceae | *Commelina diffusa* | Water Grass | A common weed of cultivations, waste places and pastures | | | | F | | F | | F | |
| Anacardiaceae | *Comocladia pinnatifolia* | Maiden Plum | Common in thickets and woodlands on limestone hills | R | | | | | | | O | |
| Boraginaceae | *Cordia brownei* | Black Sage | Common in thickets and open woodlands and on roadside banks | A | | | | | | | | |
| Boraginaceae | *Cordia collococca* | Clammy Cherry | Common in thickets and along roadsides and pasture margins | | | | R | R | | | | |
| Boraginaceae | *Cordia gerascanthus* | Spanish Elm | Common on limestone hills mostly in rather dry areas | O | F | | | | O | | R | |
| Euphorbiaceae | *Croton humilis* | Pepper Rod | Common in rough pastures and rocky thickets | F | O | R | | | O | | O | |
| Cucurbitaceae | *Cucurbita pepo* | Pumpkin | Commonly cultivated | | | | | | | R | | |
| Convolvulaceae | *Cuscuta americana* | Love Bush | A common parasite on herbs, shrubs and low trees | R | F | | | | O | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Poaceae | *Cynodon dactylon* | Bermuda Grass | Commonly cultivated or encouraged as a lawn grass particularly in the drier areas, also a weed of roadsides, pastures and waste places | D | | | | | | | | |
| Cyperaceae | *Cyperus alternifolius* | | Gregarious and locally abundant in gravel along streams and rivers and at margins of ponds | | | | | | | R | | |
| Cyperaceae | *Cyperus ligularis* | | Common in coastal marshes and sandy places near the sea, rare inland at sandy roadsides along riverbanks | | | | | | | R | | |
| Mimosaceae | *Desmanthus virgatus* | Ground Tamarind | Common in waste places and thickets | | | R | | | O | | O | |
| Fabaceae | *Desmodium canum* | Sweetheart | Common in pastures and on banks | O | | | | | | | | |
| Fabaceae | *Desmodium scorpiurus* | | Rather common, a weed of sandy pastures and roadsides and rocky or stony waste ground | F | | | F | | O | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Poaceae | *Digitaria ciliaris* | | Very common in stony waste places, pastures and roadsides | O | | | | | | | | |
| Dioscoreaceae | *Dioscorea villosa* | Guinea Yam | Cultivated | | R | | | | | | | |
| Convolvulaceae | *Distimake aegyptia* | | Rather common in the south-eastern parishes, very rare elsewhere, in thickets and waste places | R | R | | O | R | O | | R | |
| Apocynaceae | *Echites umbrellata* | Deadly Nightshade | Common in thickets and at woodland margins, also on fences and in waste grassy places on the ground | R | | | | | | | | |
| Myrtaceae | *Eugenia axillaris* | Black Cherry | Common in thickets, wooded hillsides and upland pastures | | R | | | | | R | | |
| Myrtaceae | *Eugenia biflora* | | On wooded hillsides, chiefly on limestone, commonest in the southern parishes | R | | | | | | | | |
| Asteraceae | *Eupatorium odoratum* | Jack in the Bush | Very common as a weed of pastures and clearings on limestone and waste places generally | | | A | | | F | | R | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Euphorbiaceae | *Euphorbia heterophylla* | | Occasional in the central and eastern parishes, a weed of roadside banks and open waste places | | | | | | O | O | R | |
| Euphorbiaceae | *Euphorbia hirta* | | Very common, a weed of roadsides, waste places, lawns, pastures and cultivated ground | F | | | F | | | | | |
| Euphorbiaceae | *Euphorbia hypericifolia* | | Common as a weed of cultivations and in rough pastures and along roadsides | F | O | R | | | O | | O | |
| Euphorbiaceae | *Euphorbia prostrata* | | Locally common, a weed of sandy waste places and lawn | | | | | | | R | | |
| Rutaceae | *Fagara spinosa* | | Common in mostly arid exposed thickets on limestone | | | R | | | | | R | |
| Moraceae | *Ficus pertusa* | Strangler Fig | Very common as epiphyte or in rocky woodland margins | | R | | | | R | | | |
| Fabaceae | *Galactia striata* | | Common in the southern parishes, a weed of | O | O | R | | | | | O | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | pastures, roadsides, thickets and arid sandy places | | | | | | | | | |
| Sterculiaceae | *Guazuma ulmifolia* | Bastard Cedar | Very common along roadsides, in pastures and open secondary woodlands | A | F | A | | D | O | R | | D |
| Caesalpiniaceae | *Guilandia bonduc* | Sea Nickol | Common in thickets near the sea | | | | | | | R | | |
| Caesalpiniaceae | *Haematoxylum campechianum* | Log Wood | Common on exposed limestone hillsides in dry secondary thickets | D | A | | | O | F | | | O |
| Boraginaceae | *Heliotropium angiospermum* | Dog's Tail | Common as a field and garden weed mostly in rather shady places | F | | | | | F | | | |
| Malvaceae | *Hibiscus mutabilis* | Changeable Rose | Cultivated ornamental | R | | | | | | | | |
| Fabaceae | *Indigofera tinctoria* | Indigo | Frequent in rather arid sandy places and in thickets and waste ground on open limestone | R | | | | | | | | O |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Convolvulaceae | *Ipomoea tiliacea* | Wild Slip | Very common in woodland and thicket margins and rough grassy places | O | | | | | | | O | |
| Convolvulaceae | *Ipomoea triloba* | | Common, especially in the southern parishes near the sea, a weed of sandy ground and grassy swamp margins and also on hedges and in thickets | F | | | | | R | | O | |
| Convolvulaceae | *Ipomoea pes-caprae* | Beach Morning Glory | Common on beacges and sandy waste places near sea | | | | | | | O | | |
| Oleaceae | *Jasminum fluminense* | Azores Jasmine | Locally common, in shady waste places, hedgerows and thickets | | | | | | | | R | |
| Oleaceae | *Jasminum grandiflorum* | | Common in gardens and naturalized occasionally | | | | | | R | | | |
| Euphorbiaceae | *Jatropha gossypiifolia* | Belly-ache Bush | Locally common, especially in sandy or gravelly waste places near the sea | R | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Verbenaceae | *Lantana camara* | | | O | | F | | | O | | F | R |
| Poaceae | *Lasiacis divaricata* | | Very common in secondary thickets and margins of woodland, mostly on limestone | | | | | O | O | | | |
| Poaceae | *Lasiacis maculata* | | Rather common in rocky thickets and on wooded hillsides | O | | | | | | | | |
| imosaceae | *Leucaena leucocephala*** | Lead Tree | Common along roadsides and in sandy waste places and thickets | D | O | O | R | D | D | | A | A |
| Fabaceae | *Macroptilium lathyroides* | | Very common, a weed of waste places and cultivations | | F | O | | | F | | O | |
| Malpighiaceae | *Malpighia glabra* | Wild Cherry | Very common in rough pastures, thickets and on rocky ground | | R | | | R | | | | |
| Malvaceae | *Malvastrum coromandelianum* | | Common weed of cultivated ground, pastures and waste places | | O | F | | | | | F | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Anacardiaceae | *Mangifera indica* | Mango | Cultivated and naturalized | | | | D | R | | | | |
| Euphorbiaceae | *Manihot esculenta* | Cassava | Cultivated locally on heavier soils | | | | R | | | | | |
| Sapotaceae | *Manilkara zapota* | Naseberry | Cultivated, relict and escaped generally | | | | R | | | | | |
| Convolvulaceae | *Merremia umberllata* | | | | | | R | | | | | |
| Anacardiaceae | *Metopium brownii* | Burn Wood | | | | | | R | | | O | |
| Asteraceae | *Mikania micrantha* | Cuacu | Common, especially in wet places | | | | | | | F | | |
| Mimosaceae | *Mimosa pudica* | Shame Old Lady | A common weed of pastures and open stabilized waste places | F | | | | | | | | |
| Cucurbitaceae | *Momordica charantia* | Cerasea | Very common in fences, hedgegrows, beaches and shrubs in disturbed area | | | | | | R | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rubiaceae | *Morinda citrifolia* | Noni | Locally common in open areas near the sea, cultivated inland | | | | | | | R | | |
| Rubiaceae | *Morinda royoc* | | Very common, in pastures and thickets on limestone, also on some of the cays in the coral sand | R | O | | | | | | | |
| Fabaceae | *Mucuna pruriens* | Cowitch | Frequent in cultivations, thickets and woodland margins | | | O | | O | | | F | |
| Muntingiaceae | *Muntingia calabura* | | | | | R | | R | | | | |
| Musaceae | *Musa paradisiaca* | Plantain | Commonly cultivated | | | | R | | R | | | |
| Musaceae | *Musa sapientum* | Banana | Commonly cultivated | | | | R | | R | | | |
| Orchidaceae | *Oeceoclades maculata*** | Spotted African Orchid | | | O | | | O | | | F | |
| Loranthaceae | *Oryctanthus occidentalis** | God Bush | Very common on shrubs and trees | | | | | | R | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Poaceae | *Panicum maximum*** | Guinea Grass | Very common in rough pastures, ditches and sheltered thickets | A | | A | | D | D | | | D |
| Asteraceae | *Parthenium hysterophorus* | Dog-flea Weed | Common along roadsides and in shady or open waste places | | | | | | R | | | |
| Poaceae | *Paspalum paniculatum* | | Very common in rough pastures and waste places and roadsides in limestone areas | | R | O | | | O | | R | |
| Passifloraceae | *Passiflora suberosa* | | Common in thickets and waste places, especially in semi-arid woodland on limestone | R | O | | | | O | | | |
| Lauraceae | *Persea americana* | Avocado Pear | Common in cultivation | | | | R | | | | | |
| Phytolaccaceae | *Petiveria alliacea* | Guinea Hen Weed | Locally common as a weed of semi-shaded roadsides and rough well drained undisturbed ground | | | | | | | R | | |
| Verbenaceae | *Phyla nodiflora* | | Common in damp low-lying grassland, coastal | | | | | | | O | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | thickets and on upper beaches | | | | | | | | | |
| Piperaceae | *Piper amalago* | Jointer | Very common, on gully banks, roadsides and in thickets and woodlands on limestone | | | | | | | R | | |
| Fabaceae | *Piscidia piscidia* | Dog Wood | Common in thickets and woodlands on limestone hills | R | F | | | F | O | | F | A |
| Nyctaginaceae | *Pisonia aculeata* | Cockspur | Common in secondary thickets and woodland margins mostly on limestone | R | F | O | | A | F | R | F | F |
| Portulacaceae | *Portulaca oleracea* | Pussley | Very common, a weed of cultivated ground and waste places | | O | | | | | | | |
| Verbenaceae | *Priva lappulacea* | Velvet Bur | A common weed of cultivations, roadsides and waste places | | | | | | F | | | |
| Rosaceae | *Prunus myrtifolia* | Ant's Wood | Common in open situations and woodland margins on limestone | | | | | | | | | R |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Myrtaceae | *Psidium guajava* | Guava | Common in pastures and wayside thickets, sometimes cultivated | | | F | R | | | | | |
| Rubiaceae | *Randia aculeata* | Ink Berry | Rather common in thickets and woodlands on rocky limestone | | R | R | | | O | | | |
| Commelinaceae | *Rhoeo spathacea* | Mosses in the Bulrushes | Common, on limestone banks and in rocky thickets and woodland margins | | | | | | | O | | |
| Fabaceae | *Rhynchosia minima* | Burn-mouth Vine | Common, in waste places and cultivated land | O | | | | | | | | |
| Euphorbiaceae | *Ricinus communis* | Castor Oil | Common as cultivated plant and on waste ground | | | | | | O | F | | F |
| Phytolaccaceae | *Rivina humilis* | Inflamation Weed | | F | O | R | | | F | | | R |
| Acanthaceae | *Ruellia tuberosa* | Duppy Gunshot | Very common in pastures and waste places and on roadside banks | F | | | | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Poaceae | *Saccharum officinarum* | Sugar Cane | Abundantly cultivated, mostly at low elevations on level ground in deep soils | | | | R | | | | | |
| Mimosaceae | *Samanea saman* | Guango | Common in inhabited areas and in old pastures where planted, naturalized in riparian forest and in secondary communities on level ground | R | R | O | R | R | R | | | R |
| Cyperaceae | *Scleria lithosperma* | | Very common in open or shaded thickets on rocky limestone, often arid areas | O | | | | | | | | |
| Cactaceae | *Selenicereus triangularis* | God Okra | Locally common, in thickets, on rocks and on large old trees | | | | | | | | O | |
| Caesalpiniaceae | *Senna alata* | Ringworm Bush | Locally common in swampy places but often cultivated | | | | | | | R | | |
| Caesalpiniaceae | *Senna obtusifolia* | | Common as a weed of open waste places | | | | | | | | R | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Malvaceae | *Sida acuta* | Broomweed | Very common in pastures, waste places and cultivations | A | D | F | F | | F | | | |
| Malvaceae | *Sida cordifolia* | | Occasional as a weed of waste places | F | | | | | | | | |
| Simaroubaceae | *Simarouba glauca* | Bitter Damson | Common in woodlands on limestone | | | | | O | | | | |
| Solanaceae | *Solanum erianthum* | Wild Susumber | Frequent, in thickets and steep banks on limestone | R | R | | | R | | | | |
| Solanaceae | *Solanum torvum* | Susumber | Common in woodland clearings, thickets and waste places | | | | | R | | | | |
| Rubiaceae | *Spermacoce confusa* | | Common in waste places | | | | | | | | R | |
| Asteraceae | *Sphagneticola trilobata* | Creeping Ox-eye | Common in damp pastures on roadside banks and in waste places, trailing on beaches in wet areas and on some of the cays | | | | O | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Loganiaceae | *Spigelia anthelmia* | Pink Weed | Common, a weed of waste open stony or cultivated ground | O | | | | | | O | | |
| Anacardiaceae | *Spondias dulcis* | June Plum | Occasional in cultivation | | | | | R | | | | |
| Verbenaceae | *Stachytarpheta jamaicensis* | Vervine | Very common as a weed of waste places at low elevations | A | | | | | | O | | |
| Poaceae | *Stenotaphrum secundatum* | Crab Grass | Common in pastures on heavy poorly drained soils or on coral limestone near sea | D | A | | D | | | | | |
| Fabaceae | *Stylosanthes hamata* | Donkey Weed | Common, especially in waste places on limestone and exposed pastures near the sea | | | | | | O | | O | |
| Asteraceae | *Synedrella nodiflora* | Fatten Barrow | Common weed | | | | | | | F | | |
| Araceae | *Syngonium auritum* | Three Finger | Very common on trees, rocks and sheltered banks | | | | | | | F | | |
| Bignoniaceae | *Tabebuia rosea* | Pink Poui | Cultivated | O | R | | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Apocynaceae | *Tabernaemontana laurifolia* | | Common in coastal thickets and at mangrove margins on limestone | | | | | | | R | | |
| Bignoniaceae | *Tecooma stans* | | Locally abundant on cut-over limestone hillsides and waste sandy places | | D | | | | | | D | |
| Combretaceae | *Terminalia catappa* | West Indian Almond | Commonly planted and naturalized | | | F | R | O | F | D | | |
| Combertaceae | *Terminalia latifolia** | Broadleaf | Locally common in relict woodland in gullies and depressions especially in the western parishes | R | | | | R | | | | |
| Aspleniaceae | *Thelypteris ovata* | Ovate Marsh Fern | | | | | | | | R | | |
| Malvaceae | *Thespesia populnea* | Seaside Mahoe | Common in littoral situations | | | | | | | R | | |
| Meliaceae | *Trichilia hirta* | Wild Mahogany | Locally common, especially in the southern parishes, in thickets and along roadsides on alluvial gravel | O | | O | | R | F | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Phytolaccaceae | *Trichostigma octandrum* | | Common in thickets and woodland margins and on the cays | | | O | | | A | O | | |
| Typhaceae | *Typha domingensis* | Cat-tail Reed | Local along riverbanks and in ditches, swamps and boggy pastures, usually in fresh water but sometimes in brackish | | | | | | | R | | |
| Malvaceae | *Waltheria indica* | Raichie | Common in open sandy ground and waste places, especially near the sea | O | O | | | | F | | R | |
| Rhamnaceae | *Ziziphus mauritiana* | Coolie Plum | Established and fairly common in some waste places, occasionally forming thickets | O | O | | | R | | | | |
| Poaceae | *Zoysia tenuifolia* | | Common, widely distributed | | | | | | O | | | |

Endemic species - *  Invasive Alien Species (IAS) - **  Key

| | |
|---|---|
| Endemic Species | |
| Endemic sub-species | |
| Endemic Threatened (IUCN Listed | |
| Invasive Alien Species | |

### 11.4.1 LIST OF LARGE TREES ON THE PROPERTY

*Table showing the Point ID code for the trees identified with a DBH of 30cm and over during the Large Tree Survey. The species name, DBH and GPS location is provided for each such individual.*

| GPS # | Common Name | Scientific Name | DBH | Latitude | Longitude |
|---|---|---|---|---|---|
| 924 | West Indian Almond | *Terminalia catappa* | 42.8 | 17.874438 | -76.454533 |
| 925 | West Indian Almond | *Terminalia catappa* | 44.1 | 17.874414 | -76.454534 |
| 926 | West Indian Almond | *Terminalia catappa* | 35.5 | 17.874577 | -76.454657 |
| 927 | West Indian Almond | *Terminalia catappa* | 39.2 | 17.874569 | -76.45465 |
| 928 | West Indian Almond | *Terminalia catappa* | 40.8 | 17.874524 | -76.454611 |
| 929 | West Indian Almond | *Terminalia catappa* | 37.3 | 17.874493 | -76.454599 |
| 930 | West Indian Almond | *Terminalia catappa* | 39.5 | 17.8745 | -76.454613 |
| 931 | West Indian Almond | *Terminalia catappa* | 48.4 | 17.874475 | -76.454593 |
| 932 | West Indian Almond | *Terminalia catappa* | 45.3 | 17.874397 | -76.454624 |
| 933 | West Indian Almond | *Terminalia catappa* | 32.8 | 17.874365 | -76.454599 |
| 934 | Guango | *Samanea saman* | 33 | 17.874893 | -76.455624 |
| 935 | Guango | *Samanea saman* | 37.4 | 17.875017 | -76.455663 |
| 936 | Guango | *Samanea saman* | 49.3 | 17.87452 | -76.455704 |
| 937 | Red Birch | *Bursera simaruba* | 65.2 | 17.875702 | -76.455163 |
| 938 | Red Birch | *Bursera simaruba* | 37.3 | 17.875882 | -76.45537 |
| 939 | Ackee | *Blighia sapida* | 52.6 | 17.877295 | -76.45745 |
| 940 | Red Birch | *Bursera simaruba* | 31.6 | 17.875982 | -76.459077 |
| 941 | Red Birch | *Bursera simaruba* | 51.9 | 17.875887 | -76.459175 |
| 942 | Guango | *Samanea saman* | 42.7 | 17.876916 | -76.459448 |
| 943 | Guango | *Samanea saman* | 103.9 | 17.87727 | -76.46038 |
| 944 | Guango | *Samanea saman* | 56.2 | 17.877626 | -76.460158 |
| 945 | Guango | *Samanea saman* | 48.7 | 17.878219 | -76.461074 |
| 946 | Guango | *Samanea saman* | 39.4 | 17.877895 | -76.460388 |
| 947 | Guango | *Samanea saman* | 43.3 | 17.87768 | -76.45982 |
| 948 | Cherry Fig | *Ficus perforata* | 72.5 | 17.877503 | -76.459845 |
| 949 | Guango | *Samanea saman* | 58.1 | 17.877556 | -76.459674 |
| 950 | African Tulip | *Spathodea campanulata* | 37.4 | 17.877775 | -76.45855 |
| 951 | Florida Royal Palm | *Roystonea regia* | 35.9 | 17.877794 | -76.458613 |
| 952 | Guango | *Samanea saman* | 44.2 | 17.877927 | -76.458553 |
| 953 | Guango | *Samanea saman* | 33.8 | 17.87806 | -76.458329 |
| 954 | Cherry Fig | *Ficus perforata* | 56.4 | 17.878181 | -76.458459 |
| 955 | Cherry Fig | *Ficus perforata* | 59.1 | 17.878154 | -76.458668 |

| | | | | | |
|---|---|---|---|---|---|
| 956 | Cherry Fig | *Ficus perforata* | 65.8 | 17.87817 | -76.458729 |
| 957 | Cherry Fig | *Ficus perforata* | 50.3 | 17.878162 | -76.458755 |
| 958 | West Indian Almond | *Terminalia catappa* | 32.7 | 17.878181 | -76.458794 |
| 959 | West Indian Almond | *Terminalia catappa* | 34.2 | 17.87844 | -76.458778 |
| 960 | West Indian Almond | *Terminalia catappa* | 61.5 | 17.878439 | -76.45884 |
| 961 | West Indian Almond | *Terminalia catappa* | 43.0 | 17.87836 | -76.458844 |
| 962 | West Indian Almond | *Terminalia catappa* | 39.6 | 17.878518 | -76.458823 |
| 963 | Florida Royal Palm | *Roystonea regia* | 40.9 | 17.878551 | -76.459084 |
| 964 | Florida Royal Palm | *Roystonea regia* | 46.2 | 17.878555 | -76.459061 |
| 965 | Guango | *Samanea saman* | 54.8 | 17.878651 | -76.459003 |
| 966 | West Indian Almond | *Terminalia catappa* | 37.3 | 17.878393 | -76.45922 |
| 967 | West Indian Almond | *Terminalia catappa* | 52.1 | 17.878378 | -76.459202 |
| 968 | West Indian Almond | *Terminalia catappa* | 45.3 | 17.878395 | -76.45917 |
| 969 | West Indian Almond | *Terminalia catappa* | 40.9 | 17.878364 | -76.459152 |
| 970 | West Indian Almond | *Terminalia catappa* | 46.3 | 17.878362 | -76.459124 |
| 971 | Cherry Fig | *Ficus perforata* | 67.8 | 17.878272 | -76.459259 |
| 972 | June Plum | *Spondias dulcis* | 49.4 | 17.878517 | -76.459461 |
| 973 | Cherry Fig | *Ficus perforata* | 87.1 | 17.878544 | -76.459444 |
| 974 | Strangler Fig | *Ficus pertusa* | 73.5 | 17.878556 | -76.459469 |
| 975 | West Indian Almond | *Terminalia catappa* | 69.2 | 17.878637 | -76.459525 |
| 976 | Guango | *Samanea saman* | 54.7 | 17.878198 | -76.459575 |
| 977 | Trumpet Tree | *Cecropia peltata* | 30.8 | 17.878 | -76.459722 |
| 978 | Guango | *Samanea saman* | 39.4 | 17.877879 | -76.460087 |
| 979 | Guango | *Samanea saman* | 32.8 | 17.878229 | -76.460356 |
| 980 | Guango | *Samanea saman* | 47.5 | 17.877295 | -76.461887 |
| 981 | Guango | *Samanea saman* | 71.3 | 17.876516 | -76.462293 |
| 982 | Guango | *Samanea saman* | 33.6 | 17.876541 | -76.462357 |
| 983 | Guango | *Samanea saman* | 32.9 | 17.876736 | -76.462941 |
| 984 | Guango | *Samanea saman* | 34.5 | 17.876714 | -76.463087 |
| 985 | Guango | *Samanea saman* | 33.2 | 17.876761 | -76.463169 |
| 986 | Guango | *Samanea saman* | 49.7 | 17.876686 | -76.463235 |
| 987 | Guango | *Samanea saman* | 53.5 | 17.876805 | -76.463257 |
| 988 | Guango | *Samanea saman* | 92.6 | 17.876661 | -76.463771 |
| 989 | June Plum | *Spondias dulcis* | 39.3 | 17.876702 | -76.463972 |
| 990 | June Plum | *Spondias dulcis* | 41.7 | 17.876799 | -76.463873 |
| 991 | Ackee | *Blighia sapida* | 30.7 | 17.876894 | -76.463818 |
| 992 | Trumpet Tree | *Cecropia peltata* | 38.4 | 17.876929 | -76.463797 |
| 993 | Trumpet Tree | *Cecropia peltata* | 43.7 | 17.876963 | -76.463772 |
| 994 | June Plum | *Spondias dulcis* | 36.2 | 17.877177 | -76.463805 |
| 995 | Guango | *Samanea saman* | 45.3 | 17.877551 | -76.463594 |
| 996 | Guango | *Samanea saman* | 52.9 | 17.877213 | -76.463454 |

| | | | | | |
|---|---|---|---|---|---|
| 997 | June Plum | *Spondias dulcis* | 36.1 | 17.877035 | -76.463473 |
| 998 | Guango | *Samanea saman* | 37.6 | 17.877353 | -76.463188 |
| 999 | June Plum | *Spondias dulcis* | 45.8 | 17.877744 | -76.463095 |
| 1000 | Mango | *Mangifera indica* | 32.6 | 17.87795 | -76.463062 |
| 1001 | Red Birch | *Bursera simaruba* | 35.8 | 17.878137 | -76.463188 |
| 1002 | Red Birch | *Bursera simaruba* | 36.7 | 17.878196 | -76.463303 |
| 1003 | Guango | *Samanea saman* | 31.4 | 17.878302 | -76.462907 |
| 1004 | Ackee | *Blighia sapida* | 32.6 | 17.878305 | -76.462816 |
| 1005 | Breadfruit | *Artocarpus altilis* | 37.8 | 17.878417 | -76.462414 |
| 1006 | Breadfruit | *Artocarpus altilis* | 42.0 | 17.878285 | -76.462416 |
| 1007 | Mango | *Mangifera indica* | 36.2 | 17.878268 | -76.462476 |
| 1008 | Guango | *Samanea saman* | 53.9 | 17.878394 | -76.462092 |
| 1009 | Trumpet Tree | *Cecropia peltata* | 38.4 | 17.878413 | -76.46213 |
| 1010 | Guango | *Samanea saman* | 49.5 | 17.878523 | -76.462024 |
| 1011 | Breadfruit | *Artocarpus altilis* | 30.7 | 17.87829 | -76.462122 |
| 1012 | Guango | *Samanea saman* | 52.1 | 17.878194 | -76.462012 |
| 1013 | Guango | *Samanea saman* | 39.6 | 17.878014 | -76.461968 |
| 1014 | Guango | *Samanea saman* | 35.2 | 17.8776 | -76.461979 |
| 1015 | Guango | *Samanea saman* | 39.8 | 17.877128 | -76.462476 |
| 1016 | West Indian Almond | *Terminalia catappa* | 33.7 | 17.872619 | -76.458254 |
| 1017 | Guango | *Samanea saman* | 35.9 | 17.872633 | -76.458248 |
| 1018 | Cherry Fig | *Ficus perforata* | 57.5 | 17.872626 | -76.45829 |
| 1019 | Guango | *Samanea saman* | 42.7 | 17.873297 | -76.458406 |
| 1020 | Red Birch | *Bursera simaruba* | 39.3 | 17.873659 | -76.458625 |
| 1021 | Guango | *Samanea saman* | 55.4 | 17.873614 | -76.458763 |
| 1022 | Cherry Fig | *Ficus perforata* | 68.2 | 17.873629 | -76.458818 |
| 1023 | Guango | *Samanea saman* | 43.7 | 17.8739 | -76.459531 |
| 1024 | Guango | *Samanea saman* | 58.1 | 17.874113 | -76.459745 |
| 1025 | Red Birch | *Bursera simaruba* | 34.8 | 17.874814 | -76.459407 |
| 1026 | Red Birch | *Bursera simaruba* | 77.4 | 17.874865 | -76.45941 |
| 1027 | Cherry Fig | *Ficus perforata* | 32.3 | 17.875116 | -76.459333 |
| 1028 | Red Birch | *Bursera simaruba* | 50.6 | 17.875148 | -76.459297 |
| 1029 | Bitter Damson | *Simarouba glauca* | 31.8 | 17.875206 | -76.459404 |
| 1030 | Red Birch | *Bursera simaruba* | 46 | 17.87533 | -76.459359 |
| 1031 | Bastard Fustic | *Chlorophora tinctoria* | 39.7 | 17.875277 | -76.459342 |
| 1032 | Guango | *Samanea saman* | 56.4 | 17.874269 | -76.460032 |
| 1033 | Red Birch | *Bursera simaruba* | 42.5 | 17.874263 | -76.460773 |
| 1034 | Red Birch | *Bursera simaruba* | 40.8 | 17.874255 | -76.460761 |
| 1035 | Red Birch | *Bursera simaruba* | 34.7 | 17.874066 | -76.461395 |
| 1036 | West Indian Almond | *Terminalia catappa* | 47.0 | 17.8739194 | -76.4545278 |

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|---|---|---|---|---|---|
| 1037 | West Indian Almond | *Terminalia catappa* | 54.8 | 17.8739389 | -76.4541639 |
| 1038 | West Indian Almond | *Terminalia catappa* | 55.5 | 17.87385 | -76.4535028 |
| 1039 | West Indian Almond | *Terminalia catappa* | 49.6 | 17.87355 | -76.4548972 |
| 1040 | West Indian Almond | *Terminalia catappa* | 63.6 | 17.8733639 | -76.4556 |
| 1041 | West Indian Almond | *Terminalia catappa* | 47.0 | 17.8731694 | -76.456075 |
| 1042 | West Indian Almond | *Terminalia catappa* | 61.5 | 17.873075 | -76.4563944 |
| 1043 | West Indian Almond | *Terminalia catappa* | 49.3 | 17.8727417 | -76.45715 |
| 1044 | West Indian Almond | *Terminalia catappa* | 43.7 | 17.8727056 | -76.4572528 |
| 1045 | West Indian Almond | *Terminalia catappa* | 42.8 | 17.872675 | -76.4575833 |
| 1046 | West Indian Almond | *Terminalia catappa* | 41.0 | 17.87265 | -76.457775 |
| 1047 | West Indian Almond | *Terminalia catappa* | 49.0 | 17.8727333 | -76.4588361 |
| 1048 | West Indian Almond | *Terminalia catappa* | 38.0 | 17.8727417 | -76.4590833 |
| 1049 | West Indian Almond | *Terminalia catappa* | 44.2 | 17.8726 | -76.4592694 |
| 1050 | West Indian Almond | *Terminalia catappa* | 43.7 | 17.8725111 | -76.4601167 |
| 1051 | West Indian Almond | *Terminalia catappa* | 64.1 | 17.8726306 | -76.4602639 |
| 1052 | West Indian Almond | *Terminalia catappa* | 51.6 | 17.8725111 | -76.4603639 |
| 1053 | West Indian Almond | *Terminalia catappa* | 39.3 | 17.8724167 | -76.4603556 |
| 1054 | West Indian Almond | *Terminalia catappa* | 46.3 | 17.8725 | -76.4605694 |
| 1055 | West Indian Almond | *Terminalia catappa* | 58.8 | 17.8723222 | -76.4605917 |
| 1056 | West Indian Almond | *Terminalia catappa* | 60.1 | 17.8722722 | -76.4611083 |
| 1057 | West Indian Almond | *Terminalia catappa* | 49.0 | 17.8724639 | -76.4608611 |
| 1058 | West Indian Almond | *Terminalia catappa* | 40.9 | 17.8724 | -76.4606944 |
| 1059 | West Indian Almond | *Terminalia catappa* | 59.2 | 17.8723389 | -76.4607611 |
| 1060 | West Indian Almond | *Terminalia catappa* | 58.1 | 17.8722917 | -76.4608361 |
| 1061 | West Indian Almond | *Terminalia catappa* | 49.6 | 17.8721778 | -76.4611444 |
| 1062 | West Indian Almond | *Terminalia catappa* | 48.6 | 17.8725806 | -76.4610833 |
| 1063 | West Indian Almond | *Terminalia catappa* | 43.8 | 17.8723639 | -76.4612444 |
| 1064 | West Indian Almond | *Terminalia catappa* | 52.1 | 17.8722444 | -76.4613472 |
| 1065 | West Indian Almond | *Terminalia catappa* | 42.8 | 17.8721417 | -76.4612694 |
| 1066 | West Indian Almond | *Terminalia catappa* | 42.8 | 17.8720111 | -76.4612889 |
| 1067 | West Indian Almond | *Terminalia catappa* | 55.2 | 17.8721528 | -76.4613389 |
| 1068 | West Indian Almond | *Terminalia catappa* | 44.3 | 17.8721417 | -76.4613694 |
| 1069 | West Indian Almond | *Terminalia catappa* | 40.4 | 17.8722889 | -76.4615611 |
| 1070 | West Indian Almond | *Terminalia catappa* | 50.6 | 17.872175 | -76.4615472 |
| 1071 | West Indian Almond | *Terminalia catappa* | 61.9 | 17.8719889 | -76.4615361 |
| 1072 | West Indian Almond | *Terminalia catappa* | 43.7 | 17.8720333 | -76.4616806 |
| 1073 | West Indian Almond | *Terminalia catappa* | 64.5 | 17.8719556 | -76.4614056 |
| 1074 | West Indian Almond | *Terminalia catappa* | 47.0 | 17.8718556 | -76.4616889 |
| 1075 | West Indian Almond | *Terminalia catappa* | 50.4 | 17.8718306 | -76.4618 |
| 1076 | West Indian Almond | *Terminalia catappa* | 47.4 | 17.8718111 | -76.461925 |
| 1077 | West Indian Almond | *Terminalia catappa* | 47.8 | 17.8718389 | -76.4619528 |

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|---|---|---|---|---|---|
| 1078 | West Indian Almond | *Terminalia catappa* | 64.8 | 17.8719528 | -76.4619806 |
| 1079 | West Indian Almond | *Terminalia catappa* | 61.4 | 17.8721556 | -76.4619972 |
| 1080 | West Indian Almond | *Terminalia catappa* | 41.4 | 17.8721417 | -76.4619139 |
| 1081 | Red Birch | *Bursera simaruba* | 40.2 | 17.8725028 | -76.4620361 |
| 1082 | West Indian Almond | *Terminalia catappa* | 57.7 | 17.871825 | -76.4621111 |
| 1083 | West Indian Almond | *Terminalia catappa* | 37.8 | 17.8718417 | -76.4622833 |
| 1084 | West Indian Almond | *Terminalia catappa* | 38.1 | 17.8717556 | -76.4622694 |
| 1085 | West Indian Almond | *Terminalia catappa* | 60.3 | 17.8717722 | -76.4620361 |
| 1086 | West Indian Almond | *Terminalia catappa* | 48.7 | 17.8722222 | -76.4608472 |
| 1087 | West Indian Almond | *Terminalia catappa* | 47.7 | 17.8721194 | -76.4610611 |
| 1088 | West Indian Almond | *Terminalia catappa* | 57.5 | 17.8726722 | -76.458575 |
| 1089 | Red Birch | *Bursera simaruba* | 48.3 | 17.8807917 | -76.46405 |
| 1090 | Red Birch | *Bursera simaruba* | 58.6 | 17.8811278 | -76.4619056 |
| 1091 | West Indian Almond | *Terminalia catappa* | 43.1 | 17.8798722 | -76.4612528 |
| 1092 | Guango | *Samanea saman* | 39.5 | 17.8793306 | -76.4604944 |
| 1093 | Guango | *Samanea saman* | 43.2 | 17.8789361 | -76.4608806 |
| 1094 | Red Birch | *Bursera simaruba* | 58.8 | 17.8788056 | -76.4634028 |
| 1095 | Red Birch | *Bursera simaruba* | 40.9 | 17.8789528 | -76.463025 |
| 1096 | Red Birch | *Bursera simaruba* | 46.6 | 17.8787306 | -76.4643722 |

## 11.5 APPENDIX 5-CALIBRATION CERTIFICATES

अहमदाबाद वस्त्र उद्योग अनुसंधान संस्थान
पी.ओ. आंबावाडी विस्तार, अहमदाबाद - 380015. भारत
फोन : (079) 2630 7921 - 7922 - 7923 - 5132
फैक्स : (079) 2630 4677 - 1969 - 5131
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ATIRA

AHMEDABAD TEXTILE INDUSTRY'S RESEARCH ASSOCIATION
P.O. : Ambawadi Vistar, Ahmedabad-380015. India
Phone : (079) 2630 7921- 7922 - 7923 -5132
Fax : (079) 2630 4677 - 1969 - 5131
E-mail : atiraad1@sancharnet.in Website : www.atira.in

### CALIBRATION REPORT

**Report No.:** ENV23CR431

**Issue Date:** 18-06-2024

| | |
|---|---|
| **Device ID:** IC24P0001 | **Customer:** Inteccon Inc |
| **Product:** Polludrone | **Manufacturer:** OIZOM |
| **Validity:** 1 year | |

**GAS CALIBRATION**

**Test Ambient conditions**

**Temp.:** 20+/- 2 °C **Humidity:** 54 +/- 10 %

**Pressure:** 14.56 psi

**Test Operating conditions**

**Gas Temp.:** 22+/- 2 °C **Gas Hum*.:** 30+/- 10%RH

**Gas Pressure:** 2.94 psi **Gas Flow*:** 500 sccm

*using Alicat manufactured MFC sr nos. MCS-500SCCM-D, MC-500SCCM-D-SV with an accuracy of +/- 0.2 % FS | *using Nafion tube

**Calibration Data (ppm)**

| Gas | Range | Resolution | Zero Air Output | Std. gas conc. | Std. gas Output | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 | 2 | 3 | Avg | Abs Error |
| $SO_2$ | 0-10 | 0.001 | 0 | 1.25 | 1.28 | 1.27 | 1.25 | 1.26 | 0.01 |
| $NO_2$ | 0-10 | 0.001 | 0 | 5.45 | 5.41 | 5.43 | 5.44 | 5.42 | 0.03 |
| $H_2S$ | 0-1.5 | 0.001 | 0 | 0.5 | 0.52 | 0.55 | 0.54 | 0.53 | 0.03 |
| CO | 0-5 | 0.01 | 0 | 2.75 | 2.71 | 2.72 | 2.73 | 2.72 | 0.03 |
| NO | 0-5 | 0.001 | 0 | 2.75 | 2.76 | 2.78 | 2.78 | 2.77 | 0.02 |
| $CO_2$ | 0-5000 | 1 | 0 | 2328 | 2330 | 2331 | 2332 | 2331 | 3 |
| $O_3$ | 0-10 | 0.001 | 0 | - | N/A | N/A | N/A | N/A | N/A |

**REFERENCE STANDARDS**

(*Note:* CSLPL - Chemtron Science Laboratories Pvt. Ltd; VGL - Vadilal Gases Limited)

$SO_2$: Certificate No 29112023-1006, Make:VGL, Expiry Date: Nov 2024;
$NO_2$ :Certificate No. 04092023-1861, Make: VGL., Expiry Date: Sep.2024;
$H_2S$: Certificate No. CSL-060224-13906-4-1, Make: CSLPL, Expiry: Feb. 2025;
CO : Certificate No. 28092023-2139, Make: VGL, Expiry Date: Sep.2024;
NO : Certificate No. 30122023-3977, Make: VGL, Expiry Date: Dec 2024;
$CO_2$ : Certificate No. 130220244693, Make: VGL, Expiry Date: Feb 2025;
Zero Air : Material No. FLAIR-C-5, Make: Inox Air Products.

**Remarks:** Repeatability of less than ±0.5% Full Scale was achieved for all parameters

| | | | |
|---|---|---|---|
| **Tested by:** | | **Approved by:** | |
| **Witnessed by:** | | | |

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AHMEDABAD TEXTILE INDUSTRY'S RESEARCH ASSOCIATION ATIRA

CamScanner

TISCH Calibration

Tisch Environmental, Inc.
145 South Miami Ave Cleves,
OH 45002 1.877.263.7610
sales@tisch-env.com

## CERTIFICATE OF NIST TRACEABLE CALIBRATION

| | | | |
|---|---|---|---|
| Model #: | TE-PRO-CAL | Serial #: 0025 | DATE: 04/29/2024 |
| Technician: | Tim Hoffman | **RECERTIFICATION DUE DATE:** | **04/29/2025** |

Certificate Number: 50025
Date Issued: 04/29/2024

Lab Conditions: 25.0°C
749.7 mmHg

NIST Standard: ML-800-44
NIST Certificate: 133190-17942023
Serial Number: 122561026

Serial Number: 133190
Date Due: 05-17-2024

Temperature Calibration (Tamb) Single Point Calibration set to 25.0°C

Barometric Pressure Calibration Single Point Calibration set to 749.7 mmHg

Filter Probe Temperature Single Point Calibration set to: 25.0 °C

Relative Humidity Single Point Calibration set to: 30%RH

Flow System 5-point Verification

| Test Point | BIOS NIST Reading | PROCAL Reading | % Diff |
|---|---|---|---|
| 1 | 3.14 | 3.15 | 0.32% |
| 2 | 7.11 | 7.11 | 0.00% |
| 3 | 11.21 | 11.19 | -0.18% |
| 4 | 15.07 | 15.06 | -0.07% |
| 5 | 19.2 | 19.21 | 0.05% |

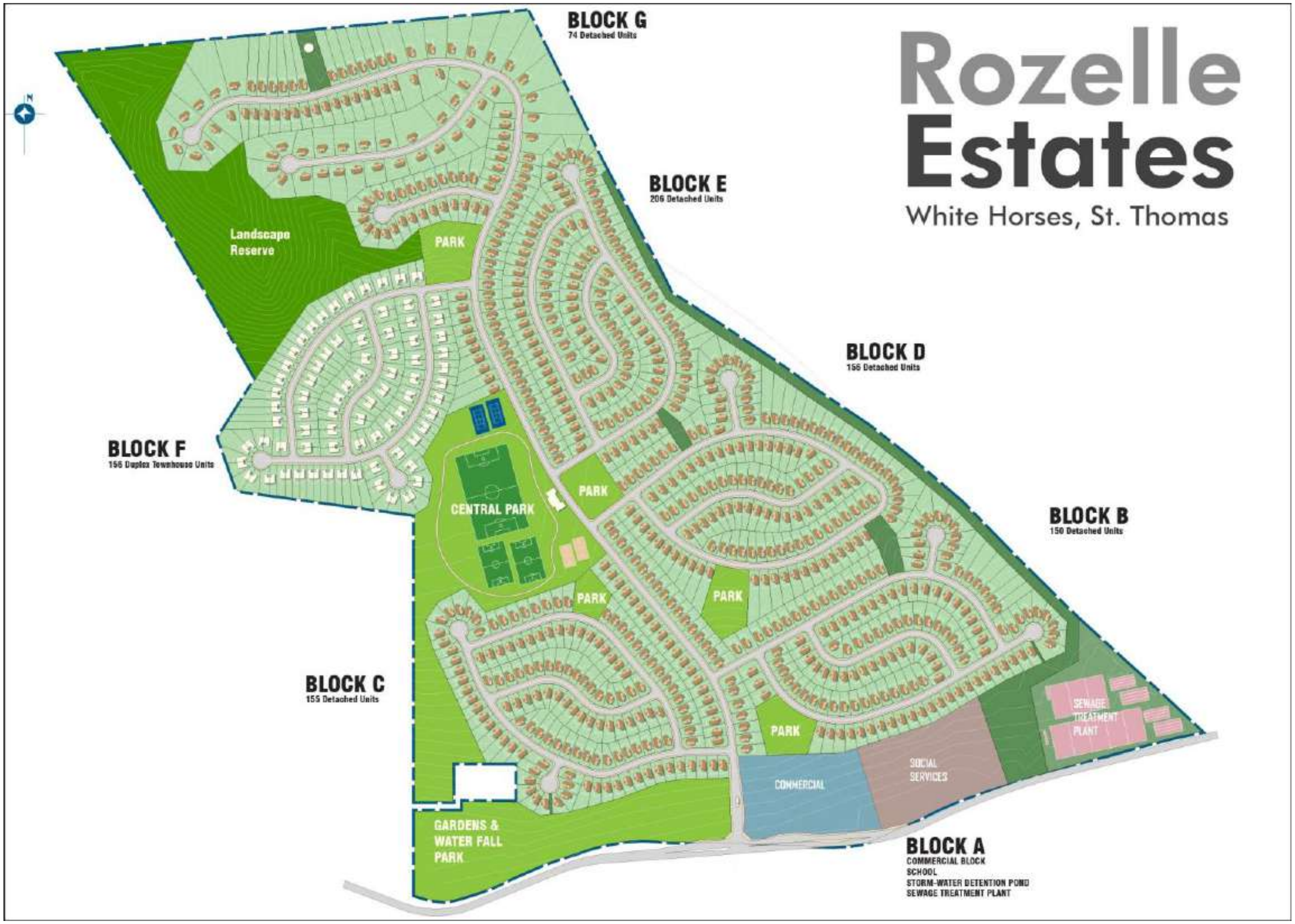
Tim Hoffman

Technician: Tim Hoffman

**Date:** 04/29/2024

## 11.6 APPENDIX 6: DRAWINGS

The Master Subdivision Layout



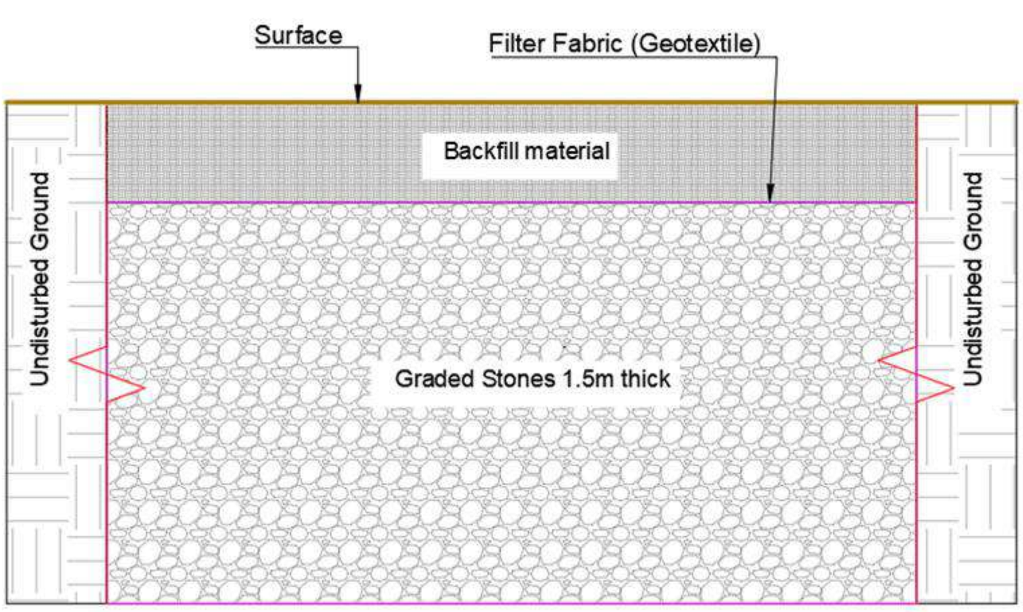




*Figure 111-1: CAD drawings of Overview of Project Site and Cross-Sections of Proposed Drainage system for Rozelle Falls (subsurface: storage area and gravel drains, cut-off drain and detention pond*