ENVIRONMENTAL IMPACT ASSESSMENT

Mammee River Development Project

for

China Harbour Engineering Company Ltd (CHEC)

FINAL REPORT - APPENDICES

Prepared for:
China Harbour Engineering Company Ltd.
6-8, 5 St Lucia Ave
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Prepared by:
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7 Hillview Avenue
Kingston 10
Jamaica

TABLE OF CONTENTS

A Terms of Reference

NATIONAL ENVIRONMENT & PLANNING AGENCY

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E-mail: ceo@nepa.gov.jm, Website: http://www.nepa.gov.jm

15 May 2023

Ms. Annmarie Goulbourne
Manager
Environmental Management Services
Environmental Solutions Limited
7 Hillview Avenue
Kingston 10

Dear Ms. Goulbourne

RE: Environmental Permit Application for Proposed Mammee River Housing Development in St. Ann

The National Environment and Planning Agency (NEPA) is in receipt of letter dated 4 May 2023 with the enclosed document titled *Terms of Reference for an Environmental Impact Assessment for a Proposed Housing and Subdivision Project at Mammee Bay, St. Ann by China Harbour Engineering Company Limited* dated 3 May 2023.

The Agency has reviewed the draft Terms of Reference (TOR) for the Environmental Impact Assessment (EIA) and is accepting the recommendation regarding the water quality data for the EIA report.

Attached is the finalized TOR to be appended to the EIA Report. The Report will be assessed against this TOR.

Should there be need for any clarification, please contact the undersigned at (876) 754-7540 ext. 2101 or by email at gabrielle-jae.watson@nepa.gov.jm.

Sincerely,
National Environment and Planning Agency

Peter Knight, CD, JP
Chief Executive Officer/Government Town Planner
//attachment

TERMS OF REFERENCE

for an

ENVIRONMENTAL IMPACT ASSESSMENT

for a

PROPOSED HOUSING and SUBDIVISION PROJECT

at

MAMMEE BAY, ST ANN

by

CHINA HABOUR ENGINEERING COMPANY LIMITED

Prepared by: (Environmental Solutions Limited)

Revised 03 May 2023

TABLE OF CONTENTS

The purpose of this document is to establish the Terms of Reference (TOR) for the EIA.

The EIA report must be produced in accordance with the approved TOR.

Where the need arises to modify the TOR, the required amendments/modifications are to be made and submitted to the Agency. Approval for the TOR must be obtained from the Agency, in writing, prior to the commencement of the EIA study.
The Terms of Reference to conduct the Environmental Impact Assessment are as follows:
The National Environment and Planning Agency and the Natural Resources Conservation Authority reserves the right to reproduce, transfer and disclose all contents contained in the submitted environmental impact assessment report without the written consent of the proponent, consultants and/or its agents.

The Terms of Reference to conduct the Environmental Impact Assessment (EIA) are as follows:

1. EXECUTIVE SUMMARY

Provide a brief statement on the content of the EIA report. The executive summary should provide a comprehensive overview and objectives for the project proposal, natural resources, justification for the project etc. In addition, it should include relevant background information and provide a summary of the main findings, including but not limited to main impacts and mitigation measures, analyses and conclusions in the report.

2. INTRODUCTION

The introduction should provide a background and seek to explain the need for and the context of the project and the EIA. It should also provide the delineation and justification of the boundary of the study area, general methodology, assumptions and constraints of the study.

The study area shall include at least the area within a 1km radius of the boundaries of the proposed site.

3. LEGISLATION AND REGULATORY CONSIDERATION

Outline the pertinent regulations, standards, government policies and legislation governing environmental quality, safety and health, cultural significant finds, protection of sensitive areas, protection of endangered species, siting and land use control at the local and national levels. The examination of the legislation should include at minimum, legislation such as the Natural Resources Conservation Authority Act 1991, Natural Resources Conservation Regulations 1996, amended 2015, Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013, Beach Control Act, Jamaica National Heritage Trust Act, Wild Life Protection Act, National Solid Waste Management Authority Act, the Housing Act, the Town and Country Planning Act, Building Act and Codes and Standards promulgated there under, Development Orders and Plans and **all** appropriate international convention/protocol/treaty where applicable. Describe traditional land use and advise of any prescriptive rights including public access rights.

4. PROJECT DESCRIPTION

Prepare a detailed description of the project. This section will provide information on the proposed project and should include:

- History and background of the project,
- A location map at a scale of 1:12,500 (or an appropriate scale) ☐ The total area of the site.
- A site layout plan showing the various components and design elements of the proposed development.
- A comprehensive description of all components and the various design elements of the project. e.g., total number of lots and/or houses, the types of units, total area to be utilized, the proposed phases, amenities to serve the proposed development such as parks, pool and club house.
- Expected project components and alternatives that may be considered by the developer,
- A detailed landscape plan highlighting grading and proposed changes in topography.
- Details of proposed access(es) to the site to be used for pre-construction, construction and operational phases.
- Details on infrastructure development including design plans for all components of the development including the proposed wastewater/sewage treatment system and disposal of treated effluent must be clearly outlined.
- A detailed description of the construction methodology should also be included.
- Schematic Plans to include the site drawings, floor plans, sections, elevations and relevant details, renderings to adequately demonstrate the magnitude of the project being proposed. This should be provided for each specific design of the proposed development scheme.
- The schematic drawings should also adequately illustrate and identify the materials being proposed for the development components and provide where necessary MSDS information and shop drawings for mechanical and electrical equipment being proposed.
- Landscape plan should also be by a qualified Landscape Architect and specify details of landscaping components, surface treatment of areas and include plant species etc.
- A comprehensive drainage assessment. This assessment should take into consideration existing natural drainage channels, proposed man-made drainage/water features or any proposed changes in topography. Potential issues of increased surface runoff and sediment loading to existing freshwater systems and coastal environment must also be addressed. Special emphasis should also be placed on the storm water run-off, drainage patterns, characteristics of the aquifer, including the level and status of the groundwater. The drainage assessment should consider the design capacity of the culverts along the north coast highway, identified in the Master Plan document prepared by Interplan Planning Consultants dated November 2022, that channel flows from the area to the sea, and assess the extent to which these culverts will be able to accommodate increased surface runoff.
- In addition, plans for providing utilities, particularly details relating to the source of potable water and electricity generation, roads and other services should be clearly stated.
- A Waste Management Plan which clearly outlines expected types and quantities of construction waste during the construction phase, general waste arising from material

consumption of the workforce, as well as the expected waste during the operational phase should be completed. Details should also be provided for any central disposal area(s) being considered to serve the proposed development.

- Details of equipment and machinery to be involved, how these will be mobilized and areas to be used for storage of machinery and material should be clearly indicated.
- Details of workforce, including proposals for mobilization and accommodation should be indicated.
- All phases of the project should be clearly defined, the relevant time schedules provided, and phased maps, diagrams and appropriate visual aids included in the Environmental Impact Assessment report.
- The study area should be clearly delineated and referenced. Considering the types of resources located in the area and the magnitude of the associated impacts, the study area should be large enough to include all valued resources that might be significantly affected by the project.

5. DESCRIPTION OF THE ENVIRONMENT

- A survey of the proposed development site should be conducted for both the wet and dry seasons. This information will form the basis upon which impacts of the project will be assessed.

The following aspects should be described in this section:

5.1 PHYSICAL ENVIRONMENT

- ➢ Topography, soil type, climate, drainage, geology (including but not limited to seismicity and faults), geomorphology of the site and hazard vulnerability including impacts on current landscape, aesthetic appeal and hydrology should be examined. Special emphasis should be placed on storm water runoff, drainage patterns in particular the Roaring River and any works proposed for same. Percolation tests should also be conducted within the proposed study area.
- ➢ Water quality for any aquatic (riverine) environment or surface water feature in or around the development. Quality Indicators should include but not be limited to Nitrate, Phosphate, Faecal Coliform, Salinity and Total Suspended Solids. Water quality monitoring samples should be collected and should be collected within both the wet and dry seasons. Historical data, not exceeding 5 years, can be used to supplement data collection.
- ➢ Climatic conditions and air quality in the area of influence including particulates.
- ➢ Noise levels of undeveloped site and the ambient noise in the area of influence.
- ➢ Sources of existing pollution and extent of contamination.
- ➢ Availability of solid waste management facilities.

5.2 CARRYING CAPACITY

- The ecological carrying capacity of the site should be assessed.

5.3 NATURAL HAZARDS

A risk assessment of the development in relation to the following must be undertaken:

- Hurricanes, Earthquakes
- Natural hazard risk assessment should take in account climate change projections.

5.4 BIOLOGICAL ENVIRONMENT

Description of terrestrial habitats, existing vegetation, flora and fauna surveys inclusive of a species list; commentary on the ecological health, function and value in the project area, threats and conservation significance. This should include:

- A detailed qualitative and quantitative assessment of terrestrial and aquatic habitats in and around the proposed project sites and the areas of impact. This must also include flora and fauna surveys and should include species lists.
- Special emphasis should be placed on rare, endemic, threatened, protected, endangered, invasive and economically important species. Migratory species should also be considered. There may be the need to incorporate micro-organisms to obtain an accurate baseline assessment. Identification and description of the different ecosystem types and structure including species dominance, species dependence, habitats/niche specificity, community structure and diversity, possible biological loss or habitat fragmentation ought to be considered.

The field data collected should include, but not be limited to:

- Vegetation profile
- Other benthic features of the proposed development areas as well as the areas of potential impact
- Species lists must be provided for each community
- A habitat map of the area

5.5 HERITAGE

- An Archaeological Impact Assessment of the Roaring River Great House and the Water Wheel Ruins located on site should be done, along with other artifacts, archaeological monuments, and cultural features of the site. Where there is a need, this should be conducted in collaboration with the Jamaica National Heritage Trust.

5.6 SOCIO-ECONOMIC ENVIRONMENT

- Demography, regional setting, location assessment and current and potential land use patterns (of neighbouring properties); description of existing infrastructure such as transportation, electricity, water and telecommunications, and public health safety; cultural peculiarities, aspirations and attitudes should be explored; and other material assets of the area should also be examined. There should also be an assessment of the present and proposed uses of the site and surrounding areas including any land acquisition needs and impacts on current users of the area during and post development. A socio-economic survey to determine public perception of the project (both negative and positive) should also be completed and this should include but not be limited to potential impacts on social, aesthetic and historical/ cultural values. This assessment may vary with community structure and may take multiple forms such as public meetings or questionnaires.

6. PUBLIC PARTICIPATION

Describe the public participation methods, timing, type of information provided and collected from public and stakeholder target groups meetings. The sampling methodology employed must be appropriate for the population size and distribution and must be weighted towards the communities in closest proximity to the proposed development. The instrument used to collect the information must be included in the appendix. Stakeholder meetings should also be held to inform the public of the proposed development and the possible impacts and gauge the feeling/response of the public toward the development.

The issues identified during the public participation process should be summarized and public input that has been incorporated or addressed in the EIA should be outlined.

Public Meeting(s) should be held in accordance with the Guidelines for Conducting Public Presentation at a time and location signed off by the National Environment and Planning Agency (NEPA). A public meeting will be held to present the findings of the EIA once the EIA is completed and submitted for consideration. All relevant documents are required to be made available to the public. In addition, any material change to the design of the project will require a further public meeting to be undertaken by the developer and all changes made to the document should be clearly outlined to the public.

7. IMPACT IDENTIFICATION AND ANALYSIS

A detailed analysis of the project components should be done in order to: identify the major potential environmental, health and safety impacts of the project; distinguish between levels of impact, significance of impact (a ranking from major to minor/significant to insignificant should be developed), positive and negative impacts, duration of impacts (long term or short term or immediate), direct and indirect and impacts, reversible or irreversible, long term and immediate impacts and identify avoidable impacts.

Cumulative impacts should also be evaluated considering previous developments and any proposed development immediately adjacent to the subject development within the area. The identified impacts should be profiled to assess the magnitude of the impacts. The major concerns surrounding environmental, health, and safety issues should be noted and their relative importance to the design of the project and the intended activities indicated. The extent and quality of the available data should be characterized, explaining significant information deficiencies and any uncertainties associated with the predictions of impacts. A major environmental issue is determined after examining the impact (positive and negative) on the environment and having the negative impact significantly outweigh the positive. It is also determined by the number and magnitude of mitigation strategies which need to be employed to reduce the risk(s) introduced to the environment. Project activities and impacts should then be ranked as major, moderate and minor and presented in separate matrices for all the phases of the project (i.e., preconstruction, construction, occupation, operational and decommissioning/closure). The potential impacts may be subdivided into Physical Impacts, Biological Impacts and Socio-economic and Cultural Impacts. All impacts should be listed, ranked and assessed, preferably in a single table.

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

7.1 PHYSICAL

- Impacts of construction activities such as site clearance, earthworks, geotechnical and engineering requirements and spoil disposal
- Impacts of spills (such as oil and chemical spills)
- Impacts on Air Quality
- Impacts on Water Quality (pollution of potable, coastal, surface and ground water o Impacts on Climate Change
- Demands/requirements of the following must be quantified:
    - Water Supply
    - Sewage Treatment and Disposal - Empirical data must be provided to show that the proposed sewage treatment facility has the capacity to treat the effluent to meet the NRCA sewage effluent standards.
    - Wastewater Disposal
    - Trade Effluent Discharges (if any)
    - Solid Waste Disposal
    - Electrical Power (fossil fuels, wind, sun, wave and tidal)
    - Communications and other utility requirements
    - Transport Systems and supporting infrastructure required.
- Operation and maintenance – waste disposal, site drainage, sewage treatment and disposal solution, and air quality.
- Impacts on visual aesthetics and landscape
- Noise
- Change in drainage pattern, including but not limited the retraining of a tributary from the eastern boundary of the property to the western boundary.
- Carrying capacity of the proposed site

7.2 NATURAL HAZARD

Potential impact of Natural Hazards: (such as Hurricanes and Earthquakes) and flooding potential

7.3 BIOLOGICAL

An assessment of the direct and indirect impacts of the project on the ecology of terrestrial and aquatic habitats with emphasis being placed on rare, endemic, threatened, protected, endangered, invasive and economically important species found. This should include habitat loss and fragmentation, loss of species and natural features due to construction and operation. Impact of noise and vibration especially on fauna.

7.4 HERITAGE

Loss of and damage to artifacts, archaeological, geological and paleontological features.

7.5 HUMAN/SOCIAL/CULTURAL

Effects on socio-economic status such as changes to public access and recreational use, impacts on existing and potential economic activities, public perception, contribution of development to national economy and development of surrounding communities. Socio-economic and cultural impacts to include land use/resource effects.

7.6 PUBLIC HEALTH ISSUES OF CONCERN

7.7 RISK ASSESSMENT

Analyze the risks to human health and ecosystems associated with the development from both human activities and natural phenomenon. This should include: 1) Identifying the hazards 2) Assessing the potential consequences 3) Assessing the probability of the consequences and 4) Characterizing the risk and uncertainty. The monetary costs of the risks, the costs of emergency response and/or avoidance of risks should also be considered. The physical, biological and sociological status will provide the framework in which to assess the impacts of the proposed project.

8 IMPACT MITIGATION

The mitigation measures should endeavour to avoid, reduce and remedy the potential negative effects identified while at the same time enhance the positive impacts projected. Mitigation and abatement measures should be developed for each potential negative impact identified. In addition, mitigation measures against pollution of the aquatic environment if sewage disposal and treatment infrastructure should be compromised should be addressed. Full details of the methods proposed to be employed in the implementation of these measures should be provided, including details on the scheduling/timelines, source of materials, location and responsible parties where appropriate. Where appropriate, maps and diagrams should also be used to illustrate areas where mitigation measures are proposed to be implemented.

Where possible and applicable green building technology should be examined, and a statement made on strategies that will be used to conserve energy and water in relation to this development.

9 ENERGY USE AND CONSERVATION

This section should provide methods of energy conservation that could be applied. Alternate sources of energy could also be provided and assessed, and a justification provided for the preferred energy source. Where possible and applicable, green building technology should be examined.

10 ANALYSIS OF ALTERNATIVES

Alternatives to the proposed development/project including the no-action alternative and project design alternatives should be examined. These should be assessed according to the physical, ecological and socio-economic parameters of the site. This examination of alternatives should incorporate the use of the history of the overall area in which the site is located and previous uses of the site itself. Alternatives should also address specific aspects of the project such as methods proposed in the execution of the project (works) that have been identified as being causes of major impacts. A rationale for the selection of any project alternative should be provided.

11 ENVIRONMENTAL MONITORING AND MANAGEMENT

An environmental monitoring and management plan should be developed which will detail the requirements for construction and operational phases of the project. This should include, but not be limited to training for construction and operation staff, as well as include recommendations to ensure the implementation of mitigation measures and long-term minimization of negative impacts.

A draft environmental monitoring programme should be included in the EIA, and a detailed version submitted to NEPA for approval should the permit be granted and prior to the commencement of the development. At the minimum the monitoring programme and report should include:

- Introduction outlining the need for a monitoring programme and the relevant specific provisions of the permit(s) and/or licence(s) granted.
- The activity being monitored
- The locations/sites selected for monitoring. These may in instances, be pre-determined by the local authority and should incorporate a control site where no impact from the development is expected.
- The parameters which will be monitored for each activity or implemented mitigation measure
- The methodology to be employed for the monitoring of the various parameters and the frequency of monitoring. o The frequency of the submission of the monitoring reports to NEPA and other relevant agencies
- The responsible parties for the monitoring
- Possible energy and water conservation measures

The Monitoring report should also include, at minimum: o Raw data collected. Tables and graphs are to be used where appropriate.

- Discussion of results with respect to the development in progress, highlighting any parameter(s) which exceeds the expected standard(s).

- Recommendations
- o Appendices of data and photographs if necessary.

12 LIST OF REFERENCES

13 APPENDICES

The appendices should include but not be limited to the following documents:

- Reference documents
- Photographs/ maps
- Data Tables
- Glossary of Technical Terms used
- Final Terms of Reference
- Composition of the consulting team, team that undertook the study/assessment, including name, qualification and roles of team members
- Notes of Public Consultation sessions
- Instruments used in community surveys

14 ACTIVITIES

In order to effectively and efficiently conduct the Environmental Impact Assessment it will be necessary to carry out various activities which include:

14.1 DOCUMENTATION REVIEW

All documentation pertaining to the development will need to be reviewed. These should include, but not limited to, the project profile, site plan, drainage plan, vegetation clearance plan, applications made for financing or planning approval, and any technical and engineering studies that have been done.

14.2 ANALYSIS OF ALTERNATIVES

Alternatives to the site location, project design and operation conditions will be analyzed including the "no-action" alternative. These alternatives will be assessed based on the physical, ecological and socio-economic parameters of the site identified. The consultant should provide justification for the selection of the chosen alternative(s). The physical, biological and sociological settings will provide the framework in which to assess the different project alternatives. This would clarify, for instance, whether the site could be used for other purposes as well as whether there are any aspects of the development that can be sited differently, operated differently, etc.

14.3 IMPACT ASSESSMENT

The consultant should carry out a detailed impact assessment of the project components (preconstruction, construction and operation stages) in order to identify the potential impacts (positive, negative and cumulative impacts) that will be associated with the project. The significance and magnitude (major, moderate and minor) of the impacts identified will also be evaluated using a weighted matrix.

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

- Effects of project design and engineering.
- Effects on visual aesthetics and landscape.
- Effect of noise and vibration.
- Effects of construction activities such as site clearance and geological formation, earthworks, hurricanes, access routes, transportation networks and spoil disposal.
- Effects of operation and maintenance activities such as waste disposal, traffic management, site drainage, sediment, sewage, public access and air quality; and
- Effects on ecology including effect on terrestrial and aquatic habitats
- Emphasis should be placed on any rare, endangered, and endemic species found
- Effects on socio-economic status such as changes to public access, recreational use, existing and potential uses, contribution of development to national economy and development of surrounding communities.

All findings must be presented in the EIA report and must reflect the headings in the body of the TORs, as well as references. GIS references should be provided where applicable. One hard copy and an electronic copy must be submitted to NEPA for review after which the Agency will indicate the number of hard copies along with an electronic copy of the report to be submitted. One copy of the document should be perfect bound.

The report should include appendices with items such as maps, site plans, the study team and their individual qualifications, photographs, and other relevant information. All the foregoing should be properly sourced and credited.

B. Summary of Relevant Legal Regulatory and Policy Instruments

LEGISLATION/REGULATIONS/POLICIES/ INTERNATIONAL TREATY	RELEVANCE TO PROJECT
	INTERNATIONAL TREATY
Biodiversity Convention, 1992	The Convention has three main goals: the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of benefits arising from genetic resources. **The project is required to ensure that during construction and operation all protections are engaged to preserve the health of the ecosystem.**
Cartagena Convention, 1983	Cartagena Convention is a regional legal agreement for the protection of the Caribbean Sea. Of note are the 1) Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region and 2) the Protocol Concerning Pollution from Land-Based Sources and Activities. **The project is required to ensure that during construction and operation all protections are engaged to preserve the health of the coastal zone and reduce sources of pollution that may harm the marine ecosystem.**
Convention for International Trade in Endangered Species (CITES), 1973	CITES is a multilateral treaty to protect endangered plants and animals from the threats of international trade. **Although no trade in any endangered species listed on the CITES list is expected to occur with this project, the provision under the CITES Convention must be considered for the protection of the species and the conservation of the habitats.**
Natural Resources Authority Conservation Act, 1991	The Act is responsible for environmental management; governs all pollution activities within Jamaica, the EIA regulatory framework (when applicable). The Act's powers and responsibilities include: • Establishing and enforcing pollution control and waste management standards and regulations. Monitoring and enforcing environmental laws and regulations, especially those included in the NRCA, Beach Control, Watershed Protection, and Wildlife Protection Acts. The NRCA Act binds the Crown and as such supersedes all other legislation relating to environmental issues. The Minister is empowered to request an Environmental Impact Statement (EIS) in relation to certain major projects. **The project requires the conduct of an EIA and the preparation of an Environmental Permit as per the Act.**

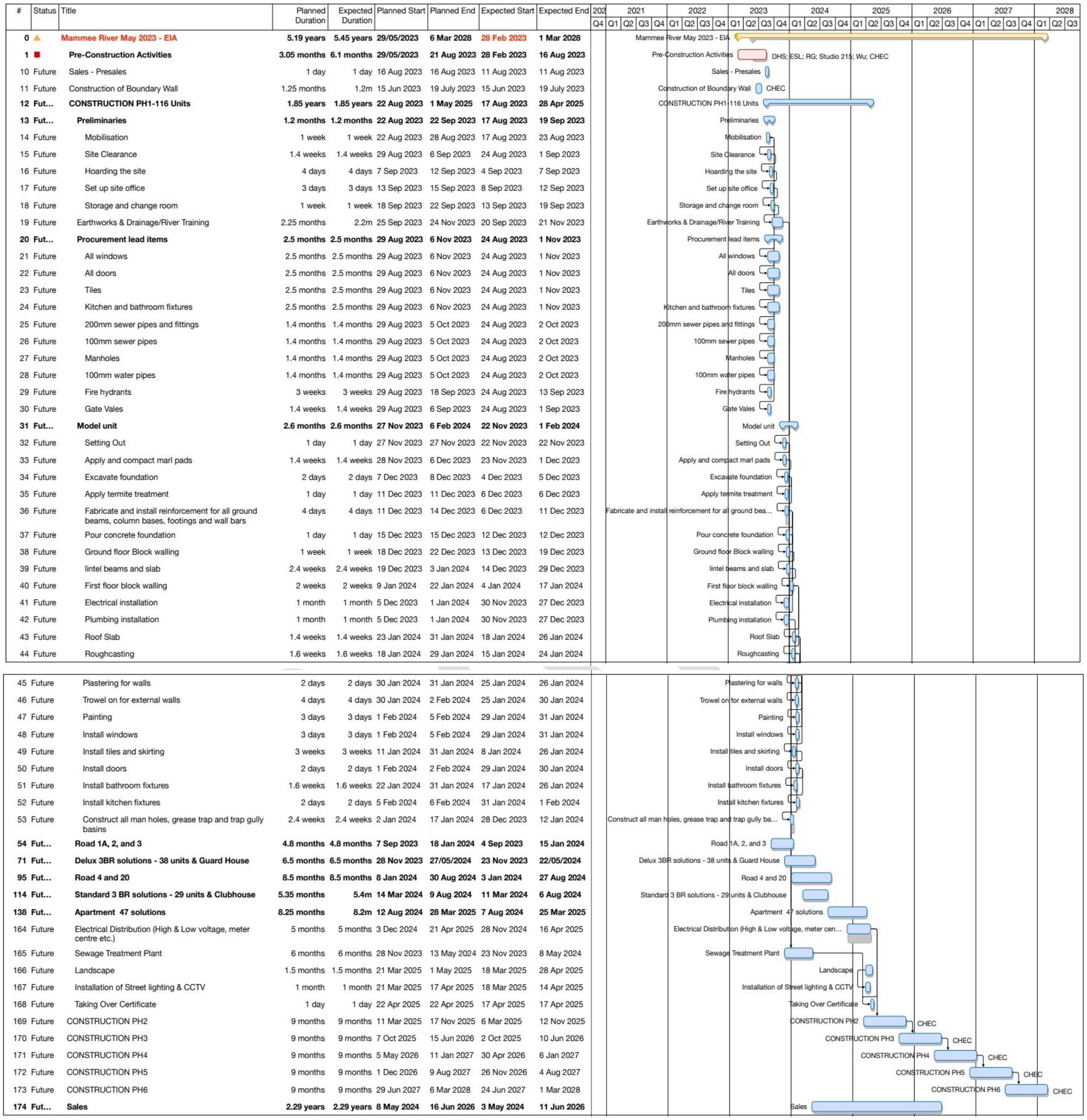
LEGISLATION/REGULATIONS/POLICIES/ INTERNATIONAL TREATY	RELEVANCE TO PROJECT
Beach Control Act, 1956	An act relating to the floor of the sea and the overlying water and to the foreshore and beaches of this island, and to the establishment of a Beach Control Authority for the purpose of controlling and regulating the use of the floor of the sea and the overlying water and of the foreshore and beaches of this island in the interests of the public and of persons who have acquired rights therein and for purposes incidental to or connected with the matters aforesaid. **This project will be required to submit an application…**
Building Act, 2018	It facilitates the adoption and efficient application of national building standards to be called the National Building Code of Jamaica for ensuring safety in the built environment, enhancing amenities and promoting sustainable development, and for connected matters. **The project will be required to submit building permit applications to the St. Ann Municipal Corporation.**
Disaster Risk Management Act, 2015	The Disaster Preparedness and Emergency Act established the Office of Disaster Preparedness and Emergency Management (ODPEM) which is responsible for carrying out the provisions of the Act. **The Act outlines the needs for agencies to have emergency response plans and contingency plans for specific hazards.**
Flood-Water Control Act, 1958	This Act makes provisions for the construction, improvement, repair and maintenance of works for the control of flood water, and for other matters connected therewith. **A Drainage Plan will be required for this project.**
Housing Act, 1968	This Act lays down the rules for urban planning with a special emphasis on lands and buildings which are unfit for human health and habitation.
Jamaica National Heritage Trust Act, 1985	The Act makes provisions for governing the operations of the Jamaica National Trust as well as to provide for matters the trust oversees. The Trust, in functioning under the Jamaica National Heritage Act, is responsible for promoting the preservation of national monuments and anything designated as protected national heritage for the benefit of Jamaica. It also carries out related development that is deemed necessary for the preservation of any national monuments or anything designated as protected national heritage. **The site is of historical and cultural importance. As such, the project is required to preserve as much as possible and to have a Chance Find Procedure/Watching Brief.**

LEGISLATION/REGULATIONS/POLICIES/ INTERNATIONAL TREATY	**RELEVANCE TO PROJECT**
National Solid Waste Management Authority Act, 2001	The Act provides for the regulation and management of solid waste. It established the National Solid Waste Management Authority (NSWMA) and outlines the matters connected therewith or incidental thereto. **Solid waste management will be essential in the construction phase and will require the removal and proper disposal of vegetative matter, soil and construction rubble. The NSWMA should be contacted regarding an approved disposal site.**
Registration of Titles Act, 1989	This Act sets out the legal basis for land registration in Jamaica. Under this system, land registration is not compulsory, although once a property is entered in the registry system the title is continued through any transfer of ownership.
Town And Country Planning (St. Ann Parish) Confirmed Development Order, 1999	Matters regulated by this order include planning permission for development, control of subdivisions, parking, roads, beaches, etc. and prescribes consultation with national authorities by the local planning authority before granting planning permissions and appeals. **The project will be required to submit building permit applications to the St. Ann Municipal Corporation.**
Town and Country Planning Act, 1958, amended 1999	The Act grants the Town and Country Planning Authority to work in consultation with local authorities to create provisional development orders in relation to any land in urban and rural areas with the intention to control the development of the area. The Act also highlights national heritage sites in St. Ann…. **The project will be required to submit building permit applications to the St. Ann Municipal Corporation.**
Water Resources Act, 1996	The Water Resources Act established the Water Resources Authority (WRA). This Authority is mandated to regulate, allocate, conserve and manage the water resources of the island and to provide for water quality control.
Watersheds Protection Act, 1963	The Act provides for the protection of watershed to Include areas adjoining watersheds and the conservation of water resources for Jamaica.
Wildlife Protection Act, 1945	The Act specifically protects designated species of animals and regulates hunting in Jamaica. The Act also regulates the hunting of game birds and provides for the declaration of game sanctuaries and game reserves in which no hunting is required. **The relevant area does not have any designated game parks nor endangered species.**

LEGISLATION/REGULATIONS/POLICIES/ INTERNATIONAL TREATY	RELEVANCE TO PROJECT
REGULATIONS STANDARDS AND GUIDELINES	
Natural Resources Conservation Authority (Air Quality) Regulations, 2002	The Regulations state that no person shall emit or cause to be emitted from any air pollutant source at a new facility, any visible air pollutants the opacity or pollutant amount of which exceeds the standards. Every owner of a facility with one or more air pollutant source or activity shall employ such control measures and operating procedures as are necessary to minimize fugitive emissions into the atmosphere, and such owner shall use available practical methods which are technologically feasible and economical, and which reduce, prevent or control fugitive emissions to facilitate the achievement of the maximum practical degree of air purity. **The client must ensure that contractors employ emission control measures to minimize fugitive emissions during construction**
Natural Resources Conservation (Permit and License) (Amendment) Regulations, 2015	These regulations were developed in 2013. They require the application for the grant of a permit to undertake an enterprise, construction or development of a prescribed description or category in a prescribed area as set out in Form 1 in the First Schedule. **This project will be required to submit a permit application.**
Natural Resources Conservation (Wastewater and Sludge) Regulations, 2013	These Regulations are designed to prevent pollution of the environment (land, surface and marine water) from manufacturers, developers, operators of various (trade and sewage) treatment facilities and other relevant sectors, etc.
Noise Standards, 1999	Jamaica has no national legislation for noise, but World Bank guidelines have been adopted by the National Environment and Planning Agency (NEPA) and are used for benchmarking purposes along with the draft National Noise Standards that are being prepared. **The client must ensure that contractors employ noise control measures to minimize excessive noise during construction, and within keeping of the ranges set for machinery and appropriate zones.**

LEGISLATION/REGULATIONS/POLICIES/ INTERNATIONAL TREATY	RELEVANCE TO PROJECT
Public Health Act, 1976	This Act establishes the Central Health Committee with the local bodies being resident under the Parish Council of respective parishes. The Public Health (air, soil and water pollution) Regulations 1976 aim at controlling, reducing, removing or preventing air, soil and water pollution in all possible forms. The excavation and construction work and use of heavy machinery and equipment may result in the temporary generation of fugitive dust. Proper care and standard best practices for the construction industry should be applied to minimize public health risks.
POLICIES	
National Hazard Mitigation Policy, 2005	This Policy provides a framework for integrating hazard mitigation into all policies, programmes and plans at national and community levels. It sets out the broad goals and guiding principles for hazard risk reduction and informs the development of national hazard mitigation plans. **The EIA must consider the susceptibility of the site to natural hazards and mitigation measures must be included in the designs as much as possible.**
National Land Policy, 1996	The goals and objectives of this Policy are to ensure the sustainable, productive and equitable development, use and management of the country's natural resources.

C. Project Implementation Schedule



#	Status	Title	Planned Duration	Expected Duration	Planned Start	Planned End	Expected Start	Expected End
0	▲	**Mammee River May 2023 - EIA**	**5.19 years**	**5.45 years**	**29/05/2023**	**6 Mar 2028**	**28 Feb 2023**	**1 Mar 2028**
1	■	**Pre-Construction Activities**	**3.05 months**	**6.1 months**	**29/05/2023**	**21 Aug 2023**	**28 Feb 2023**	**16 Aug 2023**
10	Future	Sales - Presales	1 day	1 day	16 Aug 2023	16 Aug 2023	11 Aug 2023	11 Aug 2023
11	Future	Construction of Boundary Wall	1.25 months	1.2m	15 Jun 2023	19 July 2023	15 Jun 2023	19 July 2023
12	**Fut...**	**CONSTRUCTION PH1-116 Units**	**1.85 years**	**1.85 years**	**22 Aug 2023**	**1 May 2025**	**17 Aug 2023**	**28 Apr 2025**
13	**Fut...**	**Preliminaries**	**1.2 months**	**1.2 months**	**22 Aug 2023**	**22 Sep 2023**	**17 Aug 2023**	**19 Sep 2023**
14	Future	Mobilisation	1 week	1 week	22 Aug 2023	28 Aug 2023	17 Aug 2023	23 Aug 2023
15	Future	Site Clearance	1.4 weeks	1.4 weeks	29 Aug 2023	6 Sep 2023	24 Aug 2023	1 Sep 2023
16	Future	Hoarding the site	4 days	4 days	7 Sep 2023	12 Sep 2023	4 Sep 2023	7 Sep 2023
17	Future	Set up site office	3 days	3 days	13 Sep 2023	15 Sep 2023	8 Sep 2023	12 Sep 2023
18	Future	Storage and change room	1 week	1 week	18 Sep 2023	22 Sep 2023	13 Sep 2023	19 Sep 2023
19	Future	Earthworks & Drainage/River Training	2.25 months	2.2m	25 Sep 2023	24 Nov 2023	20 Sep 2023	21 Nov 2023
20	**Fut...**	**Procurement lead items**	**2.5 months**	**2.5 months**	**29 Aug 2023**	**6 Nov 2023**	**24 Aug 2023**	**1 Nov 2023**
21	Future	All windows	2.5 months	2.5 months	29 Aug 2023	6 Nov 2023	24 Aug 2023	1 Nov 2023
22	Future	All doors	2.5 months	2.5 months	29 Aug 2023	6 Nov 2023	24 Aug 2023	1 Nov 2023
23	Future	Tiles	2.5 months	2.5 months	29 Aug 2023	6 Nov 2023	24 Aug 2023	1 Nov 2023
24	Future	Kitchen and bathroom fixtures	2.5 months	2.5 months	29 Aug 2023	6 Nov 2023	24 Aug 2023	1 Nov 2023
25	Future	200mm sewer pipes and fittings	1.4 months	1.4 months	29 Aug 2023	5 Oct 2023	24 Aug 2023	2 Oct 2023
26	Future	100mm sewer pipes	1.4 months	1.4 months	29 Aug 2023	5 Oct 2023	24 Aug 2023	2 Oct 2023
27	Future	Manholes	1.4 months	1.4 months	29 Aug 2023	5 Oct 2023	24 Aug 2023	2 Oct 2023
28	Future	100mm water pipes	1.4 months	1.4 months	29 Aug 2023	5 Oct 2023	24 Aug 2023	2 Oct 2023
29	Future	Fire hydrants	3 weeks	3 weeks	29 Aug 2023	18 Sep 2023	24 Aug 2023	13 Sep 2023
30	Future	Gate Vales	1.4 weeks	1.4 weeks	29 Aug 2023	6 Sep 2023	24 Aug 2023	1 Sep 2023
31	**Fut...**	**Model unit**	**2.6 months**	**2.6 months**	**27 Nov 2023**	**6 Feb 2024**	**22 Nov 2023**	**1 Feb 2024**
32	Future	Setting Out	1 day	1 day	27 Nov 2023	27 Nov 2023	22 Nov 2023	22 Nov 2023
33	Future	Apply and compact marl pads	1.4 weeks	1.4 weeks	28 Nov 2023	6 Dec 2023	23 Nov 2023	1 Dec 2023
34	Future	Excavate foundation	2 days	2 days	7 Dec 2023	8 Dec 2023	4 Dec 2023	5 Dec 2023
35	Future	Apply termite treatment	1 day	1 day	11 Dec 2023	11 Dec 2023	6 Dec 2023	6 Dec 2023
36	Future	Fabricate and install reinforcement for all ground beams, column bases, footings and wall bars	4 days	4 days	11 Dec 2023	14 Dec 2023	6 Dec 2023	11 Dec 2023
37	Future	Pour concrete foundation	1 day	1 day	15 Dec 2023	15 Dec 2023	12 Dec 2023	12 Dec 2023
38	Future	Ground floor Block walling	1 week	1 week	18 Dec 2023	22 Dec 2023	13 Dec 2023	19 Dec 2023
39	Future	lintel beams and slab	2.4 weeks	2.4 weeks	19 Dec 2023	3 Jan 2024	14 Dec 2023	29 Dec 2023
40	Future	First floor block walling	2 weeks	2 weeks	9 Jan 2024	22 Jan 2024	4 Jan 2024	17 Jan 2024
41	Future	Electrical installation	1 month	1 month	5 Dec 2023	1 Jan 2024	30 Nov 2023	27 Dec 2023
42	Future	Plumbing installation	1 month	1 month	5 Dec 2023	1 Jan 2024	30 Nov 2023	27 Dec 2023
43	Future	Roof Slab	1.4 weeks	1.4 weeks	23 Jan 2024	31 Jan 2024	18 Jan 2024	26 Jan 2024
44	Future	Roughcasting	1.6 weeks	1.6 weeks	18 Jan 2024	29 Jan 2024	15 Jan 2024	24 Jan 2024
45	Future	Plastering for walls	2 days	2 days	30 Jan 2024	31 Jan 2024	25 Jan 2024	26 Jan 2024
46	Future	Trowel on for external walls	4 days	4 days	30 Jan 2024	2 Feb 2024	25 Jan 2024	30 Jan 2024
47	Future	Painting	3 days	3 days	1 Feb 2024	5 Feb 2024	29 Jan 2024	31 Jan 2024
48	Future	Install windows	3 days	3 days	1 Feb 2024	5 Feb 2024	29 Jan 2024	31 Jan 2024
49	Future	Install tiles and skirting	3 weeks	3 weeks	11 Jan 2024	31 Jan 2024	8 Jan 2024	26 Jan 2024
50	Future	Install doors	2 days	2 days	1 Feb 2024	2 Feb 2024	29 Jan 2024	30 Jan 2024
51	Future	Install bathroom fixtures	1.6 weeks	1.6 weeks	22 Jan 2024	31 Jan 2024	17 Jan 2024	26 Jan 2024
52	Future	Install kitchen fixtures	2 days	2 days	5 Feb 2024	6 Feb 2024	31 Jan 2024	1 Feb 2024
53	Future	Construct all man holes, grease trap and trap gully basins	2.4 weeks	2.4 weeks	2 Jan 2024	17 Jan 2024	28 Dec 2023	12 Jan 2024
54	**Fut...**	**Road 1A, 2, and 3**	**4.8 months**	**4.8 months**	**7 Sep 2023**	**18 Jan 2024**	**4 Sep 2023**	**15 Jan 2024**
71	**Fut...**	**Delux 3BR solutions - 38 units & Guard House**	**6.5 months**	**6.5 months**	**28 Nov 2023**	**27/05/2024**	**23 Nov 2023**	**22/05/2024**
95	**Fut...**	**Road 4 and 20**	**8.5 months**	**8.5 months**	**8 Jan 2024**	**30 Aug 2024**	**3 Jan 2024**	**27 Aug 2024**
114	**Fut...**	**Standard 3 BR solutions - 29 units & Clubhouse**	**5.35 months**	**5.4m**	**14 Mar 2024**	**9 Aug 2024**	**11 Mar 2024**	**6 Aug 2024**
138	**Fut...**	**Apartment 47 solutions**	**8.25 months**	**8.2m**	**12 Aug 2024**	**28 Mar 2025**	**7 Aug 2024**	**25 Mar 2025**
164	Future	Electrical Distribution (High & Low voltage, meter centre etc.)	5 months	5 months	3 Dec 2024	21 Apr 2025	28 Nov 2024	16 Apr 2025
165	Future	Sewage Treatment Plant	6 months	6 months	28 Nov 2023	13 May 2024	23 Nov 2023	8 May 2024
166	Future	Landscape	1.5 months	1.5 months	21 Mar 2025	1 May 2025	18 Mar 2025	28 Apr 2025
167	Future	Installation of Street lighting & CCTV	1 month	1 month	21 Mar 2025	17 Apr 2025	18 Mar 2025	14 Apr 2025
168	Future	Taking Over Certificate	1 day	1 day	22 Apr 2025	22 Apr 2025	17 Apr 2025	17 Apr 2025
169	Future	CONSTRUCTION PH2	9 months	9 months	11 Mar 2025	17 Nov 2025	6 Mar 2025	12 Nov 2025
170	Future	CONSTRUCTION PH3	9 months	9 months	7 Oct 2025	15 Jun 2026	2 Oct 2025	10 Jun 2026
171	Future	CONSTRUCTION PH4	9 months	9 months	5 May 2026	11 Jan 2027	30 Apr 2026	6 Jan 2027
172	Future	CONSTRUCTION PH5	9 months	9 months	1 Dec 2026	9 Aug 2027	26 Nov 2026	4 Aug 2027
173	Future	CONSTRUCTION PH6	9 months	9 months	29 Jun 2027	6 Mar 2028	24 Jun 2027	1 Mar 2028
174	**Fut...**	**Sales**	**2.29 years**	**2.29 years**	**8 May 2024**	**16 Jun 2026**	**3 May 2024**	**11 Jun 2026**

D. Project Schematics, Elevations, Floor Plans

D.1 Apartment Blocks

D.1.i. Site Plans

Figure 14-1 Apartment Complex Schematic

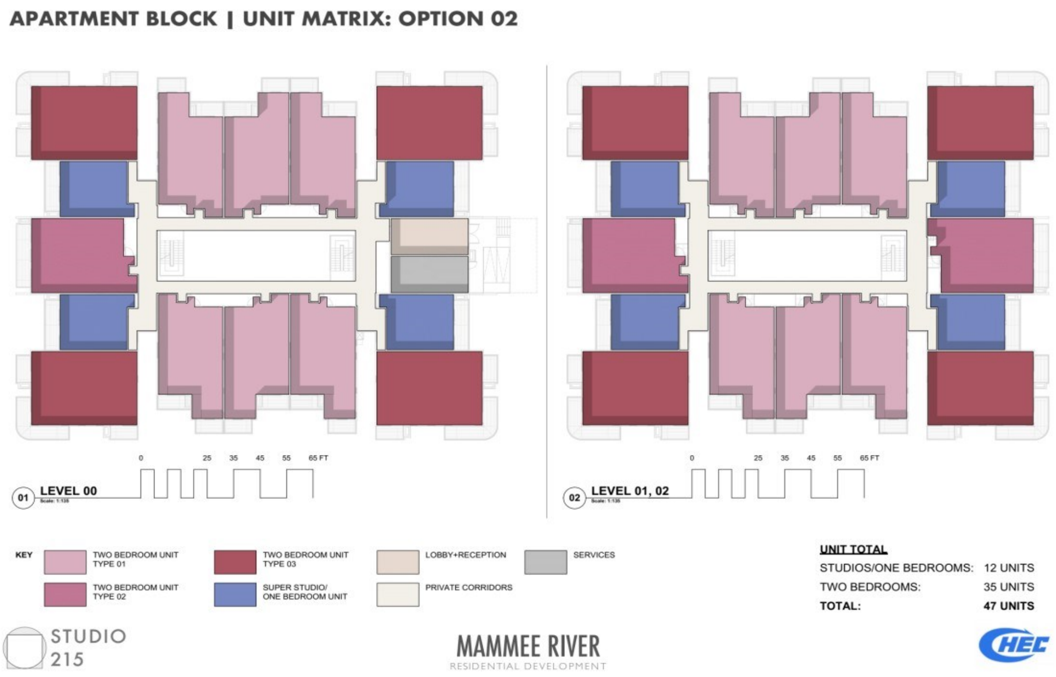


Figure 14-2 Apartment Complex Matrix

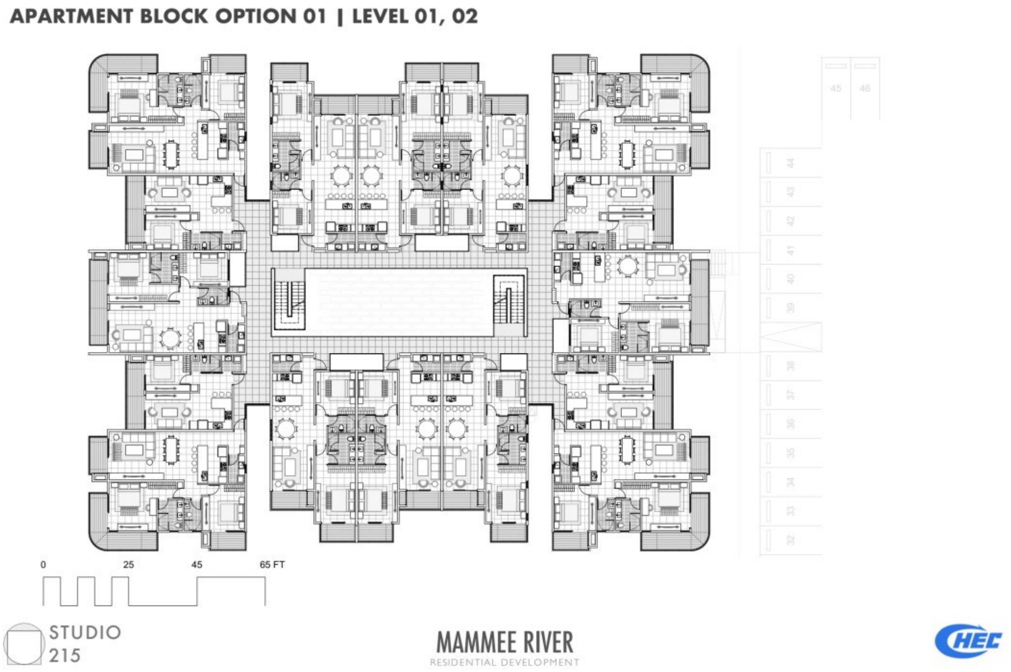


Figure 14-3 Apartment Floor Plan - Option 1

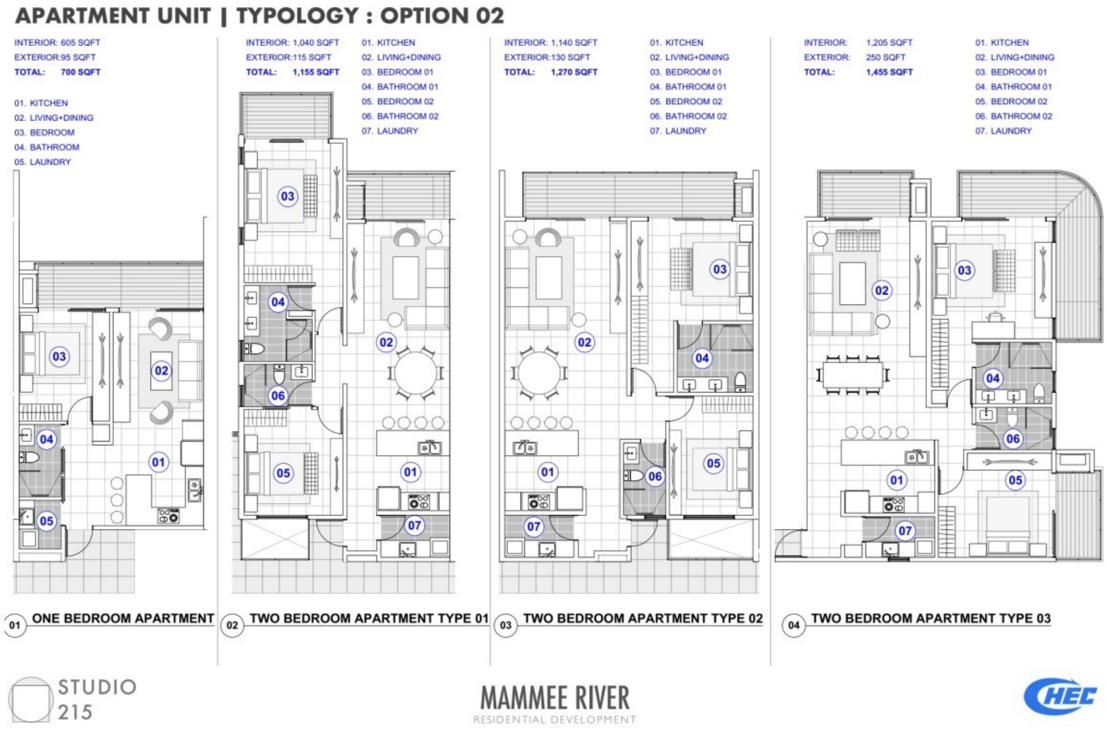


Figure 14-4 Apartment Floor Plan – Option 2

D.1.ii. Elevations

Figure 14-5 Apartment Complex Eastern Elevation

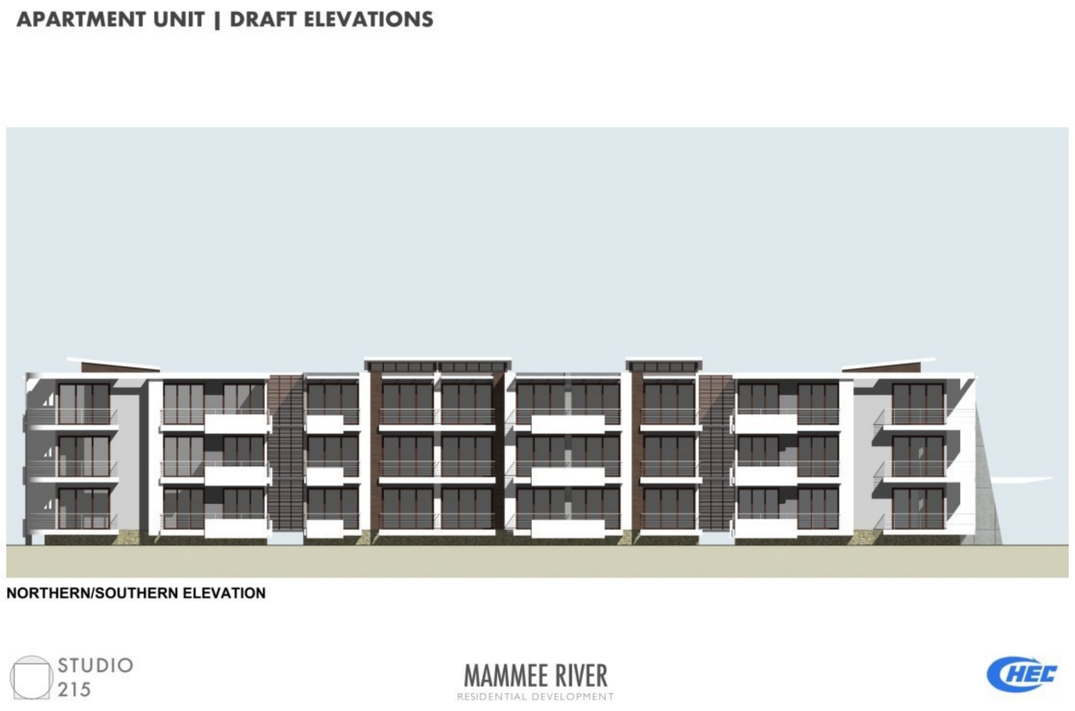


Figure 14-6 Apartment Complex Northern/Southern Elevation

APARTMENT UNIT | DRAFT ELEVATIONS

WESTERN ELEVATION

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RESIDENTIAL DEVELOPMENT

Figure 14-7 Apartment Complex Western Elevation

D.1.iii. Floor Plans

DRAWINGS FOR SUBMISSION

ARCHITECTURAL LIST

GA001	COVER SHEET
AI-100	LEVEL 00 - FLOOR PLAN
AI-101	LEVEL 01 - FLOOR PLAN
AI-102	LEVEL 02 - FLOOR PLAN
AI-103	LEVEL 03 - ROOF PLAN AND DRAINAGE DETAILS
AI-104	LEVEL 04 - CLEARSTORY ROOF PLAN
AI-105	LEVEL 00,01 & 02 - COMMON AREA
AI-107	LEVEL 00 & 01 - COMMON AREA RCP
AI-108	LEVEL 02 - COMMON AREA RCP
AI-109	LEVEL 00 & 01 - COMMON AREA ELECTRICAL
AI-110	LEVEL 02 - COMMON AREA ELECTRICAL
AI-111	APT ONE BEDROOM FLOORPLANS
AI-112	APT TWO BEDROOM TYPE 1 FLOORPLANS
AI-113	APT TWO BEDROOM TYPE 2 FLOORPLANS
AI-114	APT TWO BEDROOM TYPE 3 FLOORPLANS
AI-115	APT LOBBY FLOOR PLANS
AI-200	ELEVATIONS 01, 02
AI-201	ELEVATION 03, 04
AI-300	SECTIONS A, B
AI-301	SECTIONS C, D
AI-302	SECTIONS E, F
AI-303	SECTIONS G, H
AI-401	APT ONE BEDROOM - KITCHEN
AI-402	APT ONE BEDROOM - BATHROOM LAUNDRY
AI-403	APT TWO BEDROOM TYPE 1 KITCHEN & LAUNDRY
	APT TWO BEDROOM TYPE 1 BATHROOM
AI-405	APT TWO BEDROOM TYPE 2 - KITCHEN & LAUNDRY
AI-406	APT TWO BEDROOM TYPE 2 - BATHROOM DETAILS
AI-407	APT TWO BEDROOM TYPE 3 - KITCHEN & LAUNDRY
AI-408	APT TWO BEDROOM TYPE 3 - BATHROOM
AI-409	APT LOBBY BATHROOM
AI-500	STAIR DETAIL
AI-501	ENTRY STAIR, ENTRY RAMP, EXIT STAIR DETAIL
AI-502	BUILDING DETAILS
AI-503	SHED ROOF DETAILS
AI-504	WALL TYPE AND CLADDING DETAILS
AI-505	BAFFLE CEILING DETAILS
AI-601	DOOR SCHEDULE
AI-602	DOOR SCHEDULE
AI-603	DOOR SCHEDULE
AI-604	WINDOW SCHEDULE
AI-605	SCREEN SCHEDULE
EXI-100	OVERALL SITE PLAN
GI-100	PROPOSED SITE PLAN W/PARKING LOT

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4. Do not scale drawings. All dimensions are to be verified by the contractor and all disciplines. Any discrepancies are to be brought to the attention of the architect.

PROJECT INFORMATION

BUILDING TYPE:	MULTIFAMILY DWELLING
TOTAL BUILDING LEVELS :	3 STOREYS
TOTAL UNITS:	47
ONE BEDROOM:	12
TWO BEDROOM:	35

AREAS

.00 LEVEL SLAB	19317 SF	1795
.01 LEVEL SLAB	19961 SF	1854
.02 LEVEL SLAB	19963 SF	1855
TOTAL AREA: 3	59241 SF	5504

VICINITY MAP

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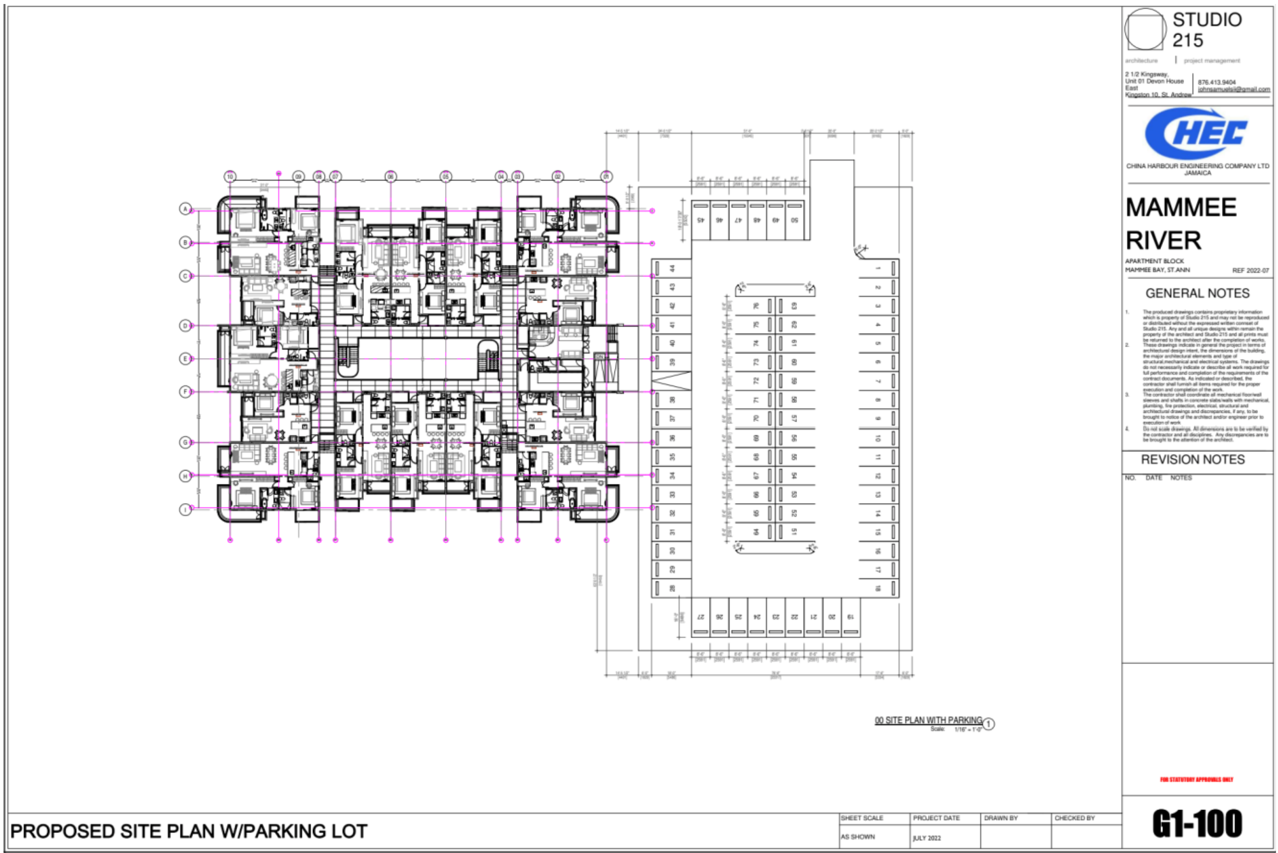

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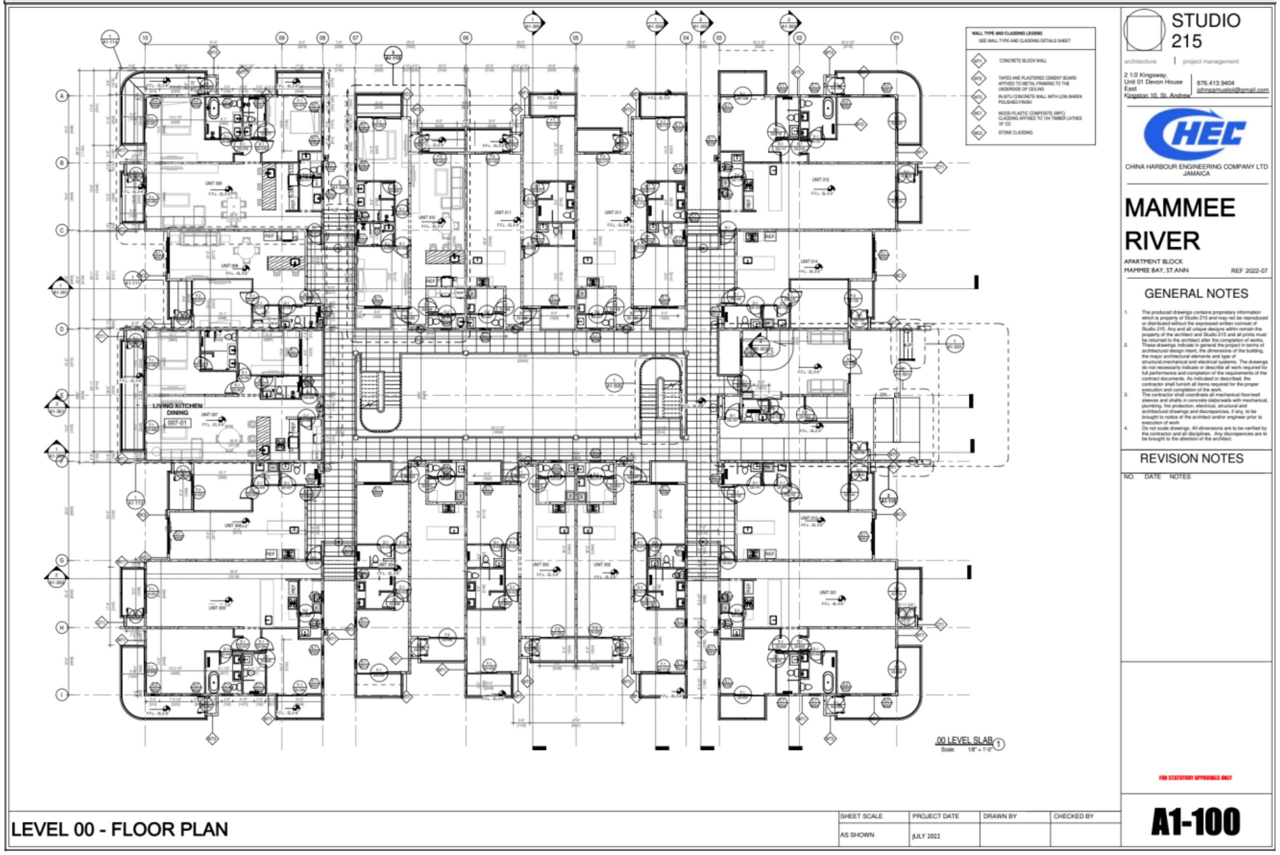
REVISION NOTES

NO.	DATE	NOTES

PROPOSED SITE PLAN W/PARKING LOT

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

G1-100



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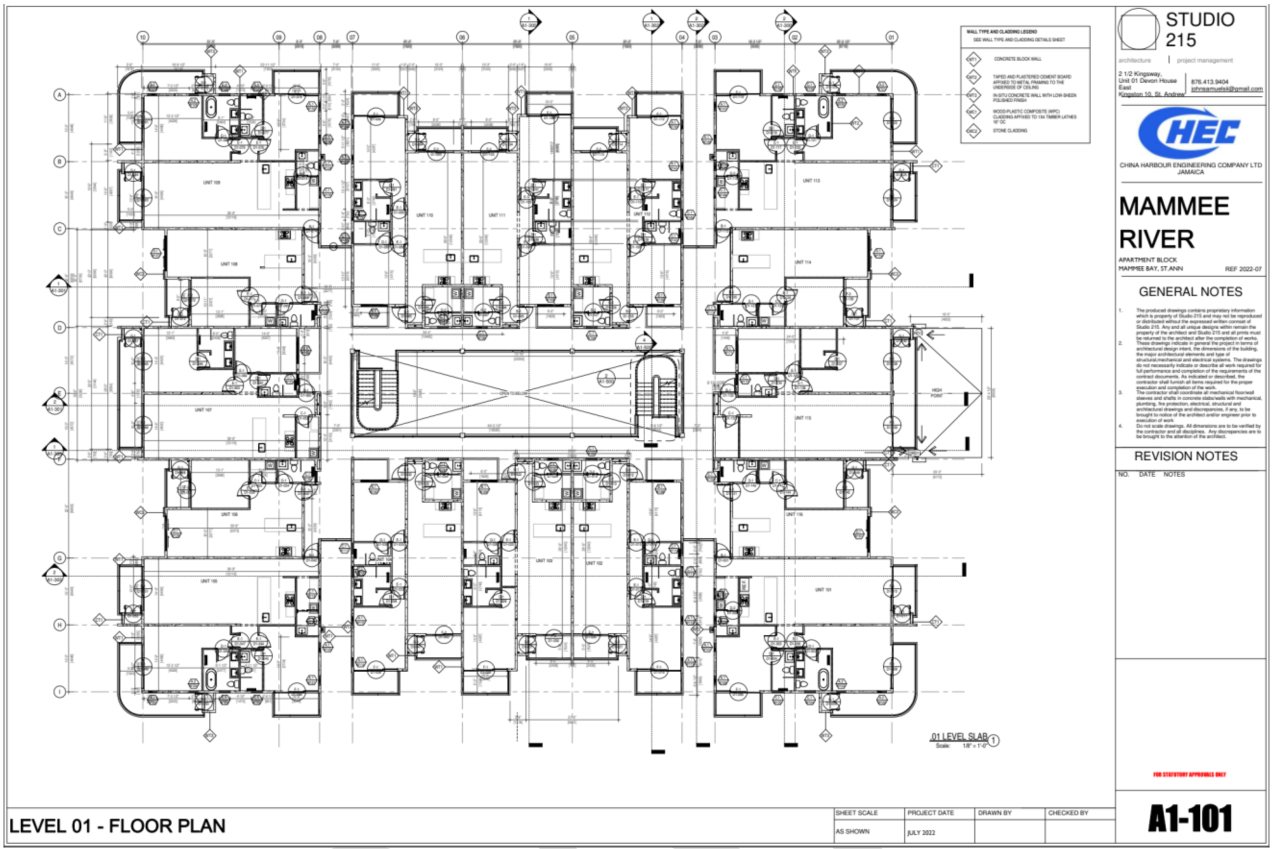
REVISION NOTES

NO. DATE NOTES

LEVEL 00 - FLOOR PLAN

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

A1-100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GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
FOR STATUTORY APPROVALS ONLY
WALL TYPE AND CLADDING LEGEND
01 LEVEL SLAB 1
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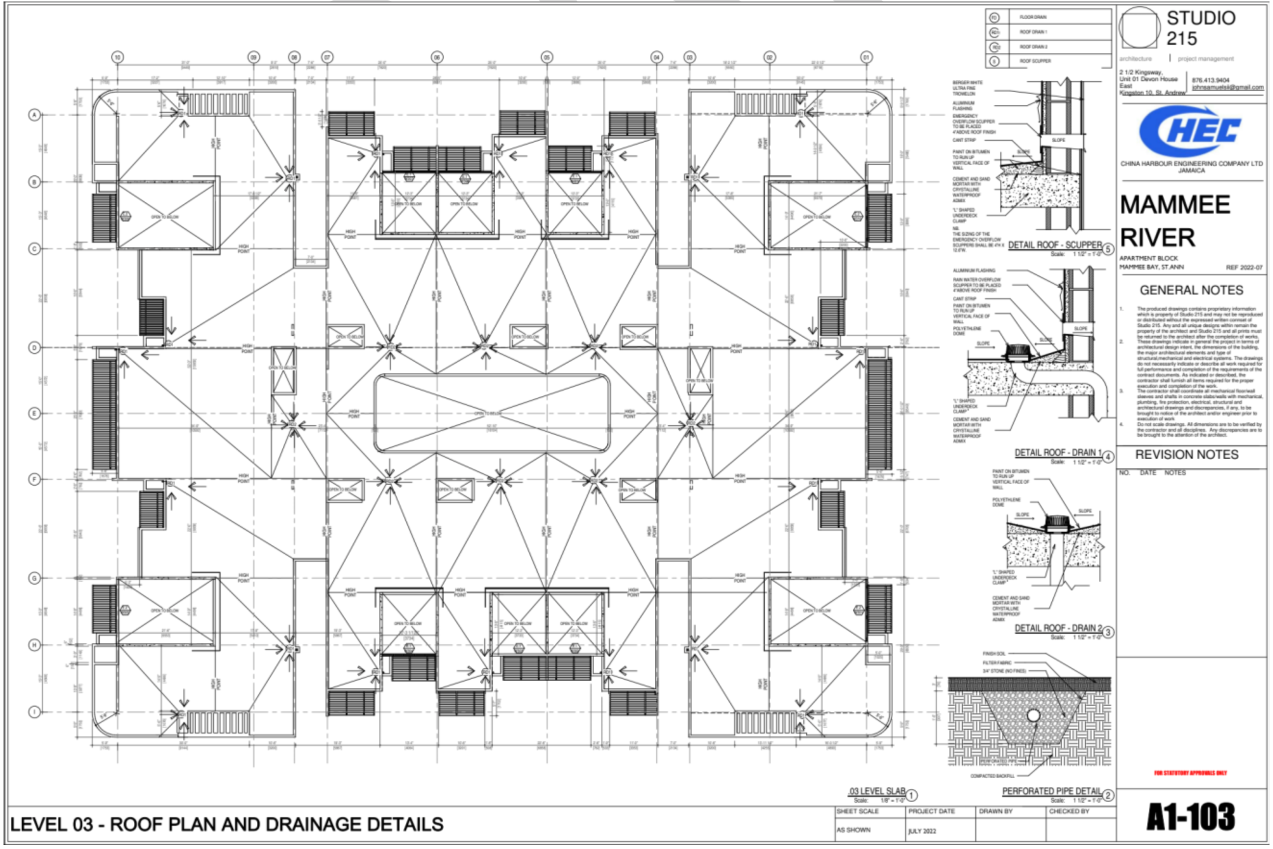
LEVEL 01 - FLOOR PLAN
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-101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GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
DETAIL ROOF - SCUPPER 5
DETAIL ROOF - DRAIN 1 4
DETAIL ROOF - DRAIN 2 3
PERFORATED PIPE DETAIL 2
03 LEVEL SLAB 1
FOR STATUTORY APPROVALS ONLY
LEVEL 03 - ROOF PLAN AND DRAINAGE DETAILS
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
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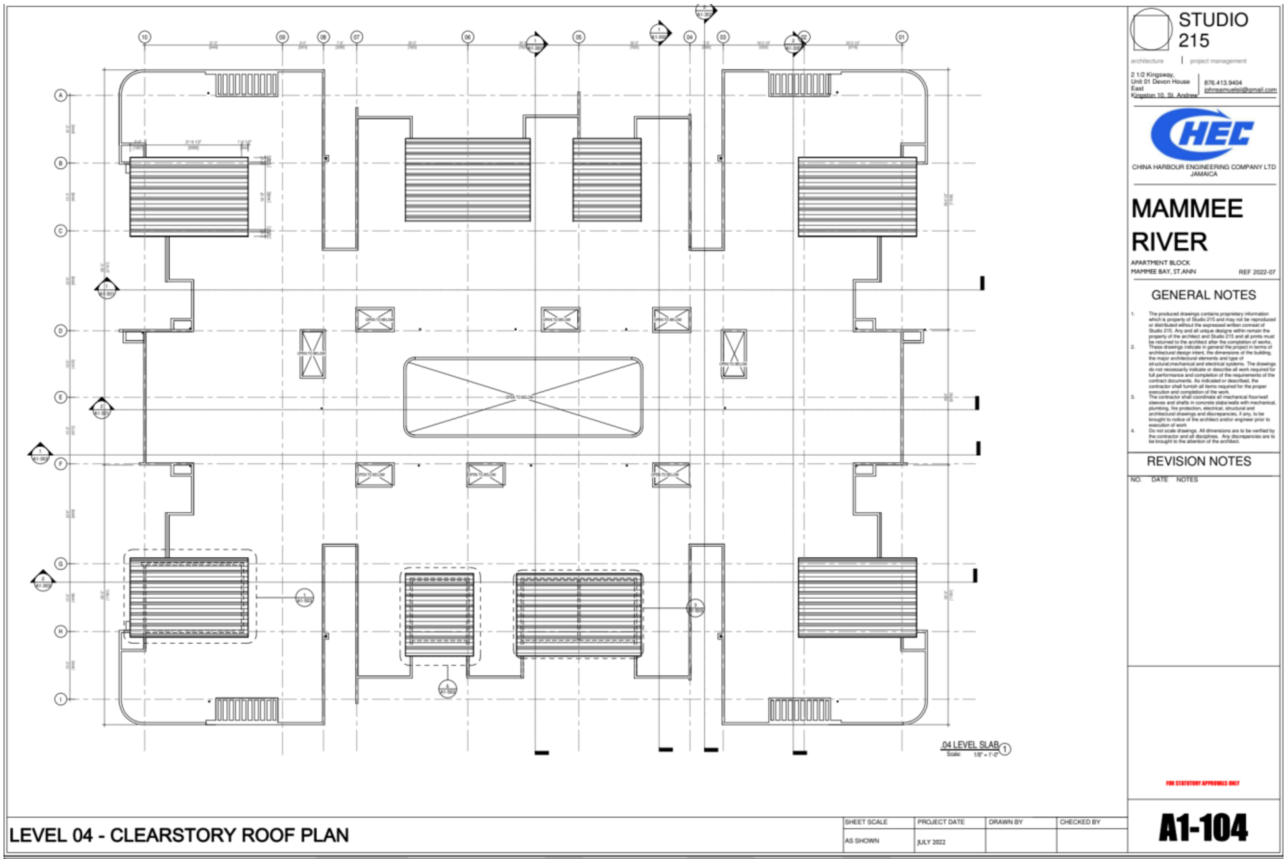
A1-103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GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
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Scale: 1/8" = 1'-0"
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SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
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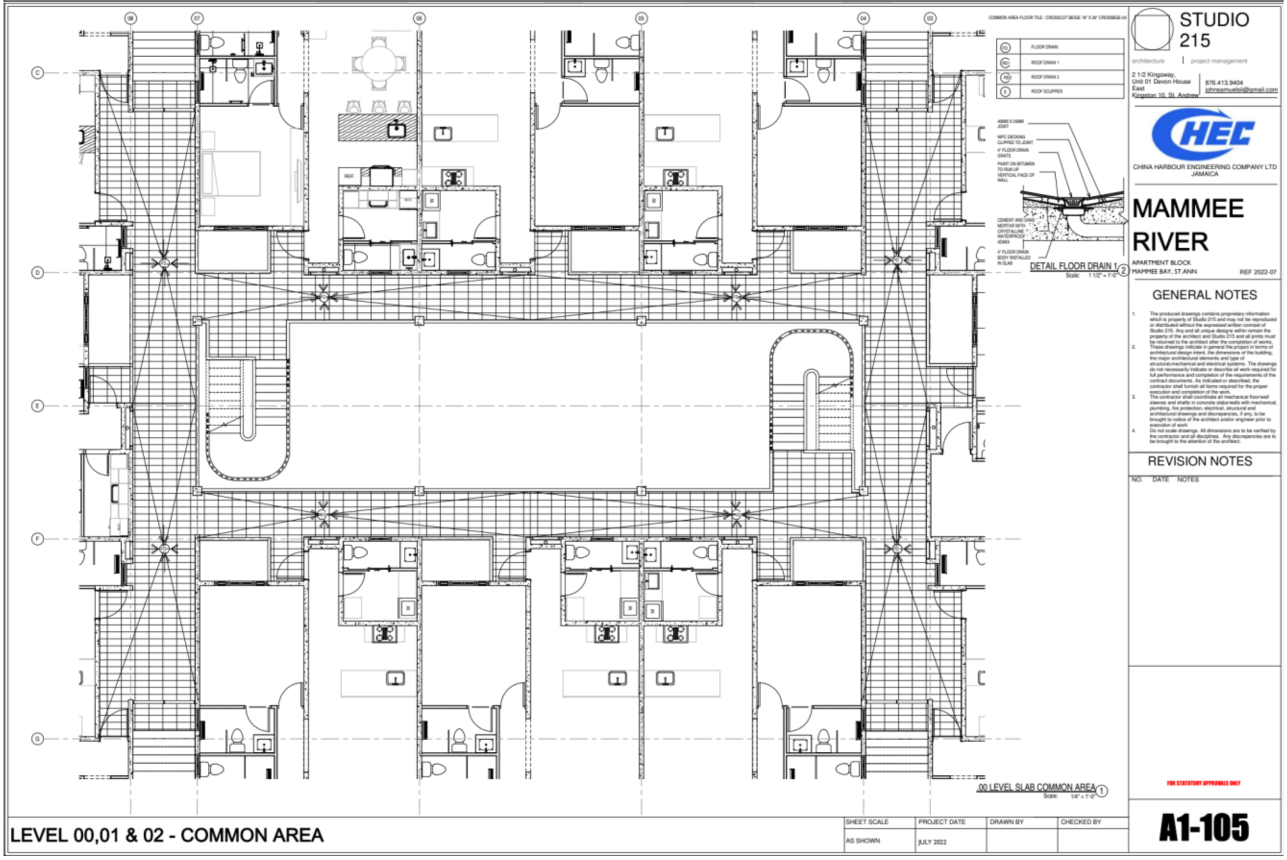
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REF 2022-07
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
FLOOR DRAIN
ROOF DRAIN 1
ROOF DRAIN 2
ROOF SCUPPER
DETAIL FLOOR DRAIN 2
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FOR STATUTORY APPROVALS ONLY
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Scale: 1/4" = 1'-0"
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SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
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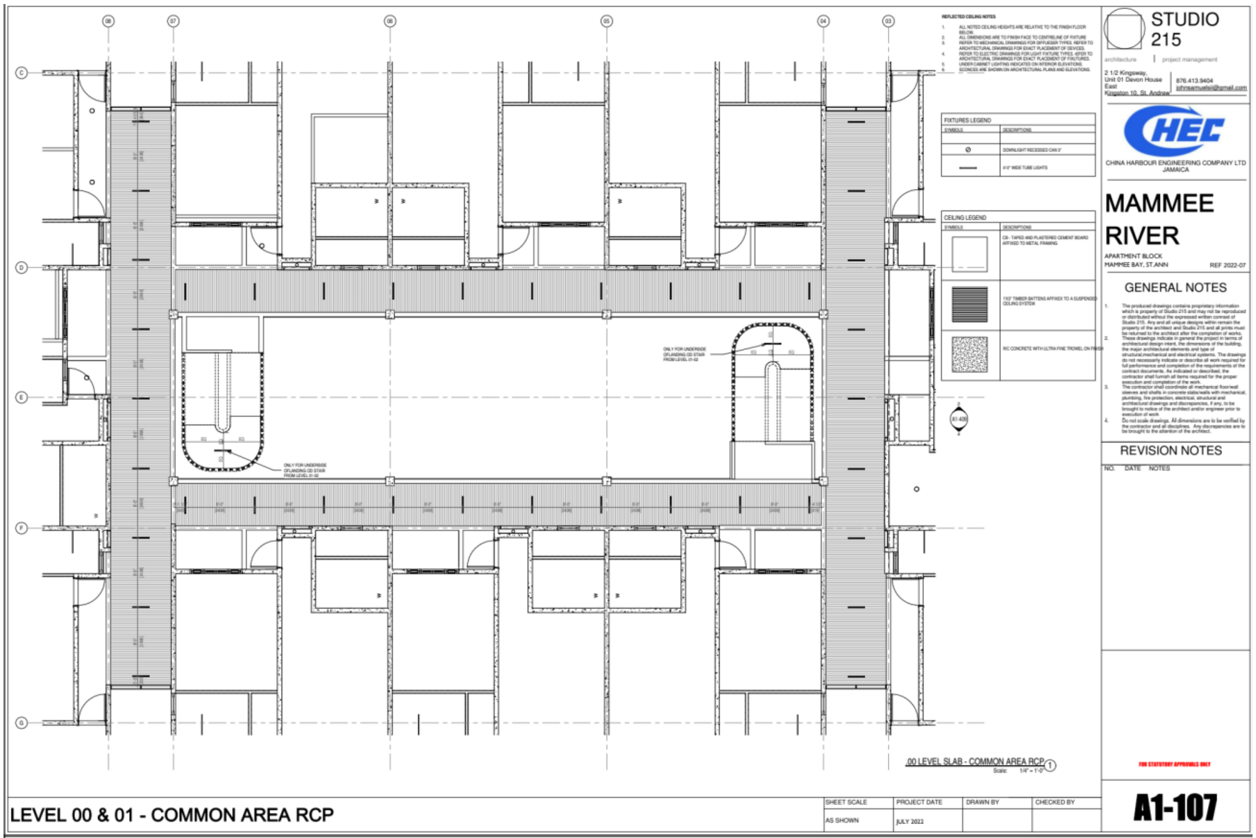
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ONLY FOR UNDERSIDE OFLANDING OD STAIR FROM LEVEL 01-02
EQ
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2. ALL DIMENSIONS ARE TO FINISH FACE TO CENTRELINE OF FIXTURE
3. REFER TO MECHANICAL DRAWINGS FOR DIFFUESER TYPES. REFER TO ARCHITECTURAL DRAWINGS FOR EXACT PLACEMENT OF DEVICES.
4. REFER TO ELECTRIC DRAWINGS FOR LIGHT FIXTURE TYPES. rEFER TO ARCHITECTURAL DRAWINGS FOR EXACT PLACEMENT OF FIXUTURES.
5. UNDER CABINET LIGHTING INDICATED ON INTERIOR ELEVATIONS.
6. SCONCES ARE SHOWN ON ARCHITECTURAL PLANS AND ELEVATIONS.
FIXTURES LEGEND
SYMBOLS
DESCRIPTIONS
⊘ DOWNLIGHT RECESSED CAN 3"
— 4'-0" WIDE TUBE LIGHTS
CEILING LEGEND
SYMBOLS
DESCRIPTIONS
CB - TAPED AND PLASTERED CEMENT BOARD AFFIXED TO METAL FRAMING
1"X3" TIMBER BATTENS AFFIXEX TO A SUSPENDED CEILING SYSTEM
R/C CONCRETE WITH ULTRA FINE TROWEL ON FINISH
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REVISION NOTES
NO. DATE NOTES
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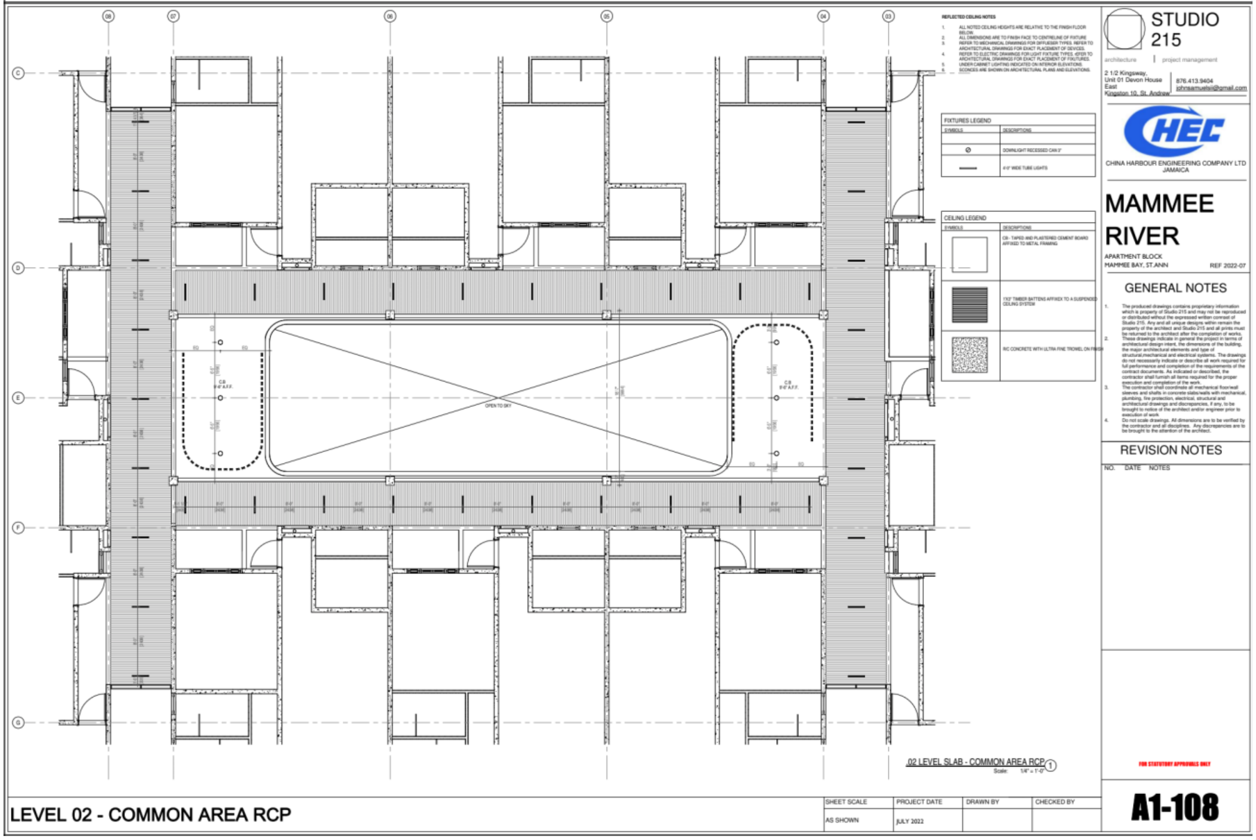
Scale: 1/4" = 1'-0"
FOR STATUTORY APPROVALS ONLY
LEVEL 00 & 01 - COMMON AREA RCP
SHEET SCALE AS SHOWN
PROJECT DATE JULY 2022
DRAWN BY
CHECKED BY
A1-107


08
07
06
05
04
03
C
D
E
F
G
OPEN TO SKY
C.B 9'-6" A.F.F.
EQ
REFLECTED CEILING NOTES
1. ALL NOTED CEILING HEIGHTS ARE RELATIVE TO THE FINISH FLOOR BELOW.
2. ALL DIMENSIONS ARE TO FINISH FACE TO CENTRELINE OF FIXTURE
3. REFER TO MECHANICAL DRAWINGS FOR DIFFUESER TYPES. REFER TO ARCHITECTURAL DRAWINGS FOR EXACT PLACEMENT OF DEVICES.
4. REFER TO ELECTRIC DRAWINGS FOR LIGHT FIXTURE TYPES. rEFER TO ARCHITECTURAL DRAWINGS FOR EXACT PLACEMENT OF FIXUTURES.
5. UNDER CABINET LIGHTING INDICATED ON INTERIOR ELEVATIONS.
6. SCONCES ARE SHOWN ON ARCHITECTURAL PLANS AND ELEVATIONS.
FIXTURES LEGEND
SYMBOLS
DESCRIPTIONS
⊘ DOWNLIGHT RECESSED CAN 3"
— 4'-0" WIDE TUBE LIGHTS
CEILING LEGEND
SYMBOLS
DESCRIPTIONS
CB - TAPED AND PLASTERED CEMENT BOARD AFFIXED TO METAL FRAMING
1"X3" TIMBER BATTENS AFFIXEX TO A SUSPENDED CEILING SYSTEM
R/C CONCRETE WITH ULTRA FINE TROWEL ON FINISH
STUDIO 215
architecture | project management
2 1/2 Kingsway, Unit 01 Devon House East Kingston 10, St. Andrew
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johnsamuelsii@gmail.com
CHEC
CHINA HARBOUR ENGINEERING COMPANY LTD JAMAICA
MAMMEE RIVER
APARTMENT BLOCK
MAMMEE BAY, ST.ANN
REF 2022-07
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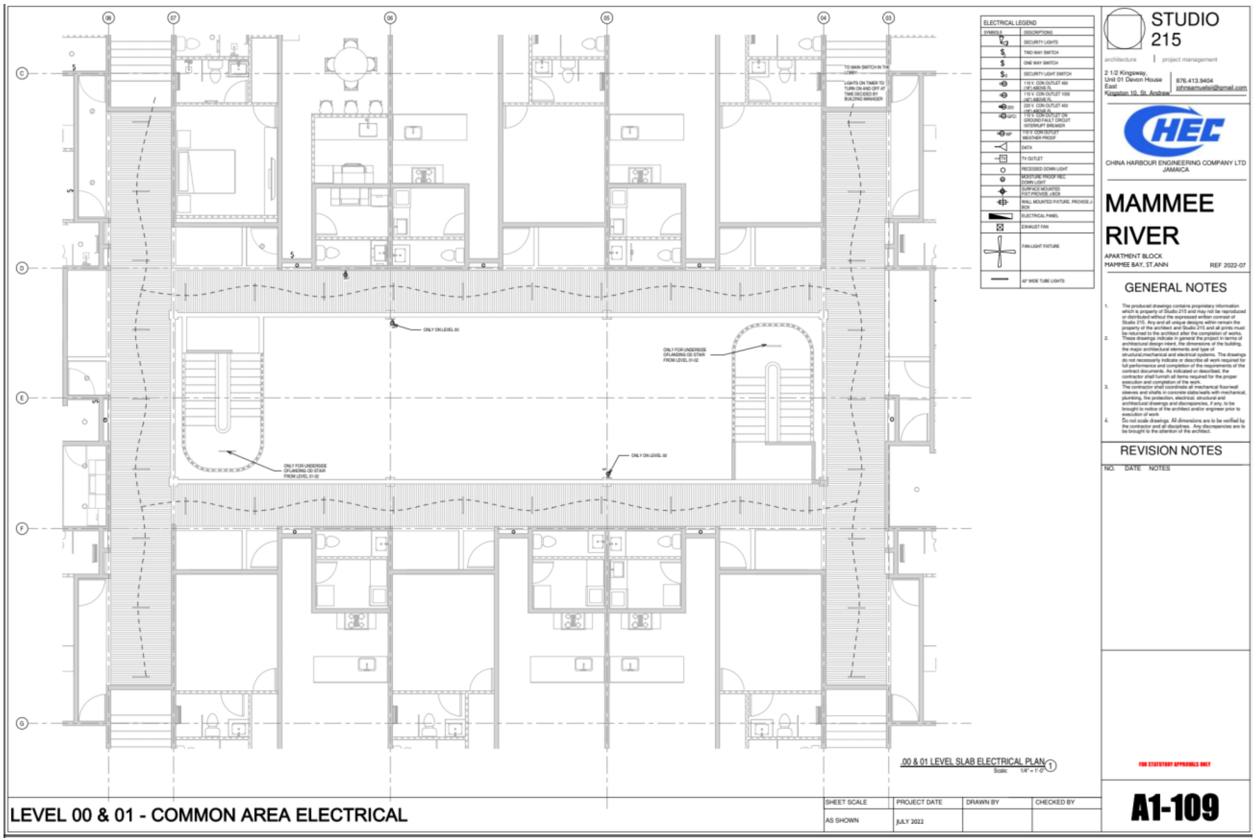
REVISION NOTES
NO. DATE NOTES
.02 LEVEL SLAB - COMMON AREA RCP ①
Scale: 1/4" = 1'-0"
FOR STATUTORY APPROVALS ONLY
LEVEL 02 - COMMON AREA RCP
SHEET SCALE AS SHOWN
PROJECT DATE JULY 2022
DRAWN BY
CHECKED BY
A1-108



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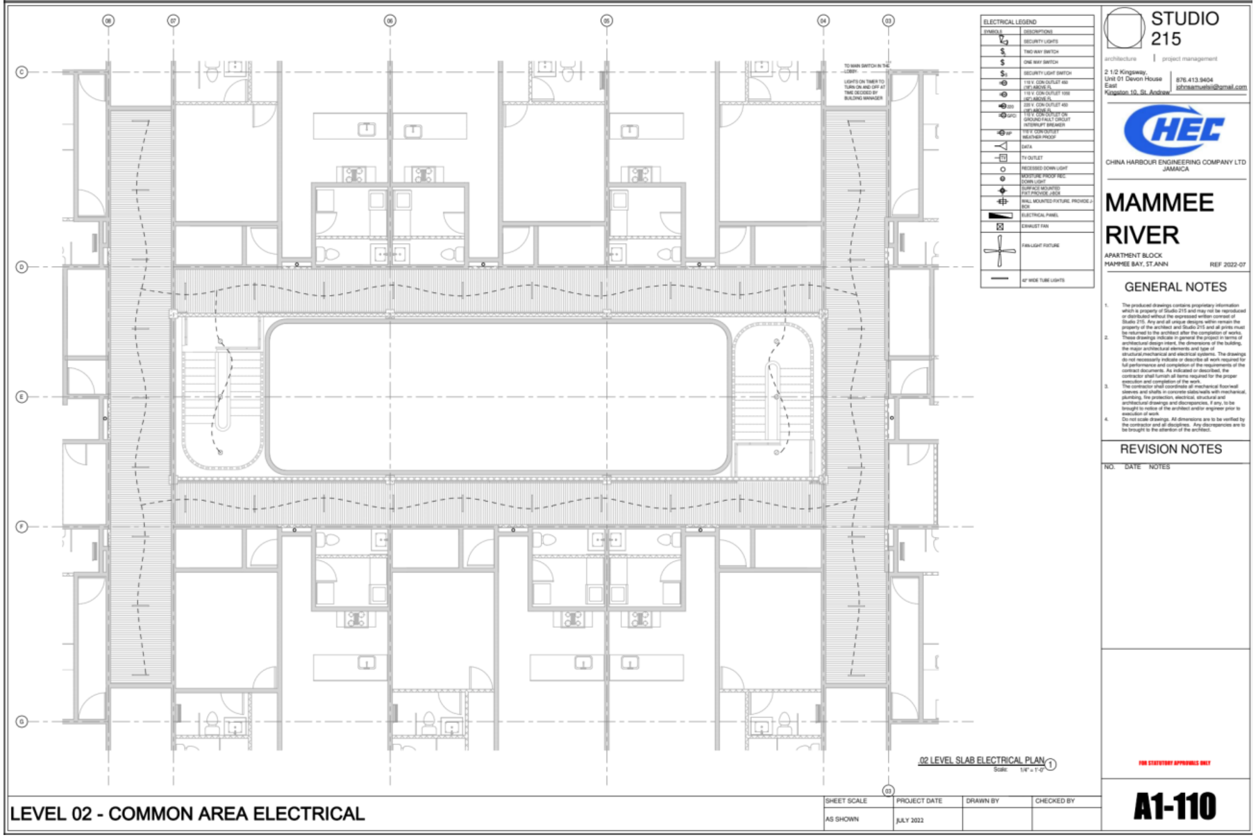

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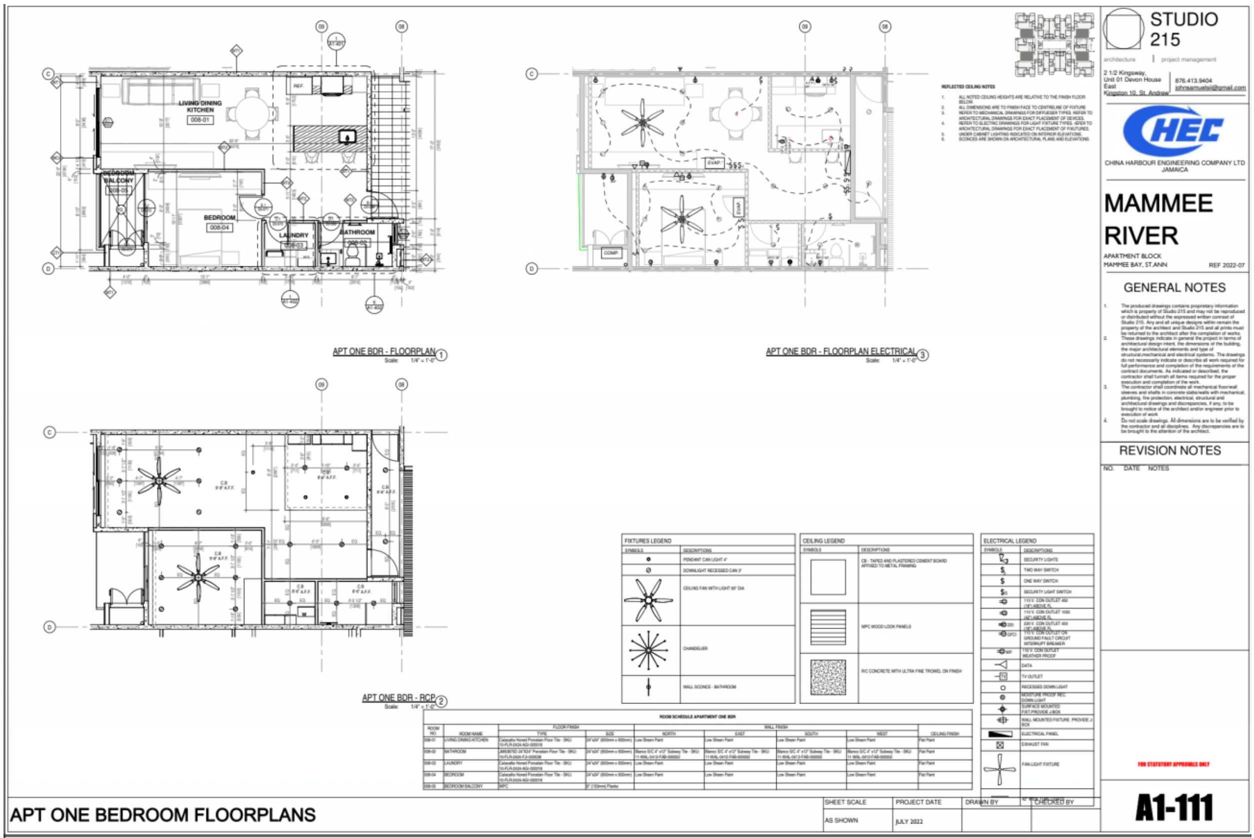

APT ONE BDR - FLOORPLAN ①
Scale: 1/4" = 1'-0"

APT ONE BDR - FLOORPLAN ELECTRICAL ③
Scale: 1/4" = 1'-0"

APT ONE BDR - RCP ②
Scale: 1/4" = 1'-0"

REFLECTED CEILING NOTES

1. ALL NOTED CEILING HEIGHTS ARE RELATIVE TO THE FINISH FLOOR BELOW.
2. ALL DIMENSIONS ARE TO FINISH FACE TO CENTRELINE OF FIXTURE
3. REFER TO MECHANICAL DRAWINGS FOR DIFFUESER TYPES. REFER TO ARCHITECTURAL DRAWINGS FOR EXACT PLACEMENT OF DEVICES.
4. REFER TO ELECTRIC DRAWINGS FOR LIGHT FIXTURE TYPES. rEFER TO ARCHITECTURAL DRAWINGS FOR EXACT PLACEMENT OF FIXUTURES.
5. UNDER CABINET LIGHTING INDICATED ON INTERIOR ELEVATIONS.
6. SCONCES ARE SHOWN ON ARCHITECTURAL PLANS AND ELEVATIONS.

FIXTURES LEGEND

SYMBOLS	DESCRIPTIONS
●	PENDANT CAN LIGHT 4"
⌀	DOWNLIGHT RECESSED CAN 3"
	CEILING FAN WITH LIGHT 60" DIA
	CHANDELIER
	WALL SCONCE - BATHROOM

CEILING LEGEND

SYMBOLS	DESCRIPTIONS
☐	CB - TAPED AND PLASTERED CEMENT BOARD AFFIXED TO METAL FRAMING
▤	WPC WOOD LOOK PANELS
▨	R/C CONCRETE WITH ULTRA FINE TROWEL ON FINISH

ELECTRICAL LEGEND

SYMBOLS	DESCRIPTIONS
	SECURITY LIGHTS
$	TWO WAY SWITCH
$	ONE WAY SWITCH
$S	SECURITY LIGHT SWITCH
	110 V. CON OUTLET 450 (18") ABOVE FL
	110 V. CON OUTLET 1050 (42") ABOVE FL
220	220 V. CON OUTLET 450 (18") ABOVE FL
GFCI	110 V. CON OUTLET ON GROUND FAULT CIRCUIT INTERRUPT BREAKER
WP	110 V. CON OUTLET WEATHER PROOF
	DATA
TV	TV OUTLET
○	RECESSED DOWN LIGHT
	MOISTURE PROOF REC. DOWN LIGHT
	SURFACE MOUNTED FIXT. PROVIDE J-BOX
	WALL MOUNTED FIXTURE. PROVIDE J-BOX
	ELECTRICAL PANEL
☒	EXHAUST FAN
	FAN-LIGHT FIXTURE
	42" WIDE TUBE LIGHTS

ROOM SCHEDULE APARTMENT ONE BDR

ROOM NO.	ROOM NAME	FLOOR FINISH		WALL FINISH				CEILING FINISH
		TYPE	SIZE	NORTH	EAST	SOUTH	WEST	
008-01	LIVING DINING KITCHEN	Calacatta Honed Porcelain Floor Tile - SKU: 10-FLR-2424-AGI-000016	24"x24" (600mm x 600mm)	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
008-02	BATHROOM	JM63875D 24"X24" Porcelain Floor Tile - SKU: 10-FLR-2424-FJI-000038	24"x24" (600mm x 600mm)	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Flat Paint
008-03	LAUNDRY	Calacatta Honed Porcelain Floor Tile - SKU: 10-FLR-2424-AGI-000016	24"x24" (600mm x 600mm)	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
008-04	BEDROOM	Calacatta Honed Porcelain Floor Tile - SKU: 10-FLR-2424-AGI-000016	24"x24" (600mm x 600mm)	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
008-05	BEDROOM BALCONY	WPC	6" (150mm) Planks					

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REVISION NOTES

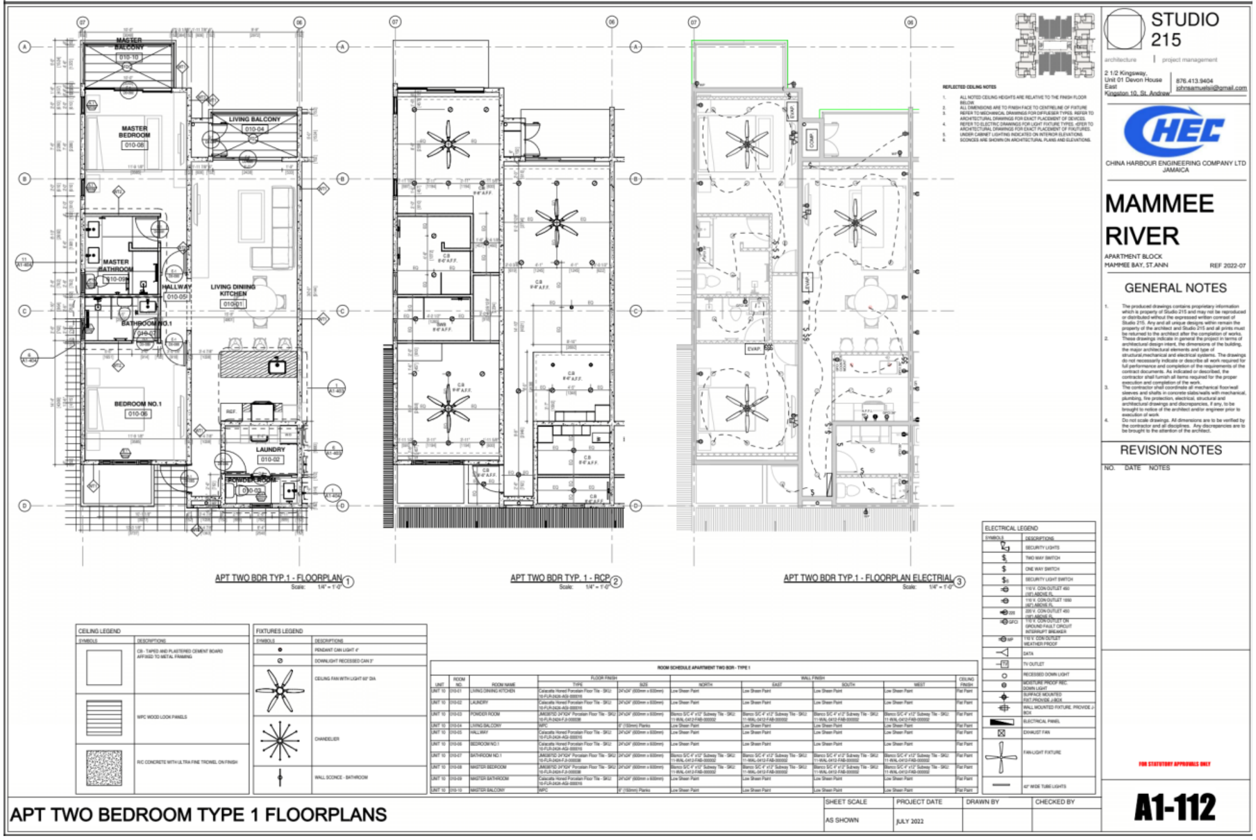
NO. DATE NOTES

FOR STATUTORY APPROVALS ONLY

APT ONE BEDROOM FLOORPLANS

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

A1-111



APT TWO BDR TYP. 1 - FLOORPLAN ①
Scale: 1/4" = 1'-0"

APT TWO BDR TYP. 1 - RCP ②
Scale: 1/4" = 1'-0"

APT TWO BDR TYP.1 - FLOORPLAN ELECTRIAL ③
Scale: 1/4" = 1'-0"

REFLECTED CEILING NOTES

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2. ALL DIMENSIONS ARE TO FINISH FACE TO CENTRELINE OF FIXTURE
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CEILING LEGEND

SYMBOLS	DESCRIPTIONS
☐	CB - TAPED AND PLASTERED CEMENT BOARD AFFIXED TO METAL FRAMING
▤	WPC WOOD LOOK PANELS
▨	R/C CONCRETE WITH ULTRA FINE TROWEL ON FINISH

FIXTURES LEGEND

SYMBOLS	DESCRIPTIONS
●	PENDANT CAN LIGHT 4"
⌀	DOWNLIGHT RECESSED CAN 3"
	CEILING FAN WITH LIGHT 60" DIA
	CHANDELIER
	WALL SCONCE - BATHROOM

ELECTRICAL LEGEND

SYMBOLS	DESCRIPTIONS
	SECURITY LIGHTS
$	TWO WAY SWITCH
$	ONE WAY SWITCH
$S	SECURITY LIGHT SWITCH
	110 V. CON OUTLET 450 (18") ABOVE FL
	110 V. CON OUTLET 1050 (42") ABOVE FL
220	220 V. CON OUTLET 450 (18") ABOVE FL
GFCI	110 V. CON OUTLET ON GROUND FAULT CIRCUIT INTERRUPT BREAKER
WP	110 V. CON OUTLET WEATHER PROOF
	DATA
TV	TV OUTLET
○	RECESSED DOWN LIGHT
	MOISTURE PROOF REC. DOWN LIGHT
	SURFACE MOUNTED FIXT. PROVIDE J-BOX
	WALL MOUNTED FIXTURE. PROVIDE J-BOX
	ELECTRICAL PANEL
☒	EXHAUST FAN
	FAN-LIGHT FIXTURE
	42" WIDE TUBE LIGHTS

ROOM SCHEDULE APARTMENT TWO BDR - TYPE 1

UNIT	ROOM NO.	ROOM NAME	FLOOR FINISH		WALL FINISH				CEILING FINISH
			TYPE	SIZE	NORTH	EAST	SOUTH	WEST	
UNIT 10	010-01	LIVING DINING KITCHEN	Calacatta Honed Porcelain Floor Tile - SKU: 10-FLR-2424-AGI-000016	24"x24" (600mm x 600mm)	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
UNIT 10	010-02	LAUNDRY	Calacatta Honed Porcelain Floor Tile - SKU: 10-FLR-2424-AGI-000016	24"x24" (600mm x 600mm)	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
UNIT 10	010-03	POWDER ROOM	JM63875D 24"X24" Porcelain Floor Tile - SKU: 10-FLR-2424-FJI-000038	24"x24" (600mm x 600mm)	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Flat Paint
UNIT 10	010-04	LIVING BALCONY	WPC	6" (150mm) Planks	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
UNIT 10	010-05	HALLWAY	Calacatta Honed Porcelain Floor Tile - SKU: 10-FLR-2424-AGI-000016	24"x24" (600mm x 600mm)	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
UNIT 10	010-06	BEDROOM NO.1	Calacatta Honed Porcelain Floor Tile - SKU: 10-FLR-2424-AGI-000016	24"x24" (600mm x 600mm)	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
UNIT 10	010-07	BATHROOM NO.1	JM63875D 24"X24" Porcelain Floor Tile - SKU: 10-FLR-2424-FJI-000038	24"x24" (600mm x 600mm)	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Flat Paint
UNIT 10	010-08	MASTER BEDROOM	JM63875D 24"X24" Porcelain Floor Tile - SKU: 10-FLR-2424-FJI-000038	24"x24" (600mm x 600mm)	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Flat Paint
UNIT 10	010-09	MASTER BATHROOM	Calacatta Honed Porcelain Floor Tile - SKU: 10-FLR-2424-AGI-000016	24"x24" (600mm x 600mm)	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint
UNIT 10	010-10	MASTER BALCONY	WPC	6" (150mm) Planks	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Low Sheen Paint	Flat Paint

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NO. DATE NOTES

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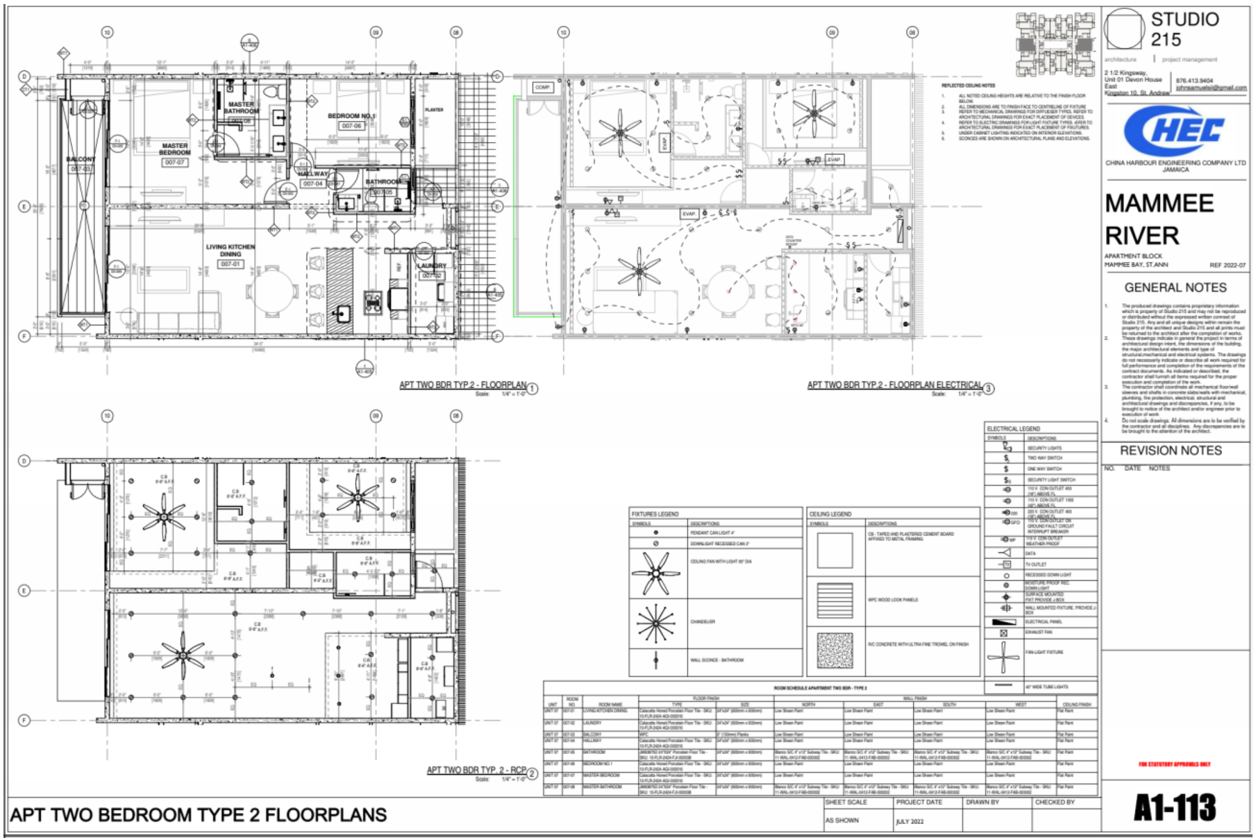
APT TWO BEDROOM TYPE 1 FLOORPLANS

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

A1-112



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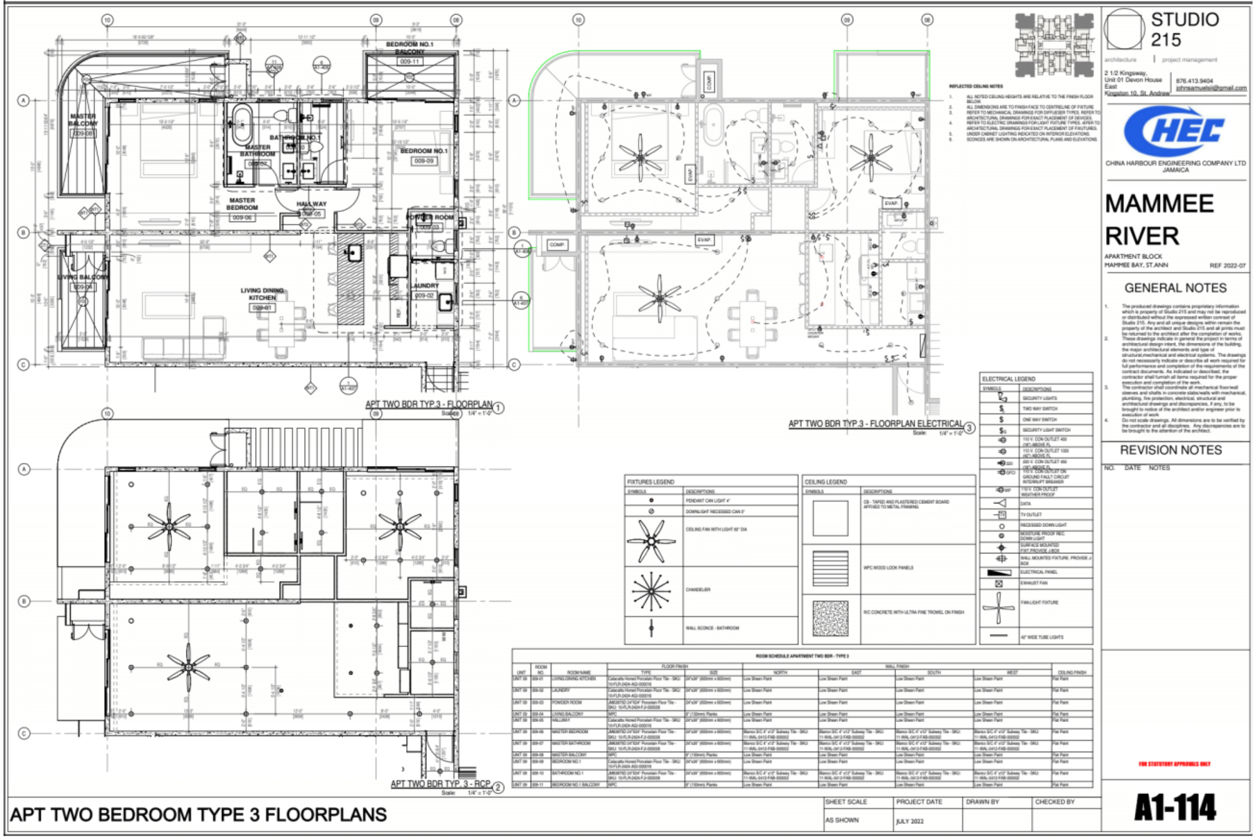

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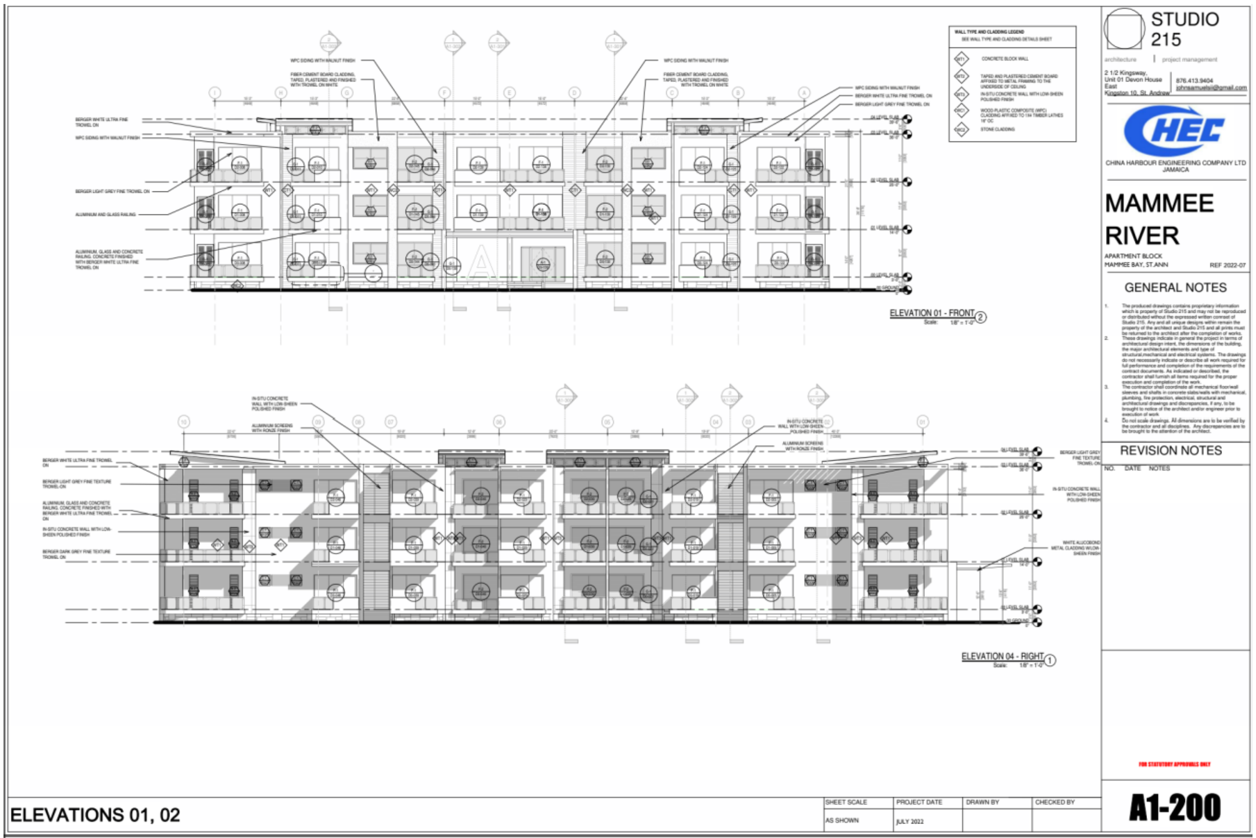
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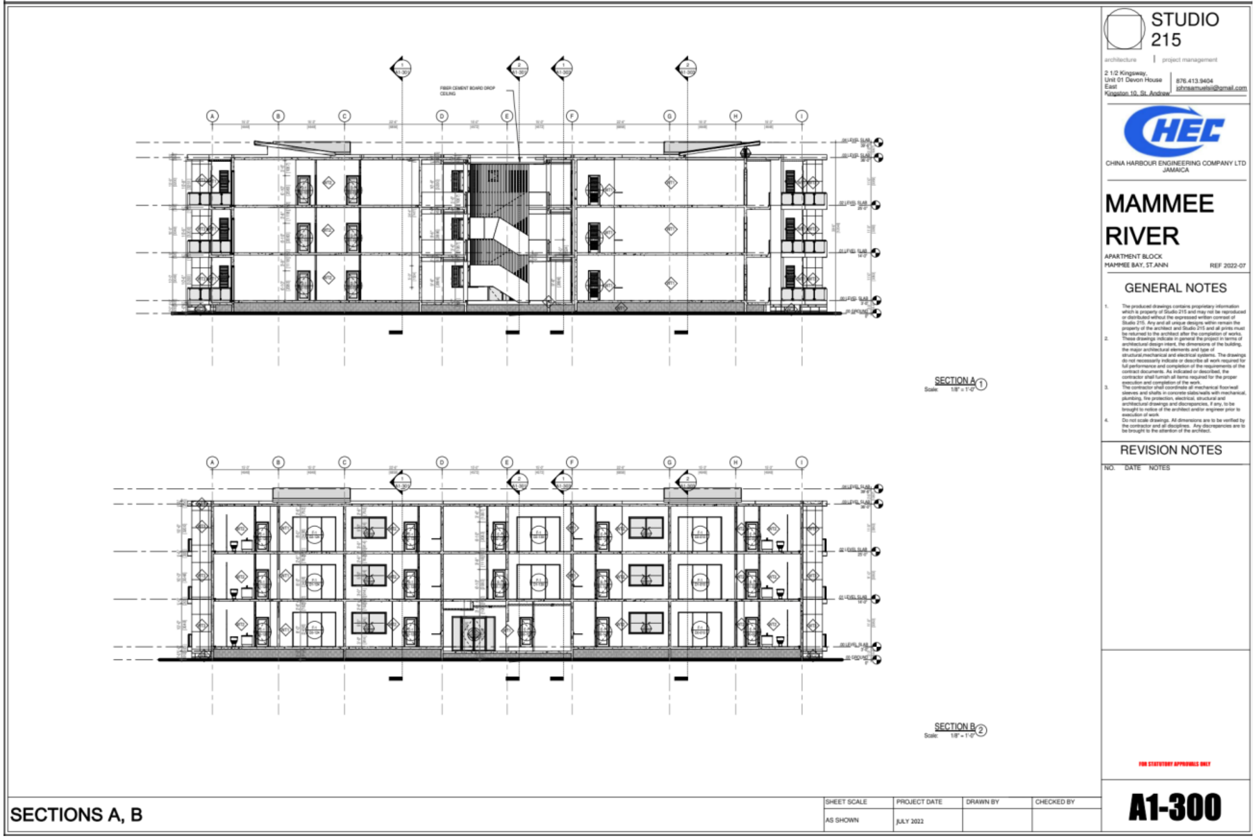
REF 2022-07
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
ELEVATION 01 - FRONT
ELEVATION 04 - RIGHT
ELEVATIONS 01, 02
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-200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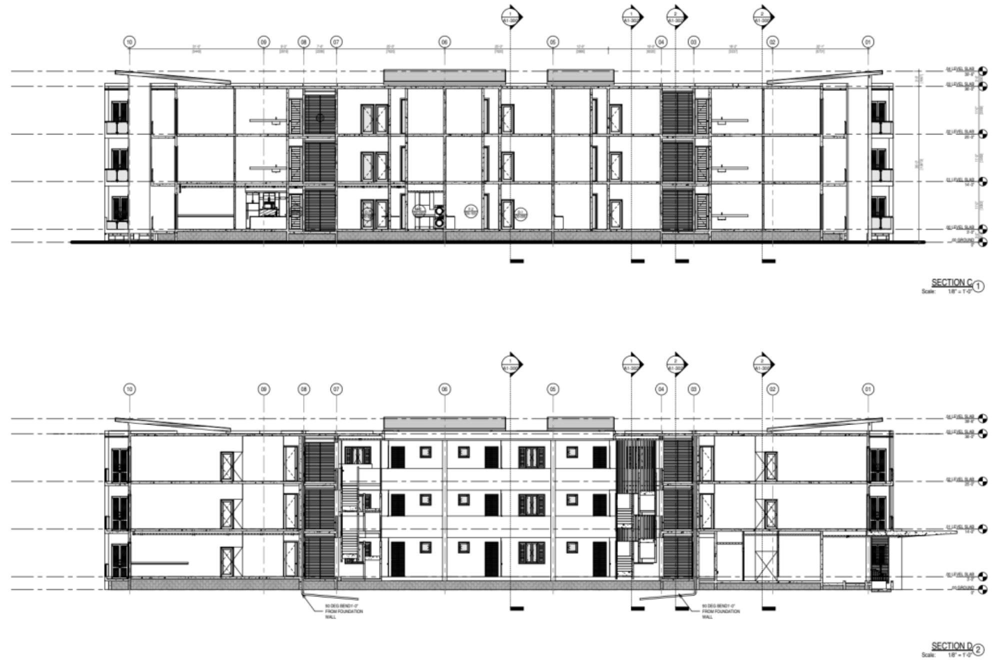
MAMMEE BAY, ST.ANN
REF 2022-07
GENERAL NOTES
REVISION NOTES
SECTION A
SECTION B
SECTIONS A, B
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-300



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REVISION NOTES

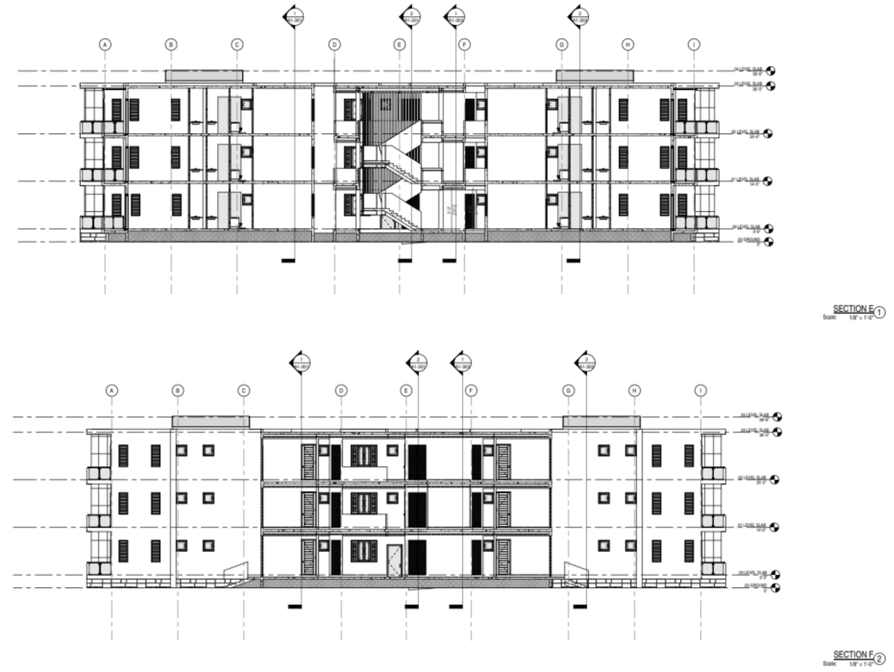
NO.	DATE	NOTES

FOR STATUTORY APPROVALS ONLY

SECTIONS C, D

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

A1-301



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REVISION NOTES

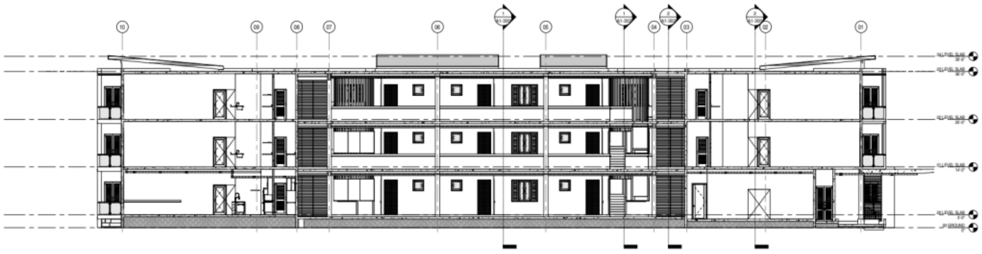
NO. DATE NOTES

FOR STATUTORY APPROVALS ONLY

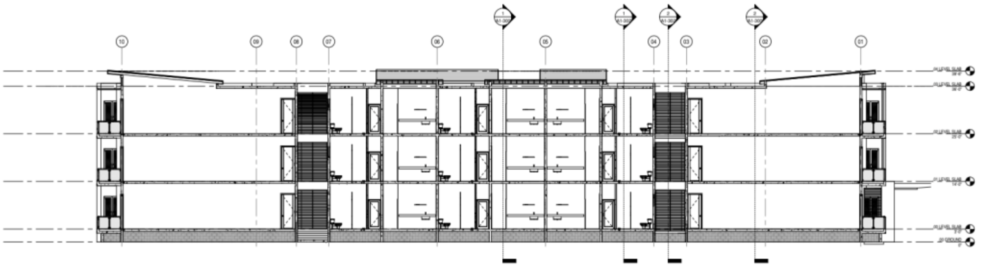
SECTIONS E, F

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

A1-302



SECTION G ①
Scale: 1/8" = 1'-0"



SECTION H ②
Scale: 1/8" = 1'-0"

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REVISION NOTES

NO. DATE NOTES

FOR STATUTORY APPROVALS ONLY

SECTIONS G, H

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

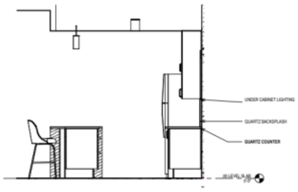
A1-303

ACCESSORIES SCHEDULE - APT ONE BDR

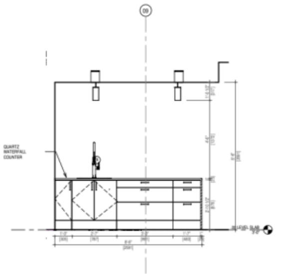
TAG	NO.	FIXTURE	DESCRIPTION	MODEL	COMMENTS
D1	1	Drain - Linear	H-D612 Linear Shower Drain in Nickel	SKU: 31-DRN-STNL-SAN-000001	24" drain
F1	1	Faucet - Bathroom Sink	WDG16431JW Lavatory Faucet in White and Chrome	SKU: 34-LAV-CHWH-HKA-000002	
F2	1	Faucet - Shower	522880C Tub & Shower Faucet in Chrome	SKU: 34-TSH-CHRM-CAE-000001	
F4	1	Faucet - Kitchen	503742C Kitchen Faucet in Chrome	SKU: 34-KIT-CHRM-CAE-000005	
F5	1	Faucet - Laundry	Single Handle Pull-Down Kitchen Faucet in Chrome	SKU: 34-KIT-CHRM-PER-000003	
S1	1	Sink - Bathroom Vessel	5122 Select Countertop Basin in White	SKU: 32-CTB-WHIT-MUY-000004	
S5	2	Sink - Kitchen	23" Undermount Kitchen Single Sink in Stainless Steel	SKU: 42-UMT-SNGL-YJA-000002	
T1	1	Toilet	Select MY2133 One Piece Toilet in White	SKU: 30-1PC-WHEL-MUY-000002	
T2	2	Toilet - Paper Holder	Voisin Towel Ring in Polished Chrome	SKU: 33-TPH-PLCH-LIB-000007	
TL1	1	Towel - Bar	Utah 18" Towel Bar in Chrome	SKU: 33-TBR-CHRM-DEL-000005	
TL2	1	Towel - Ring	Voisin Toilet Paper Holder in Polished Chrome	SKU: 33-TRG-PLCH-LIB-000007	

CASEWORK NOTES

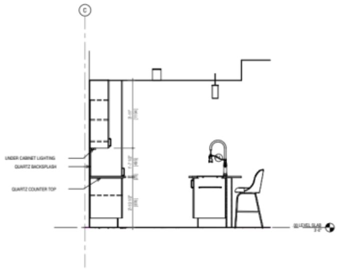
1. 1 1/2" FILLER PANELS SHALL OCCUR AT THE WALL. AT ALL CABINET LOCATIONS ABUTTING A WALL UNLESS OTHERWISE NOTED.
2. WHEN FILLER PANELS ARE REQUIRED AT BOTH ENDS OF CASEWORK TERMINATION, BOTH FILLER PANELS SHALL BE EQUAL WIDTH.
3. PROVIDE 4" BACKSPLASH UNLESS OTHERWISE NOTED
4. COORDINATE ROUGH-IN FOR ELECTRICAL OUTLETTS, SWITCHED AND UNDER CABINTER ELECTRICAL DRAWINGS
5. CONTRACTOR TO VERIFY MEP AND DIMENSIONAL ROUCH IN REQUIREMENTS OF ALL OWNER PROVIDED EQUIPMENT AND APPLIANCES
6. PROVIDE 4" TOE-KICK, TYPICAL UNLESS OTHERWISE NOTED
7. PROVIDE GROMMETS IN COUNTERTOPS AS REQUIRED BY THE OWNER. FIELD VERIFY APPROX LOCATIONS
8. PROVIDE A 2" RADIUS AT THE END OF EXPOSED COUNTERTOPS



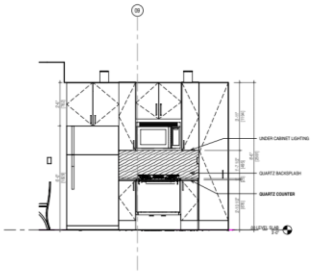
APT ONE BDR - KITCHEN ELV 4 ⑤
Scale: 1/2" = 1'-0"



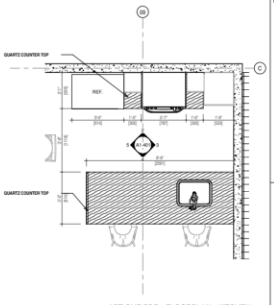
APT ONE BDR - KITCHEN ELV 3 ④
Scale: 1/2" = 1'-0"



APT ONE BDR - KITCHEN ELV 2 ③
Scale: 1/2" = 1'-0"



APT ONE BDR - KITCHEN ELV 1 ②
Scale: 1/2" = 1'-0"



APT ONE BDR - FLOORPLAN - KITCHEN ①
Scale: 1/2" = 1'-0"

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JAMAICA

MAMMEE RIVER

APARTMENT BLOCK
MAMMEE BAY, ST.ANN
REF 2022-07

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REVISION NOTES

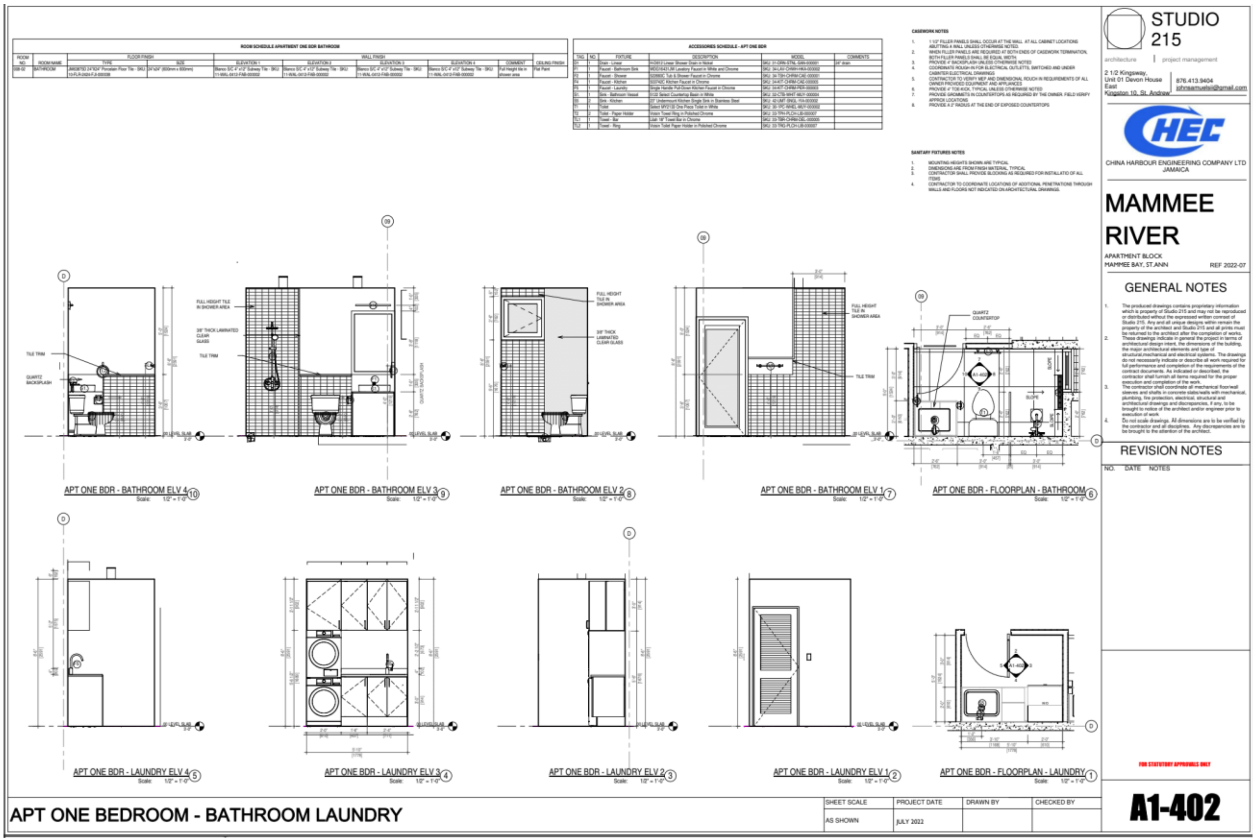
NO. DATE NOTES

FOR STATUTORY APPROVALS ONLY

APT ONE BEDROOM - KITCHEN

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

A1-401



ROOM SCHEDULE APARTMENT ONE BDR BATHROOM

ROOM NO.	ROOM NAME	FLOOR FINISH		WALL FINISH					CEILING FINISH
		TYPE	SIZE	ELEVATION 1	ELEVATION 2	ELEVATION 3	ELEVATION 4	COMMENT	
008-02	BATHROOM	JM6087SD 24"X24" Porcelain Floor Tile - SKU: 10-FLR-2424-FJI-000038	24"x24" (600mm x 600mm)	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Blanco S/C 4" x12" Subway Tile - SKU: 11-WAL-0412-FAB-000002	Full Height tile in shower area	Flat Paint

ACCESSORIES SCHEDULE - APT ONE BDR

TAG	NO.	FIXTURE	DESCRIPTION	MODEL	COMMENTS
D1	1	Drain - Linear	H-D612 Linear Shower Drain in Nickel	SKU: 31-DRN-STNL-SAN-000001	24" drain
F1	1	Faucet - Bathroom Sink	WDG16431.JW Lavatory Faucet in White and Chrome	SKU: 34-LAV-CHWH-HKA-000002	
F2	1	Faucet - Shower	520880C Tub & Shower Faucet in Chrome	SKU: 34-TSH-CHRM-CAE-000001	
F4	1	Faucet - Kitchen	503742C Kitchen Faucet in Chrome	SKU: 34-KIT-CHRM-CAE-000005	
F5	1	Faucet - Laundry	Single Handle Pull-Down Kitchen Faucet in Chrome	SKU: 34-KIT-CHRM-PER-000003	
S1	1	Sink - Bathroom Vessel	S122 Select Countertop Basin in White	SKU: 32-CTB-WHIT-MUY-000004	
S5	2	Sink - Kitchen	23" Undermount Kitchen Single Sink in Stainless Steel	SKU: 42-UMT-SNGL-YIA-000002	
T1	1	Toilet	Select MY2133 One Piece Toilet in White	SKU: 30-1PC-WHEL-MUY-000002	
T2	2	Toilet - Paper Holder	Voisin Towel Ring in Polished Chrome	SKU: 33-TPH-PLCH-LIB-000007	
TL1	1	Towel - Bar	Utah 18" Towel Bar in Chrome	SKU: 33-TBR-CHRM-DEL-000005	
TL2	1	Towel - Ring	Voisin Toilet Paper Holder in Polished Chrome	SKU: 33-TRG-PLCH-LIB-000007	

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7. PROVIDE GROMMETS IN COUNTERTOPS AS REQUIRED BY THE OWNER. FIELD VERIFY APPROX LOCATIONS
8. PROVIDE A 2" RADIUS AT THE END OF EXPOSED COUNTERTOPS

SANITARY FIXTURES NOTES

1. MOUNTING HEIGHTS SHOWN ARE TYPICAL
2. DIMENSIONS ARE FROM FINISH MATERIAL, TYPICAL
3. CONTRACTOR SHALL PROVIDE BLOCKING AS REQUIRED FOR INSTALLATIO OF ALL ITEMS
4. CONTRACTOR TO COORDINATE LOCATIONS OF ADDITIONAL PENETRATIONS THROUGH WALLS AND FLOORS NOT INDICATED ON ARCHITECTURAL DRAWINGS.

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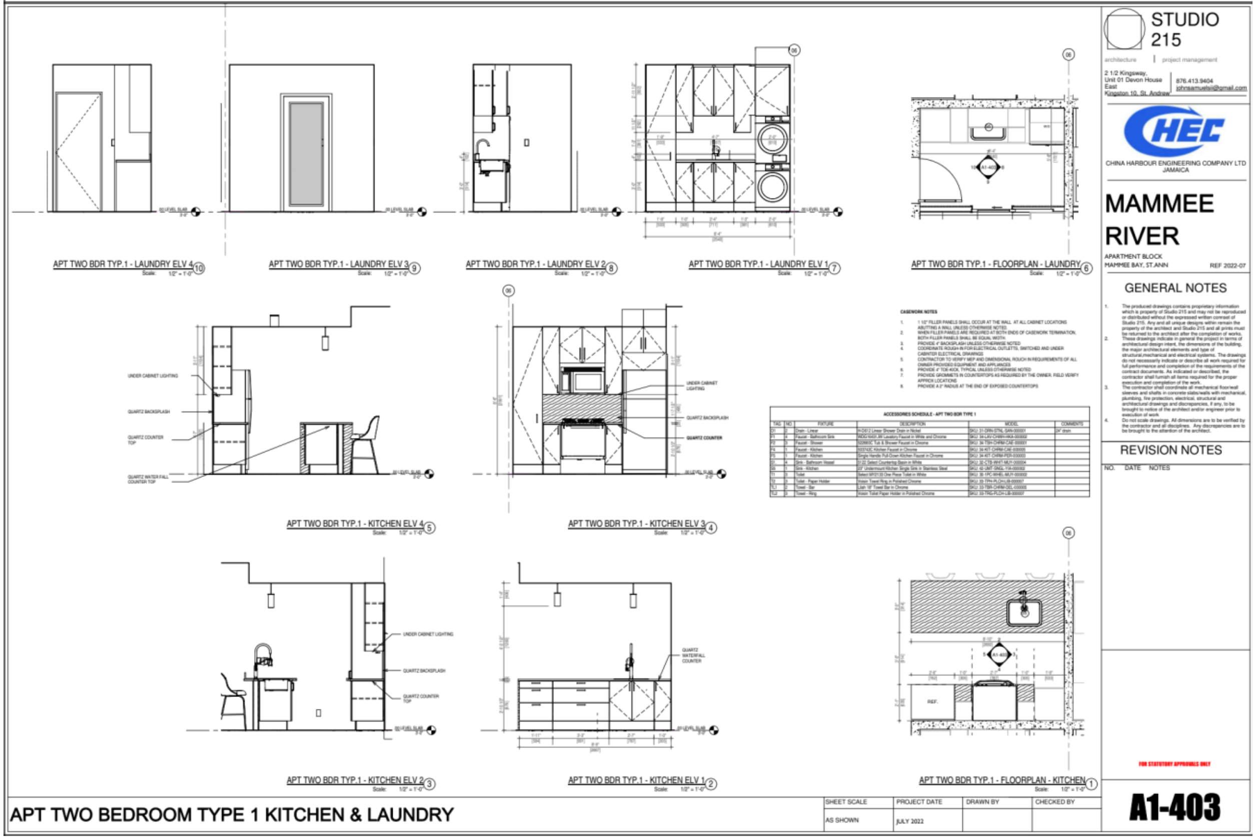
REVISION NOTES

NO. DATE NOTES

APT ONE BEDROOM - BATHROOM LAUNDRY

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

A1-402



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8. PROVIDE A 2" RADIUS AT THE END OF EXPOSED COUNTERTOPS

ACCESSORIES SCHEDULE - APT TWO BDR TYPE 1

TAG	NO.	FIXTURE	DESCRIPTION	MODEL	COMMENTS
D1	2	Drain - Linear	H-D612 Linear Shower Drain in Nickel	SKU: 31-DRN-STNL-SAN-000001	24" drain
F1	4	Faucet - Bathroom Sink	WDG16431.JW Lavatory Faucet in White and Chrome	SKU: 34-LAV-CHWH-HKA-000002	
F2	3	Faucet - Shower	520880C Tub & Shower Faucet in Chrome	SKU: 34-TSH-CHRM-CAE-000001	
F4	1	Faucet - Kitchen	503742C Kitchen Faucet in Chrome	SKU: 34-KIT-CHRM-CAE-000005	
F5	1	Faucet - Kitchen	Single Handle Pull-Down Kitchen Faucet in Chrome	SKU: 34-KIT-CHRM-PER-000003	
S1	4	Sink - Bathroom Vessel	S122 Select Countertop Basin in White	SKU: 32-CTB-WHIT-MUY-000004	
S5	1	Sink - Kitchen	23" Undermount Kitchen Single Sink in Stainless Steel	SKU: 42-UMT-SNGL-YIA-000002	
T1	3	Toilet	Select MY2133 One Piece Toilet in White	SKU: 30-1PC-WHEL-MUY-000002	
T2	3	Toilet - Paper Holder	Voisin Towel Ring in Polished Chrome	SKU: 33-TPH-PLCH-LIB-000007	
TL1	2	Towel - Bar	Utah 18" Towel Bar in Chrome	SKU: 33-TBR-CHRM-DEL-000005	
TL2	3	Towel - Ring	Voisin Toilet Paper Holder in Polished Chrome	SKU: 33-TRG-PLCH-LIB-000007	

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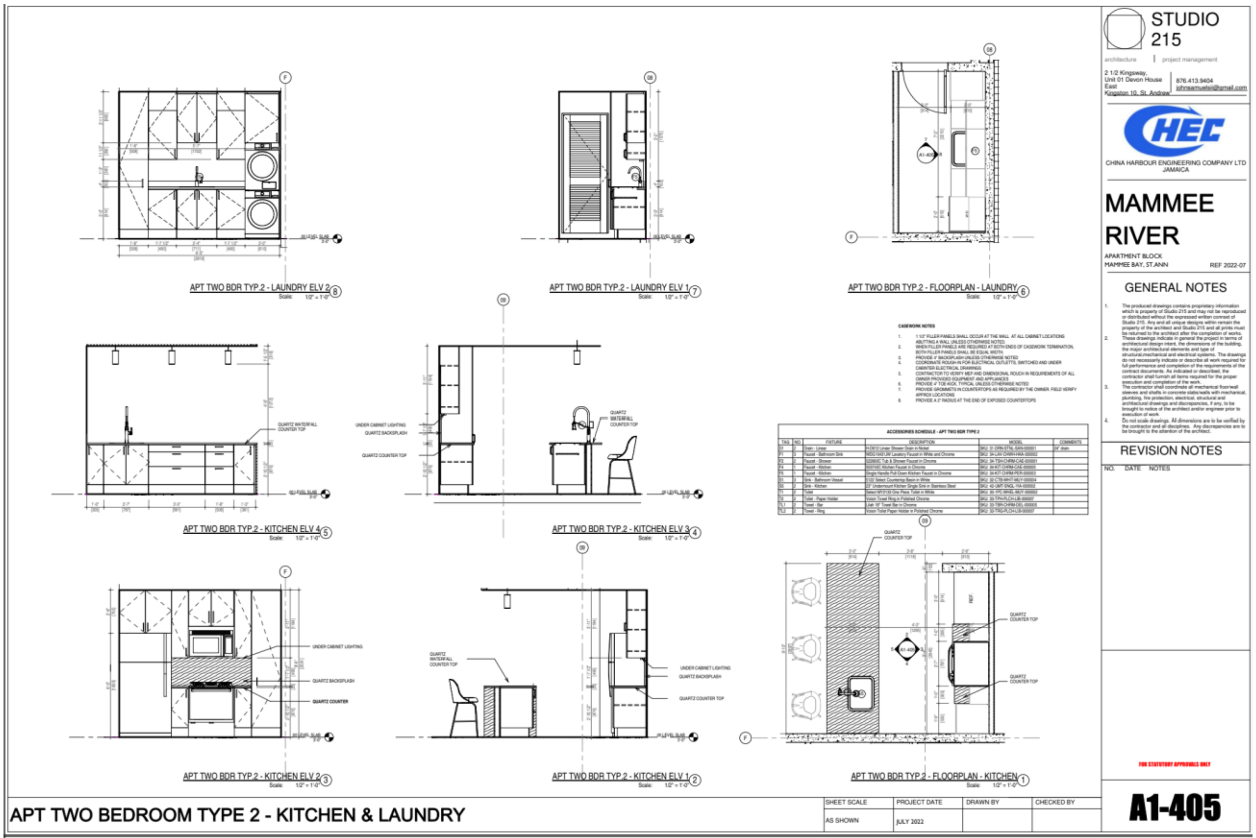
REVISION NOTES

NO. DATE NOTES

APT TWO BEDROOM TYPE 1 KITCHEN & LAUNDRY

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

A1-403


APT TWO BDR TYP.2 - LAUNDRY ELV 2 8
APT TWO BDR TYP.2 - LAUNDRY ELV 1 7
APT TWO BDR TYP.2 - FLOORPLAN - LAUNDRY 6
CASEWORK NOTES
ACCESSORIES SCHEDULE - APT TWO BDR TYPE 2
APT TWO BDR TYP.2 - KITCHEN ELV 4 5
APT TWO BDR TYP.2 - KITCHEN ELV 3 4
APT TWO BDR TYP.2 - KITCHEN ELV 2 3
APT TWO BDR TYP.2 - KITCHEN ELV 1 2
APT TWO BDR TYP.2 - FLOORPLAN - KITCHEN 1
Scale: 1/2" = 1'-0"
QUARTZ WATERFALL COUNTER TOP
UNDER CABINET LIGHTING
QUARTZ BACKSPLASH
QUARTZ COUNTER TOP
APT TWO BEDROOM TYPE 2 - KITCHEN & LAUNDRY
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
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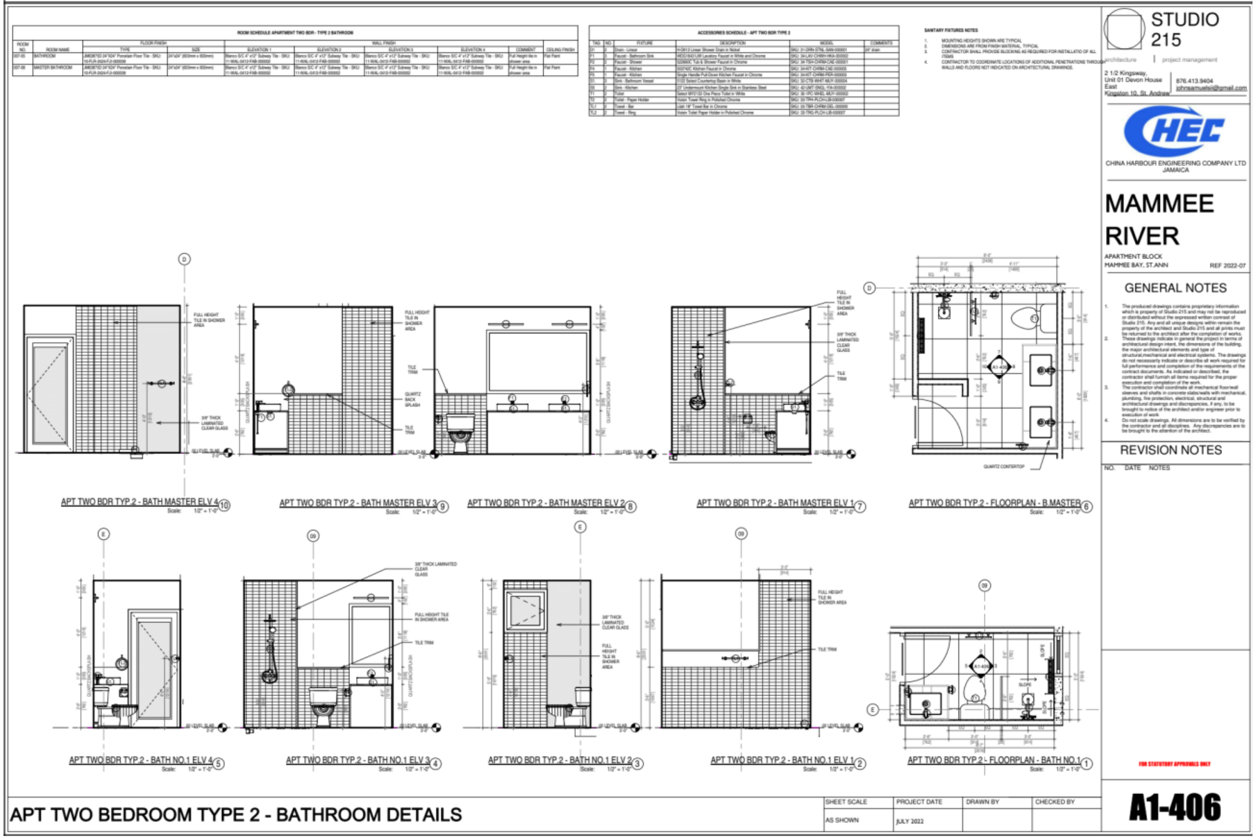
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
A1-405


ROOM SCHEDULE APARTMENT TWO BDR - TYPE 2 BATHROOM
ACCESSORIES SCHEDULE - APT TWO BDR TYPE 2
SANITARY FIXTURES NOTES
FULL HEIGHT TILE IN SHOWER AREA
3/8" THICK LAMINATED CLEAR GLASS
TILE TRIM
QUARTZ BACK SPLASH
QUARTZ COUNTERTOP
APT TWO BDR TYP.2 - BATH MASTER ELV 4 10
APT TWO BDR TYP.2 - BATH MASTER ELV 3 9
APT TWO BDR TYP.2 - BATH MASTER ELV 2 8
APT TWO BDR TYP.2 - BATH MASTER ELV 1 7
APT TWO BDR TYP.2 - FLOORPLAN - B.MASTER 6
APT TWO BDR TYP.2 - BATH NO.1 ELV 4 5
APT TWO BDR TYP.2 - BATH NO.1 ELV 3 4
APT TWO BDR TYP.2 - BATH NO.1 ELV 2 3
APT TWO BDR TYP.2 - BATH NO.1 ELV 1 2
APT TWO BDR TYP.2 - FLOORPLAN - BATH NO.1 1
Scale: 1/2" = 1'-0"
APT TWO BEDROOM TYPE 2 - BATHROOM DETAILS
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
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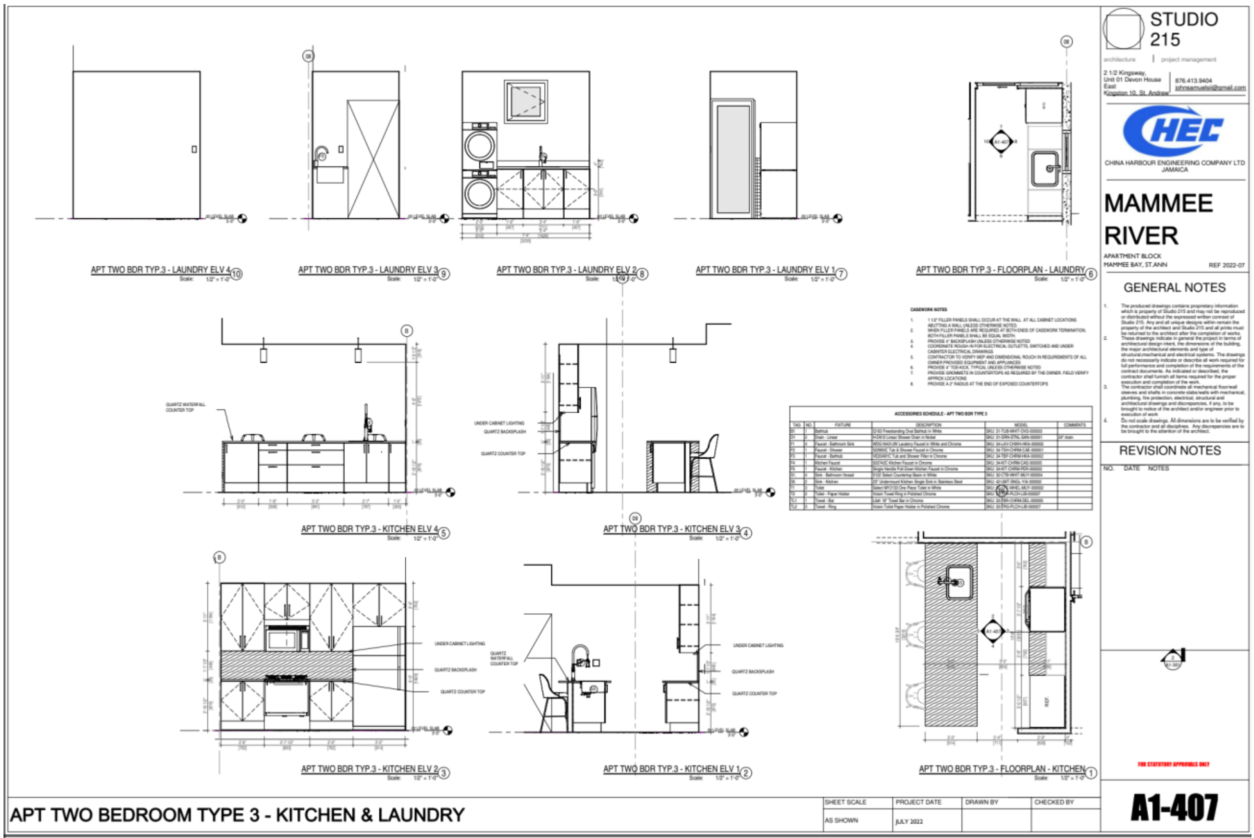
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
A1-406



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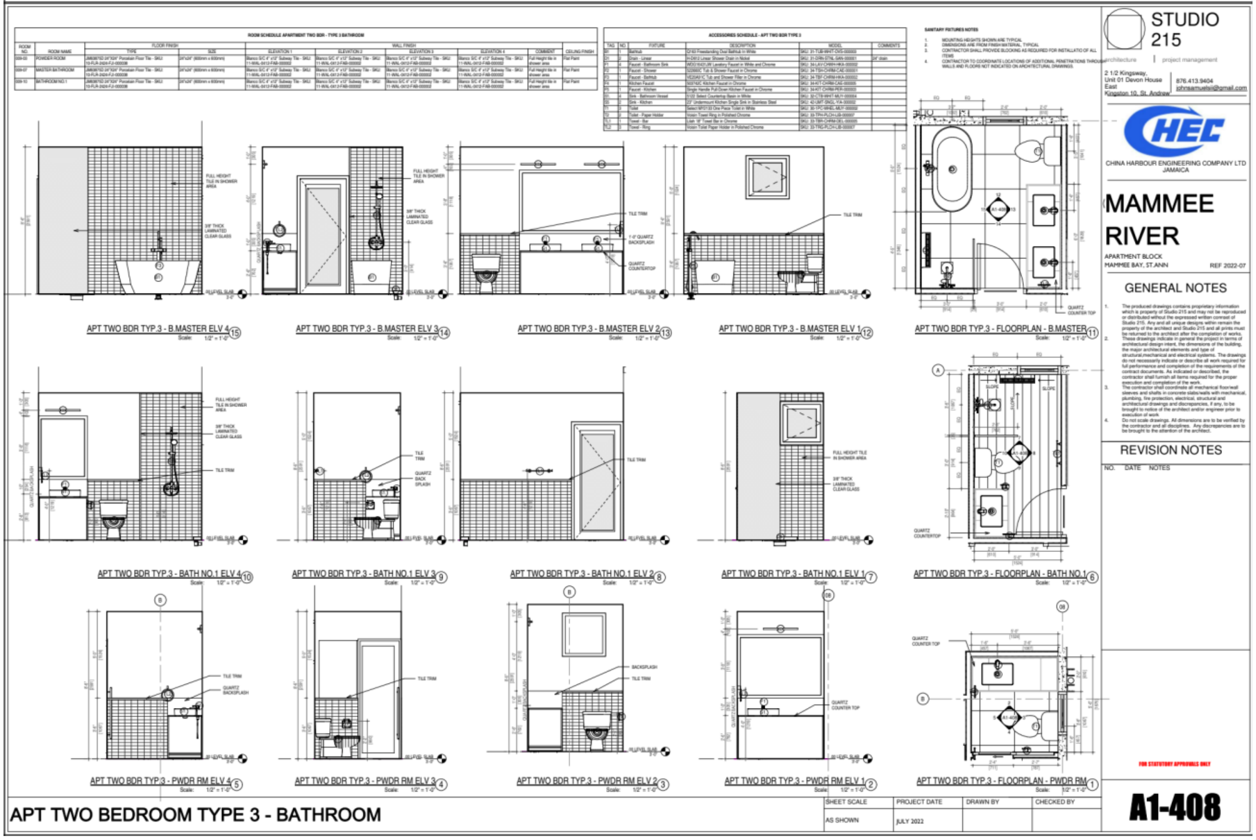
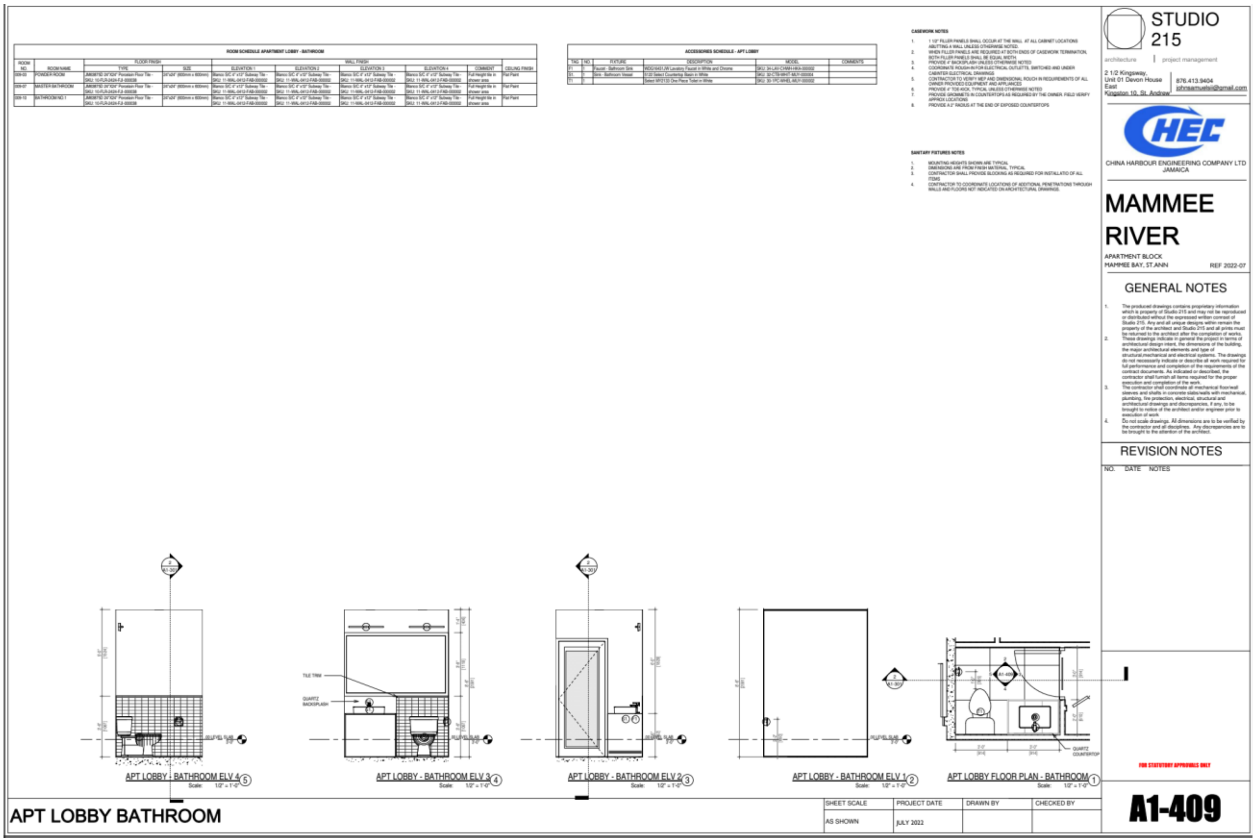
ACCESSORIES SCHEDULE - APT TWO BDR TYPE 3

TAG	NO.	FIXTURE	DESCRIPTION	MODEL	COMMENTS
B1	1	Bathtub	Q163 Freestanding Oval Bathtub in White	SKU: 31-TUB-WHIT-OVS-000003	
D1	2	Drain - Linear	H-D612 Linear Shower Drain in Nickel	SKU: 31-DRN-STNL-SAN-000001	24" drain
F1	4	Faucet - Bathroom Sink	WDG1643UW Lavatory Faucet in White and Chrome	SKU: 34-LAV-CHWH-HKA-000002	
F2	1	Faucet - Shower	N20660C Tub & Shower Faucet in Chrome	SKU: 34-TSH-CHRM-CAE-000001	
F3	1	Faucet - Bathtub	1VE20A61C Tub and Shower Filler in Chrome	SKU: 34-TBF-CHRM-HKA-000002	
F4	1	Kitchen Faucet	502742C Kitchen Faucet in Chrome	SKU: 34-KIT-CHRM-CAE-000005	
F5	1	Faucet - Kitchen	Single Handle Pull-Down Kitchen Faucet in Chrome	SKU: 34-KIT-CHRM-PER-000003	
S1	4	Sink - Bathroom Vessel	N122 Select Countertop Basin in White	SKU: 32-CTR-WHIT-MUY-000004	
S5	2	Sink - Kitchen	23" Undermount Kitchen Single Sink in Stainless Steel	SKU: 42-UMT-SNGL-YJA-000002	
T1	3	Toilet	Select MY2133 One Piece Toilet in White	SKU: [illegible]-WHEL-MUY-000002	
T2	2	Toilet - Paper Holder	Voisin Towel Ring in Polished Chrome	SKU: [illegible]-PLCH-LIB-000007	
TL1	1	Towel - Bar	Lilah 18" Towel Bar in Chrome	SKU: 33-TBR-CHRM-DEL-000005	
TL2	3	Towel - Ring	Voisin Toilet Paper Holder in Polished Chrome	SKU: 33-TRG-PLCH-LIB-000007	

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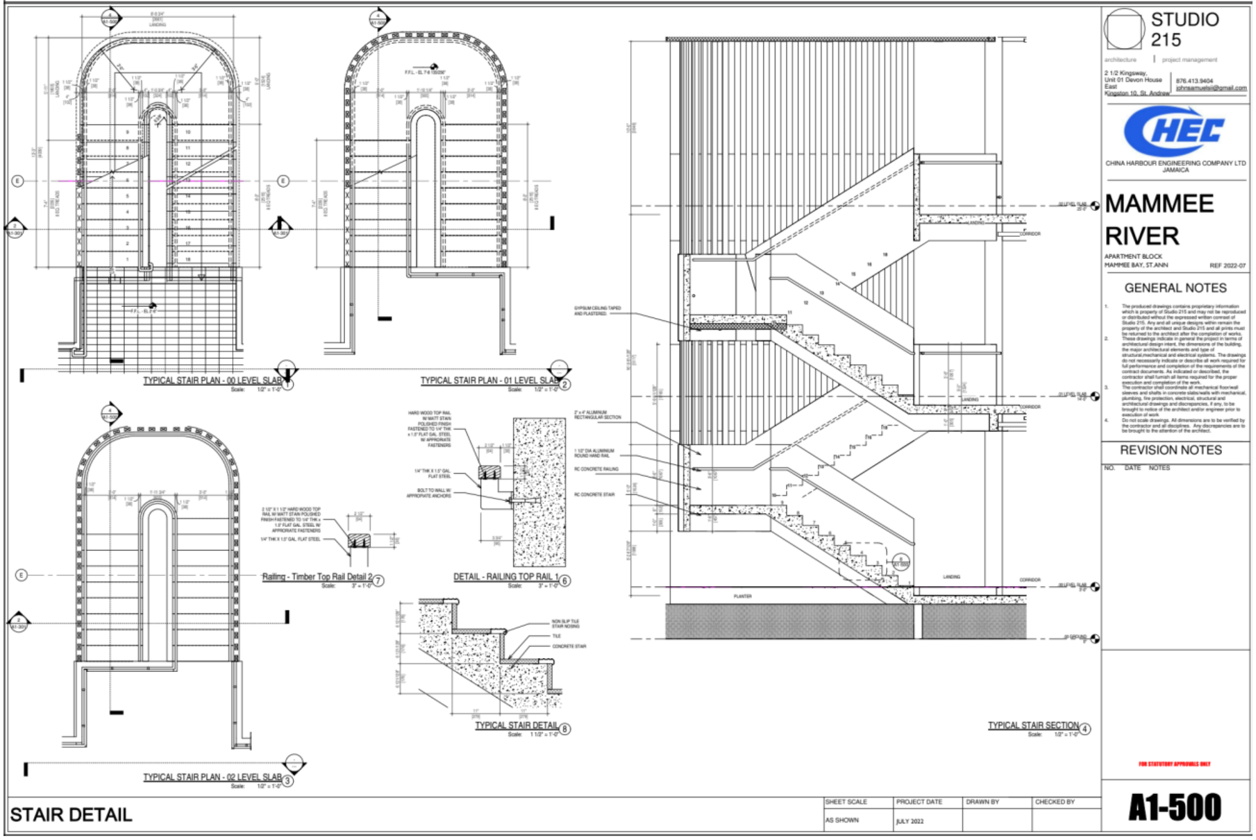
APARTMENT BLOCK
MAMMEE BAY, ST.ANN
REF 2022-07
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
ROOM SCHEDULE APARTMENT LOBBY - BATHROOM
ACCESSORIES SCHEDULE - APT LOBBY
CASEWORK NOTES
SANITARY FIXTURES NOTES
APT LOBBY - BATHROOM ELV 4 ⑤
APT LOBBY - BATHROOM ELV 3 ④
APT LOBBY - BATHROOM ELV 2 ③
APT LOBBY - BATHROOM ELV 1 ②
APT LOBBY FLOOR PLAN - BATHROOM ①
Scale: 1/2" = 1'-0"
TILE TRIM
QUARTZ BACKSPLASH
QUARTZ COUNTERTOP
FOR STATUTORY APPROVALS ONLY
APT LOBBY BATHROOM
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-409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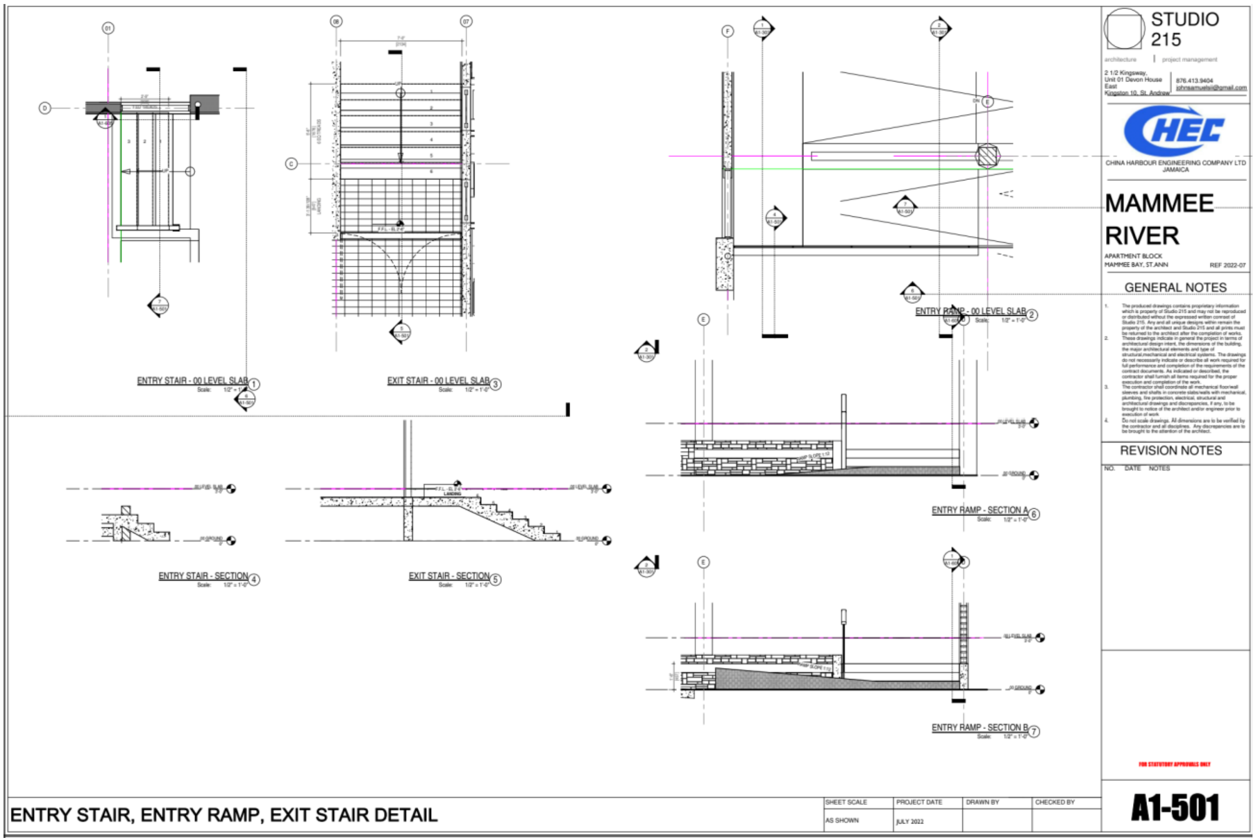
MAMMEE BAY, ST.ANN
REF 2022-07
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
TYPICAL STAIR PLAN - 00 LEVEL SLAB ①
TYPICAL STAIR PLAN - 01 LEVEL SLAB ②
TYPICAL STAIR PLAN - 02 LEVEL SLAB ③
TYPICAL STAIR SECTION ④
DETAIL - RAILING TOP RAIL 1 ⑥
Railing - Timber Top Rail Detail 2 ⑦
TYPICAL STAIR DETAIL ⑧
Scale: 1/2" = 1'-0"
Scale: 3" = 1'-0"
Scale: 1 1/2" = 1'-0"
GYPSUM CEILING TAPED AND PLASTERED
2" x 4" ALUMINIUM RECTANGULAR SECTION
1 1/2" DIA ALUMINIUM ROUND HAND RAIL
RC CONCRETE RAILING
RC CONCRETE STAIR
HARD WOOD TOP RAIL W/ MATT STAIN POLISHED FINISH FASTENED TO 1/4" THK x 1.5" FLAT GAL. STEEL W/ APPROPRIATE FASTENERS
1/4" THK X 1.5" GAL FLAT STEEL
BOLT TO WALL W/ APPROPRIATE ANCHORS
NON SLIP TILE STAIR NOSING
TILE
CONCRETE STAIR
LANDING
CORRIDOR
PLANTER
FOR STATUTORY APPROVALS ONLY
STAIR DETAIL
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-500


STUDIO 215
architecture | project management
2 1/2 Kingsway, Unit 01 Devon House East Kingston 10, St. Andrew
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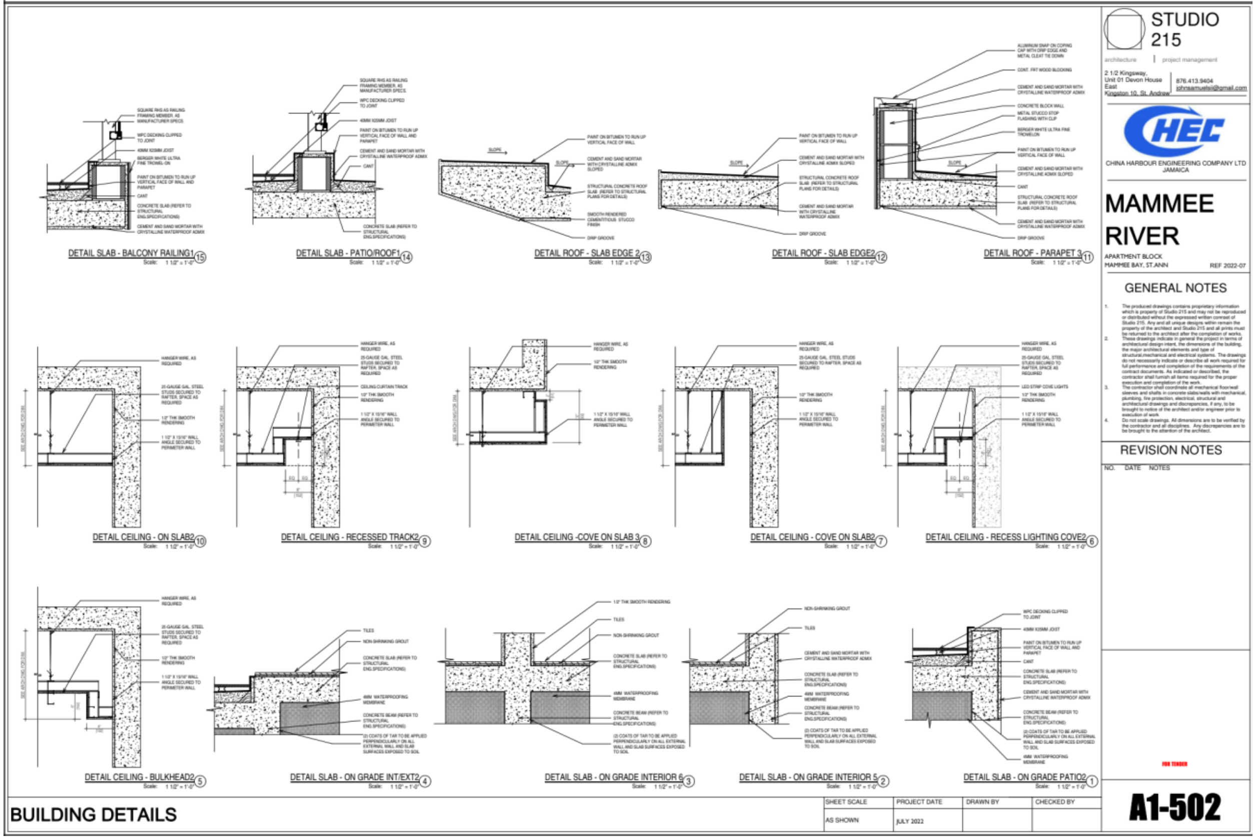
johnsamuelsl@gmail.com
CHEC
CHINA HARBOUR ENGINEERING COMPANY LTD JAMAICA
MAMMEE RIVER
APARTMENT BLOCK
MAMMEE BAY, ST.ANN
REF 2022-07
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
FOR STATUTORY APPROVALS ONLY
ENTRY STAIR - 00 LEVEL SLAB 1
Scale: 1/2" = 1'-0"
ENTRY RAMP - 00 LEVEL SLAB 2
Scale: 1/2" = 1'-0"
EXIT STAIR - 00 LEVEL SLAB 3
Scale: 1/2" = 1'-0"
ENTRY STAIR - SECTION 4
Scale: 1/2" = 1'-0"
EXIT STAIR - SECTION 5
Scale: 1/2" = 1'-0"
ENTRY RAMP - SECTION A 6
Scale: 1/2" = 1'-0"
ENTRY RAMP - SECTION B 7
Scale: 1/2" = 1'-0"
ENTRY STAIR, ENTRY RAMP, EXIT STAIR DETAIL
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-501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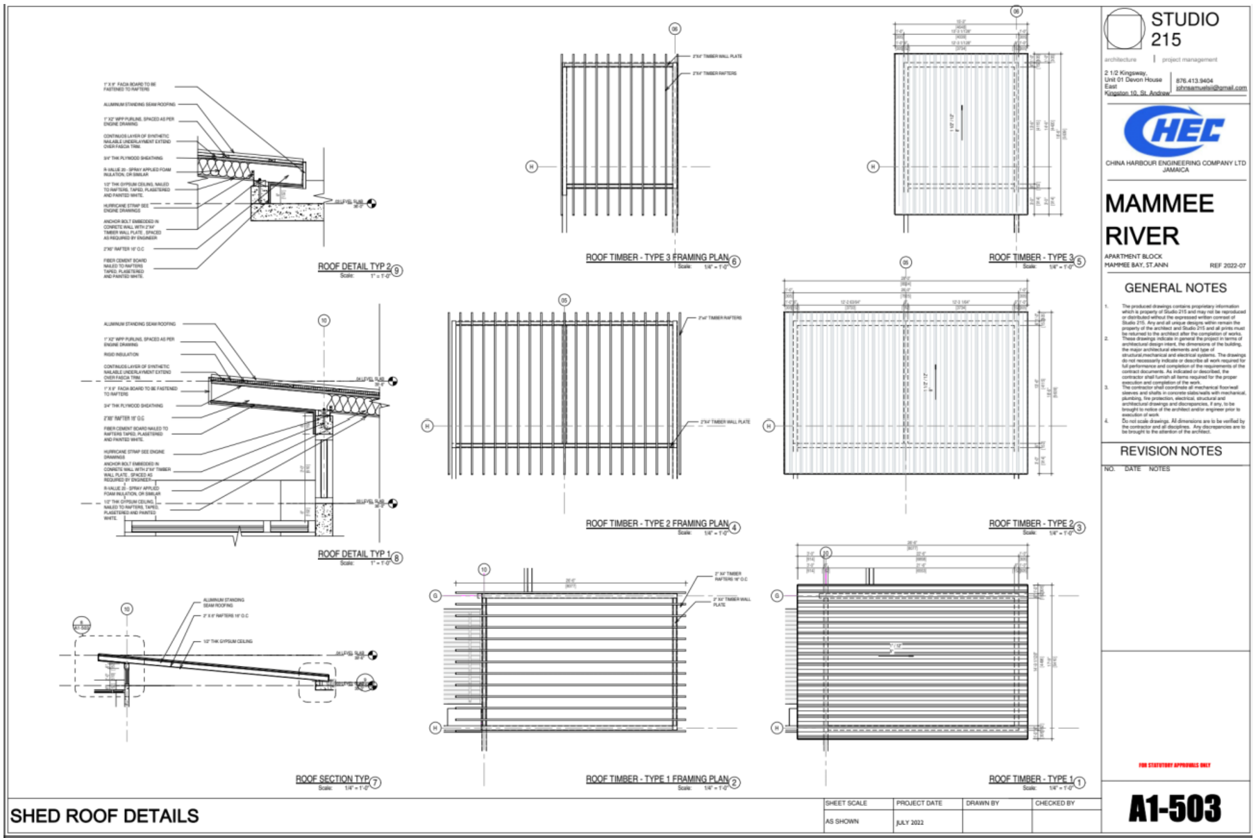
CHEC
CHINA HARBOUR ENGINEERING COMPANY LTD JAMAICA
MAMMEE RIVER
APARTMENT BLOCK
MAMMEE BAY, ST.ANN
REF 2022-07
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
FOR TENDER
DETAIL SLAB - BALCONY RAILING1 15
DETAIL SLAB - PATIO/ROOF1 14
DETAIL ROOF - SLAB EDGE 2 13
DETAIL ROOF - SLAB EDGE2 12
DETAIL ROOF - PARAPET 3 11
DETAIL CEILING - ON SLAB2 10
DETAIL CEILING - RECESSED TRACK2 9
DETAIL CEILING -COVE ON SLAB 3 8
DETAIL CEILING - COVE ON SLAB2 7
DETAIL CEILING - RECESS LIGHTING COVE2 6
DETAIL CEILING - BULKHEAD2 5
DETAIL SLAB - ON GRADE INT/EXT2 4
DETAIL SLAB - ON GRADE INTERIOR 6 3
DETAIL SLAB - ON GRADE INTERIOR 5 2
DETAIL SLAB - ON GRADE PATIO2 1
Scale: 1 1/2" = 1'-0"
BUILDING DETAILS
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-502


ROOF DETAIL TYP 2 (9) Scale: 1" = 1'-0"
ROOF TIMBER - TYPE 3 FRAMING PLAN (6) Scale: 1/4" = 1'-0"
ROOF TIMBER - TYPE 3 (5) Scale: 1/4" = 1'-0"
ROOF DETAIL TYP 1 (8) Scale: 1" = 1'-0"
ROOF TIMBER - TYPE 2 FRAMING PLAN (4) Scale: 1/4" = 1'-0"
ROOF TIMBER - TYPE 2 (3) Scale: 1/4" = 1'-0"
ROOF SECTION TYP (7) Scale: 1/4" = 1'-0"
ROOF TIMBER - TYPE 1 FRAMING PLAN (2) Scale: 1/4" = 1'-0"
ROOF TIMBER - TYPE 1 (1) Scale: 1/4" = 1'-0"
STUDIO 215
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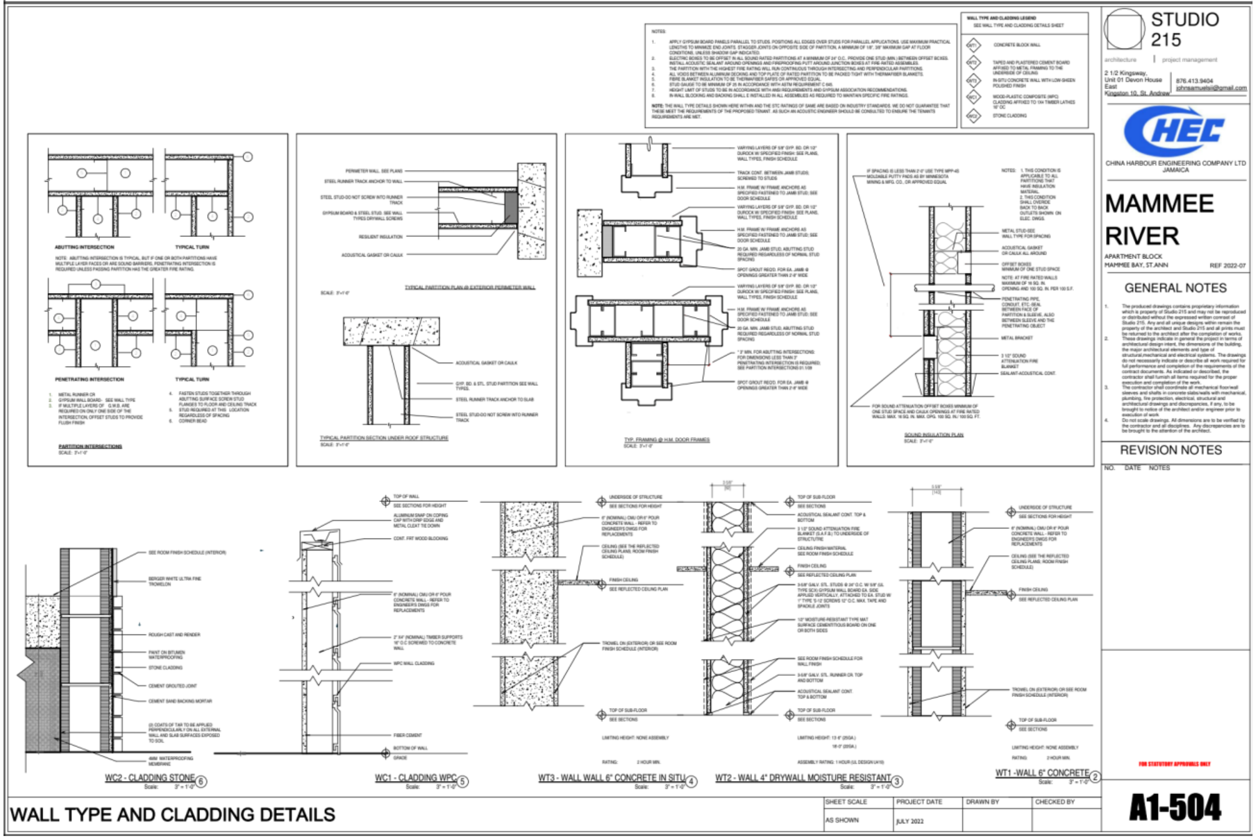
johnsamuelsi@gmail.com
HEC
CHINA HARBOUR ENGINEERING COMPANY LTD JAMAICA
MAMMEE RIVER
APARTMENT BLOCK MAMMEE BAY, ST.ANN
REF 2022-07
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
FOR STATUTORY APPROVALS ONLY
SHED ROOF DETAILS
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-503


NOTES:
WALL TYPE AND CLADDING LEGEND
SEE WALL TYPE AND CLADDING DETAILS SHEET
CONCRETE BLOCK WALL
STONE CLADDING
ABUTTING INTERSECTION
TYPICAL TURN
PENETRATING INTERSECTION
PARTITION INTERSECTIONS
TYPICAL PARTITION PLAN @ EXTERIOR PERIMETER WALL
TYPICAL PARTITION SECTION UNDER ROOF STRUCTURE
TYP. FRAMING @ H.M. DOOR FRAMES
SOUND INSULATION PLAN
WC2 - CLADDING STONE (6) Scale: 3" = 1'-0"
WC1 - CLADDING WPC (5) Scale: 3" = 1'-0"
WT3 - WALL WALL 6" CONCRETE IN SITU (4) Scale: 3" = 1'-0"
WT2 - WALL 4" DRYWALL MOISTURE RESISTANT (3) Scale: 3" = 1'-0"
WT1 - WALL 6" CONCRETE (2) Scale: 3" = 1'-0"
STUDIO 215
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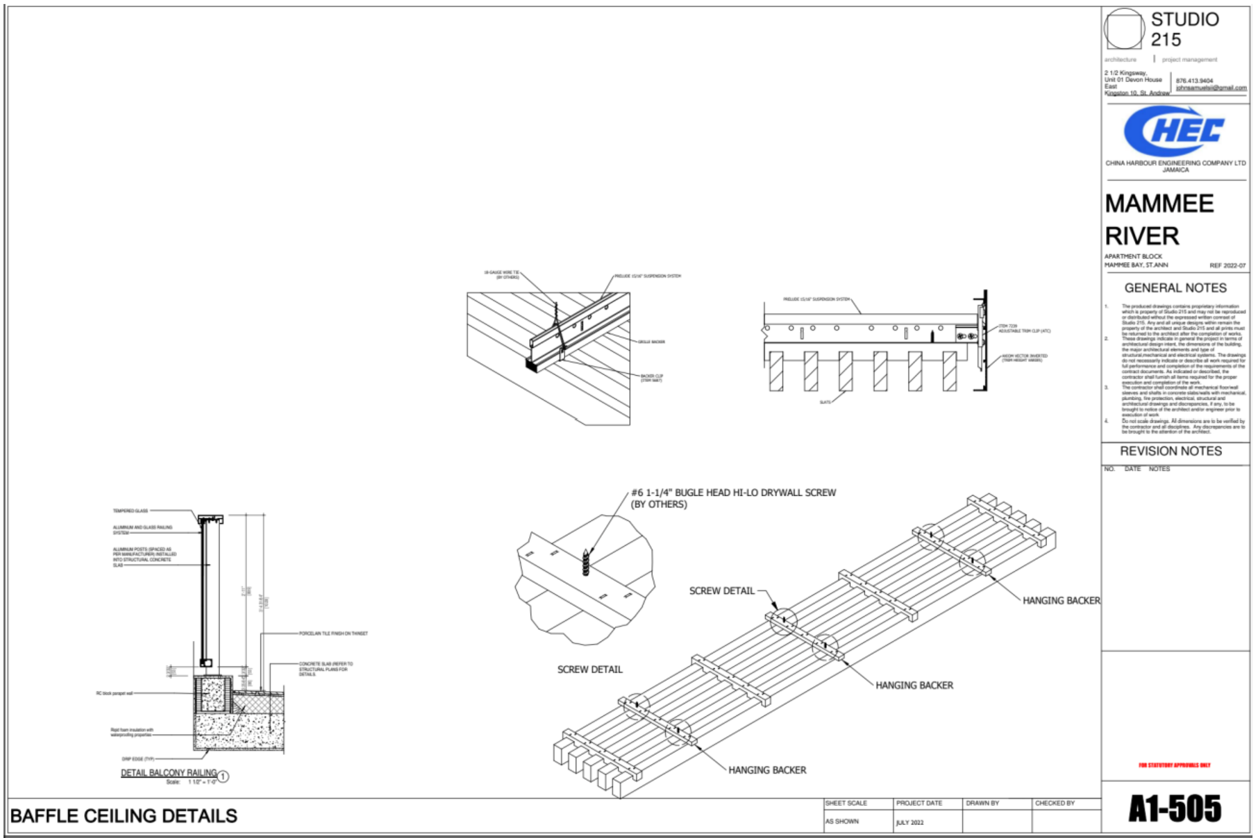
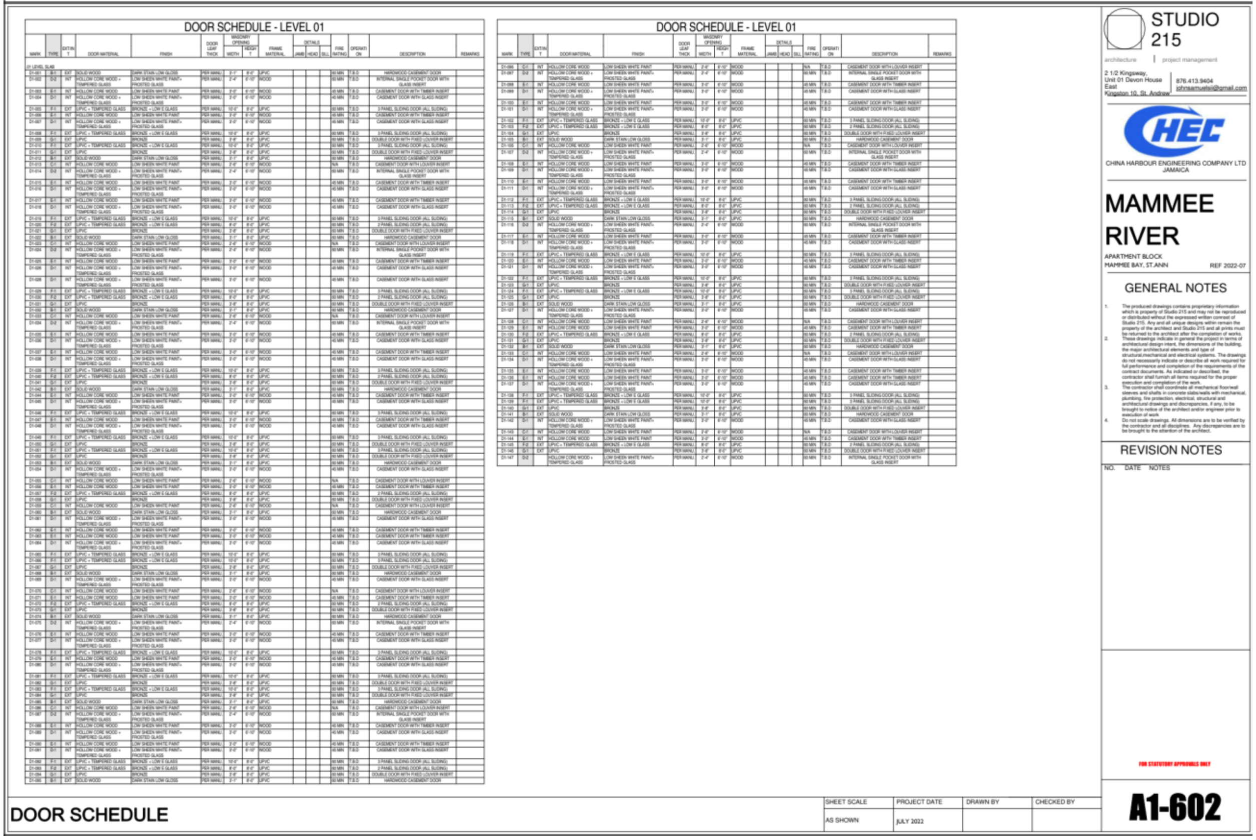
REF 2022-07
GENERAL NOTES
REVISION NOTES
NO. DATE NOTES
FOR STATUTORY APPROVALS ONLY
WALL TYPE AND CLADDING DETAILS
SHEET SCALE
AS SHOWN
PROJECT DATE
JULY 2022
DRAWN BY
CHECKED BY
A1-504



GENERAL NOTES

1. The produced drawings contains proprietary information which is property of Studio 215 and may not be reproduced or distributed without the expressed written conrset of Studio 215. Any and all unique designs within remain the property of the architect and Studio 215 and all prints must be returned to the architect after the completion of works.
2. These drawings indicate in general the project in terms of architectural design intent, the dimensions of the building, the major architectural elements and type of structural,mechanical and electrical systems. The drawings do not necessarily indicate or describe all work required for full performance and completion of the requirements of the contract documents. As indicated or described, the contractor shall furnish all items required for the proper execution and completion of the work.
3. The contractor shall coordinate all mechanical floor/wall sleeves and shafts in concrete slabs/walls with mechanical, plumbing, fire protection, electrical, structural and architectural drawings and discrepancies, if any, to be brought to notice of the architect and/or engineer prior to execution of work.
4. Do not scale drawings. All dimensions are to be verified by the contractor and all disciplines. Any discrepancies are to be brought to the attention of the architect.



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2. These drawings indicate in general the project in terms of architectural design intent, the dimensions of the building, the major architectural elements and type of structural,mechanical and electrical systems. The drawings do not necessarily indicate or describe all work required for full performance and completion of the requirements of the contract documents. As indicated or described, the contractor shall furnish all items required for the proper execution and completion of the work.
3. The contractor shall coordinate all mechanical floor/wall sleeves and shafts in concrete slabs/walls with mechanical, plumbing, fire protection, electrical, structural and architectural drawings and discrepancies, if any, to be brought to notice of the architect and/or engineer prior to execution of work.
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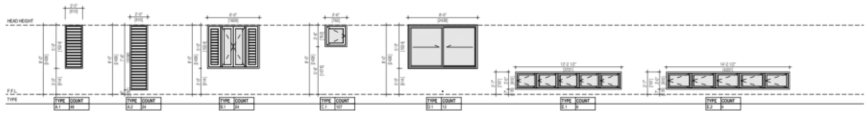

WINDOW TYPE COUNT

Type Mark	Count
A.1	48
A.2	24
B.1	24
C.1	107
D.1	12
E.1	6
E.2	4

WINDOW SCHEDULE 00

Mark	Type Mark	Rough Opening Width	Rough Opening Height	Finishes	Detail Head	Detail Jamb	Detail Sill	Sill Height	Head Height	Description
.00 LEVEL SLAB										
W001	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W002	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W003	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W004	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W005	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W006	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W007	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W008	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W009	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W010	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W011	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W012	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W013	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W014	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W015	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W016	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W017	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W018	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W019	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W020	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W021	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W022	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W023	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W024	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W025	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W026	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W027	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W028	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W029	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W030	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W031	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W032	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W033	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W034	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W035	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W036	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W037	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W038	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W039	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W040	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W041	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W042	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W043	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W044	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W045	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W046	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W047	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W048	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W049	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W050	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W051	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W052	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W053	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W054	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W055	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W056	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W057	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W058	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W059	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W060	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W061	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W062	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W063	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W064	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W065	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W066	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W067	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W068	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W069	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W070	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W071	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
.01 LEVEL SLAB										
W101	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W102	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W103	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W104	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W105	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W106	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W107	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W108	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W109	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W110	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W111	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W112	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W113	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W114	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W115	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W116	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W117	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W118	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W119	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W120	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W121	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W122	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W123	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W124	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W125	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W126	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W127	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W128	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W129	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W130	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W131	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W132	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W133	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W134	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W135	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W136	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W137	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W138	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W139	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W140	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W141	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W142	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W143	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W144	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W145	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W146	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W147	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W148	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W149	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W150	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W151	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W152	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W153	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W154	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W155	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W156	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W157	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W158	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W159	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W160	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W161	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W162	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W163	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W164	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W165	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W166	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W167	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W168	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W169	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W170	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W171	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W172	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
.02 LEVEL SLAB										
W201	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W202	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W203	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W204	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W205	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W206	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W207	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W208	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W209	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W210	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W211	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W212	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W213	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W214	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W215	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W216	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W217	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W218	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W219	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W220	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W221	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W222	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W223	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W224	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W225	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W226	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W227	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W228	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W229	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W230	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W231	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W232	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W233	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W234	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W235	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W236	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W237	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W238	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W239	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W240	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W241	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W242	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W243	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W244	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W245	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W246	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W247	A.1	2'-0"	5'-0"	UPVC DARK BROWN				3'-0"	8'-0"	LOUVER WINDOWS
W248	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W249	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W250	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W251	A.2	2'-0"	7'-6"	UPVC DARK BROWN				6"	8'-0"	LOUVER WINDOWS
W252	D.1	8'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	SLIDING TWO PANEL WINDOW
W253	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W254	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W255	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W256	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W257	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W258	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W259	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W260	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W261	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W262	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W263	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W264	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W265	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W266	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W267	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W268	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W269	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W270	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
W271	B.1	6'-0"	5'-0"	UPVC DARK BROWN + TEMPERED GLASS				3'-0"	8'-0"	DOUBLE CASEMENT WITH LOUVERS
W272	C.1	2'-6"	2'-6"	UPVC DARK BROWN + TEMPERED GLASS				5'-6"	8'-0"	AWNING WINDOW
.03 LEVEL SLAB										
W301	E.2	14'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W302	E.1	12'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W303	E.1	12'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W304	E.1	12'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W305	E.2	14'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W306	E.2	14'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W307	E.1	12'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W308	E.1	12'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W309	E.1	12'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
W310	E.2	14'-2 1/2"	2'-0"	ALUMINIUM BRONZE+ TEMPERED GLASS				0"	2'-0"	AWNING WINDOW
Grand total: 225										

WINDOW SCHEDULE

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

STUDIO 215
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JAMAICA

MAMMEE RIVER

APARTMENT BLOCK
MAMMEE BAY, ST.ANN
REF 2022-07

GENERAL NOTES

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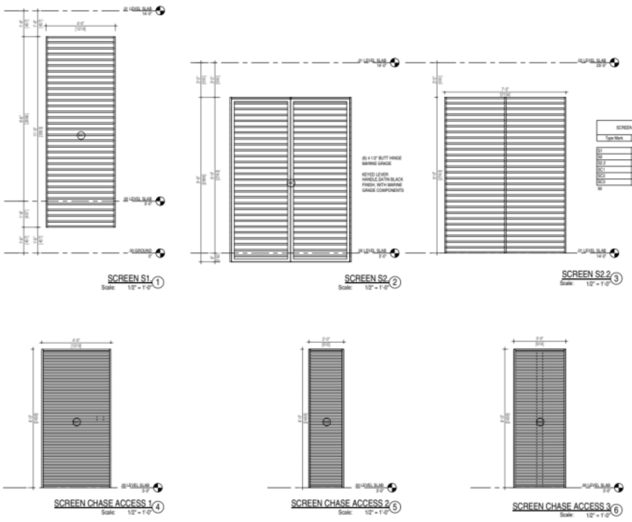
2. These drawings indicate in general the project in terms of architectural design intent, the dimensions of the building, the major architectural elements and type of structural,mechanical and electrical systems. The drawings do not necessarily indicate or describe all work required for full performance and completion of the requirements of the contract documents. As indicated or described, the contractor shall furnish all items required for the proper execution and completion of the work.
3. The contractor shall coordinate all mechanical floor/wall sleeves and shafts in concrete slabs/walls with mechanical, plumbing, fire protection, electrical, structural and architectural drawings and discrepancies, if any, to be brought to notice of the architect and/or engineer prior to execution of work.
4. Do not scale drawings. All dimensions are to be verified by the contractor and all disciplines. Any discrepancies are to be brought to the attention of the architect.

REVISION NOTES

NO. DATE NOTES

FOR STATUTORY APPROVALS ONLY

A1-604



SCREEN S1 ①
Scale: 1/2" = 1'-0"

SCREEN S2 ②
Scale: 1/2" = 1'-0"

SCREEN S2.2 ③
Scale: 1/2" = 1'-0"

SCREEN CHASE ACCESS 1 ④
Scale: 1/2" = 1'-0"

SCREEN CHASE ACCESS 2 ⑤
Scale: 1/2" = 1'-0"

SCREEN CHASE ACCESS 3 ⑥
Scale: 1/2" = 1'-0"

SCREEN COUNT

Type Mark	Count
S1	2
S2	4
S2.2	8
SC1	6
SC2	12
SC3	18
50	

SCREEN SCHEDULE

Mark	Type Mark	Rough opening Length	Rough opening Height	Detail Sill	Detail Head	Area	Material	Colour	Description
.00 LEVEL SLAB									
	S1	4'-0"	11'-0"			44 SF	UPVC	WHITE	
	S1	4'-0"	11'-0"			44 SF	UPVC	WHITE	
	S2	7'-0"	9'-6"			67 SF	UPVC	WHITE	
	S2	7'-0"	9'-6"			67 SF	UPVC	WHITE	
	S2	7'-0"	9'-6"			67 SF	UPVC	WHITE	
	S2	7'-0"	9'-6"			67 SF	UPVC	WHITE	
	SC1	4'-0"	8'-0"			32 SF	UPVC	WHITE	
	SC1	4'-0"	8'-0"			32 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-6"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-6"	8'-0"			16 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
.01 LEVEL SLAB									
	S2.2	7'-0"	9'-0"			63 SF	UPVC	WHITE	
	S2.2	7'-0"	9'-0"			63 SF	UPVC	WHITE	
	S2.2	7'-0"	9'-0"			63 SF	UPVC	WHITE	
	S2.2	7'-0"	9'-0"			63 SF	UPVC	WHITE	
	SC1	4'-0"	8'-0"			32 SF	UPVC	WHITE	
	SC1	4'-0"	8'-0"			32 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
.02 LEVEL SLAB									
	S2.2	7'-0"	9'-6"			67 SF	UPVC	WHITE	
	S2.2	7'-0"	9'-6"			67 SF	UPVC	WHITE	
	S2.2	7'-0"	9'-0"			63 SF	UPVC	WHITE	
	S2.2	7'-0"	9'-6"			67 SF	UPVC	WHITE	
	SC1	4'-0"	8'-0"			32 SF	UPVC	WHITE	
	SC1	4'-0"	8'-0"			32 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC2	2'-0"	8'-0"			16 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
	SC3	3'-0"	8'-0"			24 SF	UPVC	WHITE	
Grand total: 50									

SCREEN SCHEDULE

SHEET SCALE	PROJECT DATE	DRAWN BY	CHECKED BY
AS SHOWN	JULY 2022		

STUDIO 215
architecture | project management

2 1/2 Kingsway,
Unit 01 Devon House
East
Kingston 10, St. Andrew

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CHINA HARBOUR ENGINEERING COMPANY LTD
JAMAICA

MAMMEE RIVER

APARTMENT BLOCK
MAMMEE BAY, ST.ANN
REF 2022-07

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4. Do not scale drawings. All dimensions are to be verified by the contractor and all disciplines. Any discrepancies are to be brought to the attention of the architect.

REVISION NOTES

NO. DATE NOTES

FOR STATUTORY APPROVALS ONLY

A1-605

D.2Two-Three Bedroom Bungalows

D.2.i. Elevations

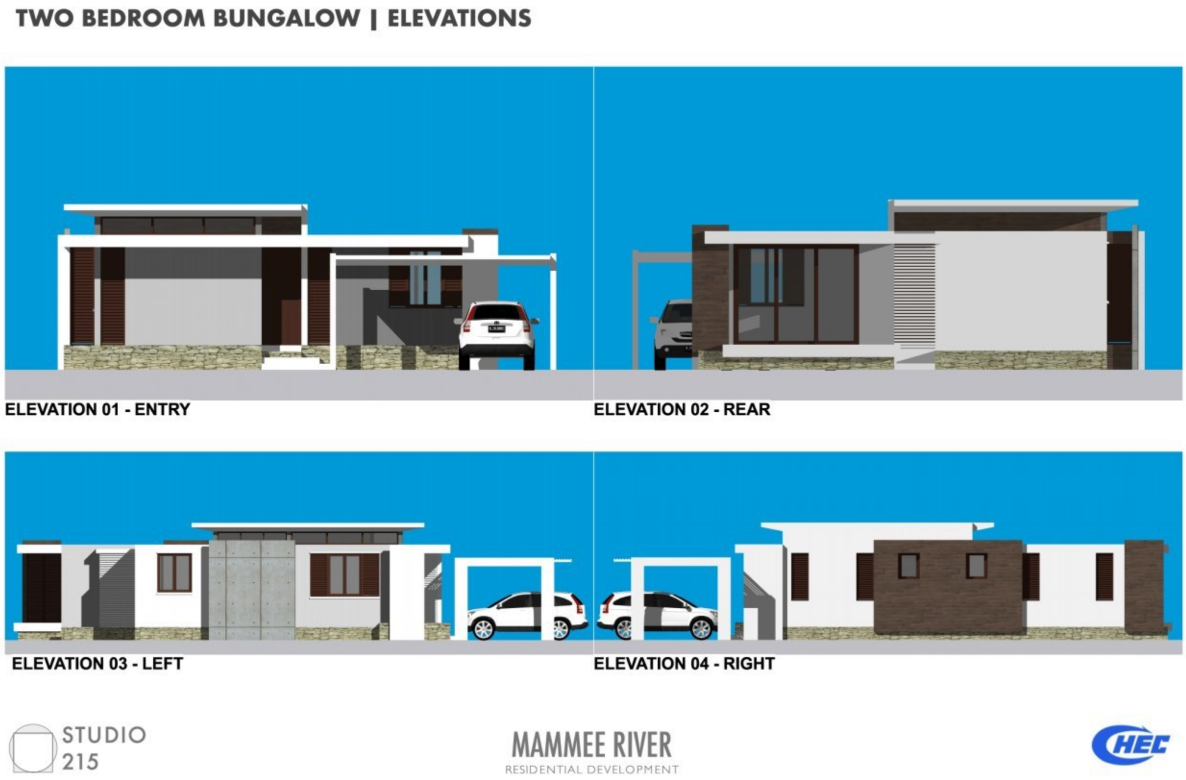


Figure 14-8 Two-Bedroom Elevation

E. Materials List

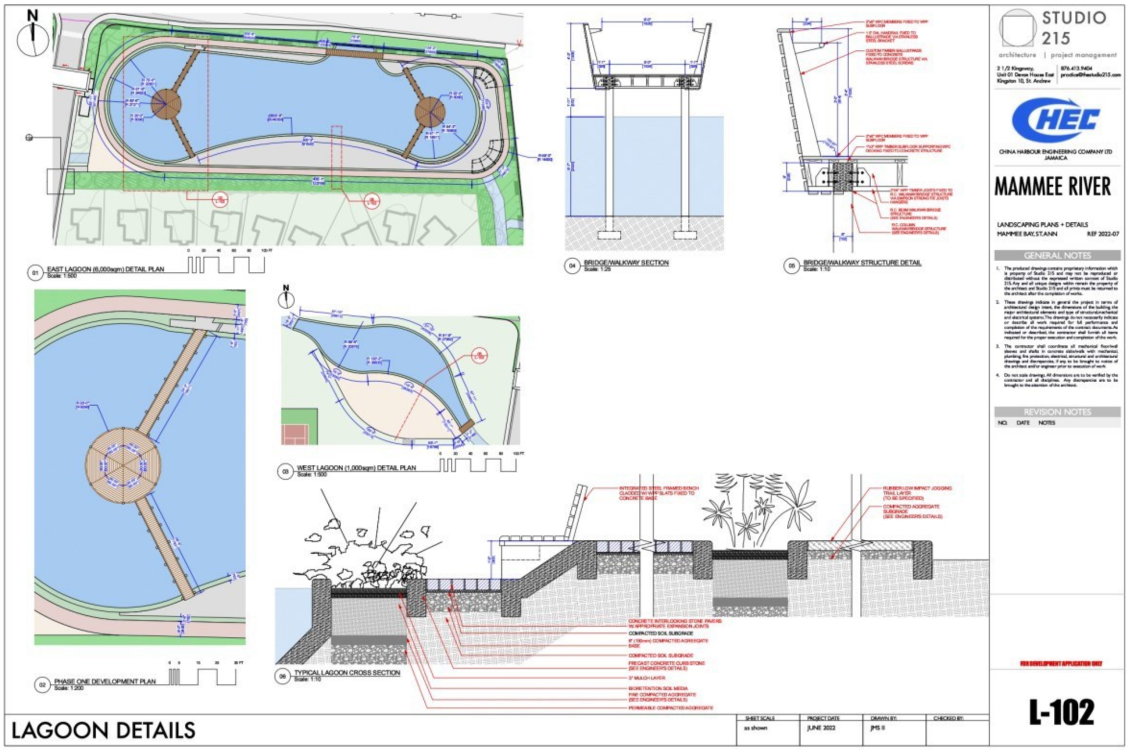
MAMMEE BAY BASIC MATERIAL LIST

ITEM	*MATERIAL*	*UNIT*
	General	
1	Cement	Bag
2	Marl	yd3
3	Wash sand	yd3
4	Granite sand	yd3
5	Dump sand	yd3
6	Crush & run	yd3
7	River shingle	yd3
8	3/8" - 3/4" Gravel	yd3
9	5/8" Construction ply	Sheet
10	T1-11 ply	Sheet
11	6" Blocks	no.
12	8" Blocks	no.
13	4" Blocks	no.
14	kerb blocks	no.
15	Binding wire (50 lbs)	roll
16	126 BRC fabric mesh	Sheet
17	Paver bricks	sf
18	Grasscrete pavers	no.
19	Termite treatment	sf
20	Bondcrete	gallon
	Mild steel	
21	3/8" bars	Tonne
22	1/2"" bars	Tonne
23	5/8" bars	Tonne
24	3/4" bars	Tonne
25	1" bars	Tonne
	High tensile steel	
26	1/2" steel	Tonne
27	5/8" bars	Tonne
28	3/4" bars	Tonne
29	1" bars	Tonne
	Concrete	
30	2500 psi	yd3
31	3000 psi	yd3
32	3500 psi	yd3

33	4000 psi	yd3
34	4500 psi	yd3
35	5000 psi	yd3
36	Pump truck	yd3
	Wall	
37	WPP lumber	Board foot
38	Drywall primer	Gallon
39	wall primer	Gallon
40	Emulsion paint	Gallon
41	Oil paint	Gallon
42	Enamel paint	Gallon
43	Red oxide primer	Gallon
44	Trowel on (fine grade)	Gallon
45	Trowel on (medium grade)	Gallon
46	Trowel on (course grade)	Gallon
47	Sure coat (70 lbs)	Box
48	Sure patch (70 lbs)	Box
49	Caulking	no.
50	1/2" Gypsum board	Sheet
51	1/2" Moisture resistant board	Sheet
52	1/2" plycem board	Sheet
53	1/2" cement board	Sheet
54	WPC siding (8' long)	Bundle
55	2 1/2" Track	Length
56	2 1/2" Studd	Length
57	3 5/8" Track	Length
58	3 5/8" Studd	Length
59	Joint compound (5 gallon)	Bucket
60	Ply-rock compound (5 gallon)	Bucket
61	PVC corner bead 10'	Length
62	Metal corner bead 10'	Length
63	Granite	sf
64	Quartz	sf
65	Cupboard (cedar)	ft
66	Cupboard (pine)	ft
	Floor	
67	Porceline tile	sf
68	Ceramic tiles	sf
69	Sanded grout	Bag
70	Unsanded grout	Bag
71	Thinset	Bag
72	White cement	Bag

73	PVC noising strip	Length
74	Metal noising strip	Length
	Plumbing	
75	Water closet	no.
76	Sanitary basin	no.
77	Single bowl kitchen sink	no.
78	Double bowl kitchen sink	no.
79	Shower mixer	no.
80	Basin mixer	no.
81	Kitchen sink mixer	no.
82	Fire hydrant	no.
83	150mm dia water pipe	Length
84	100mm dia water pipe	Length
85	50mm dia water pipe	Length
86	25mm dia water pipe	Length
87	19mm dia water pipe	Length
88	12mm dia water pipe	Length
89	200mm dia sewer pipe	Length
90	100mm dia sewer pipe	Length
91	75mm dia sewer pipe	Length
92	50mm dia sewer pipe	Length
93	38mm dia sewer pipe	Length
94	2'x2' medium duty manhole cover	no.
95	2'x2' heavy duty manhole cover	no.
96	4'x4' medium duty manhole cover	no.
97	4'x4' heavy duty manhole cover	no.
98	450mm HDPE pipe	Length
99	600mm HDPE pipe	Length
100	750mm HDPE pipe	Length
101	900mm HDPE pipe	Length
102	1200mm HDPE pipe	Length
103	25mm dia. galvanized pipe	Length
104	100mm gate valve	no.
105	150mm gate valve	no.
106	200mm gate valve	no.
	Road works	
107	Bitumen concrete	Tonne
108	Bitumen	Liter

F. Additional Landscaping Details



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4. Do not scale drawings. All dimensions are to be verified by the contractor and all disciplines. Any discrepancies are to be brought to the attention of the architect.

Figure 14-9 Lagoon Landscaping Schematic

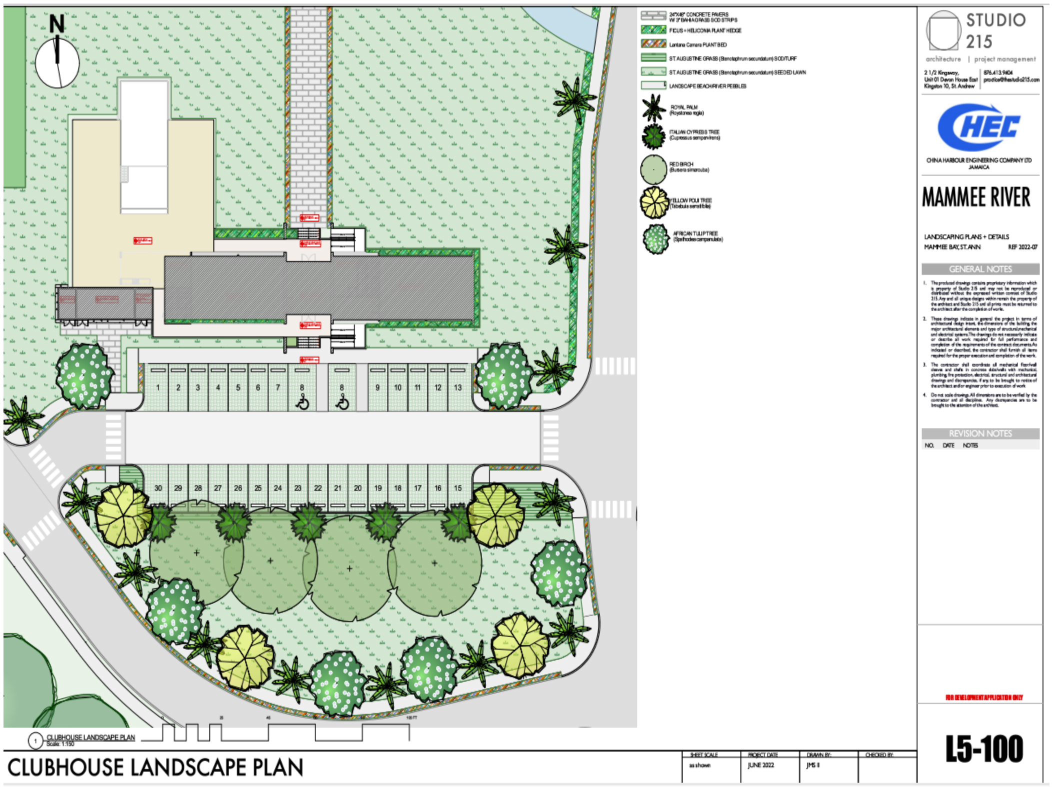

Figure 14-10 Clubhouse Landscaping Schematic

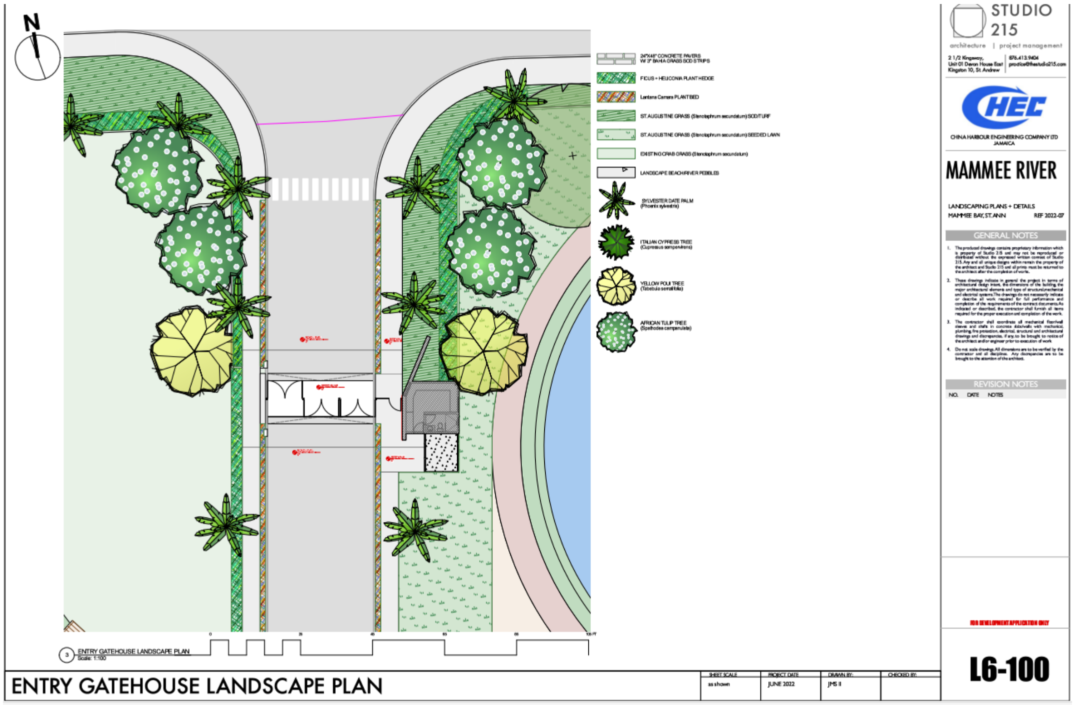

Figure 14-11 Gatehouse Landscaping Schematic

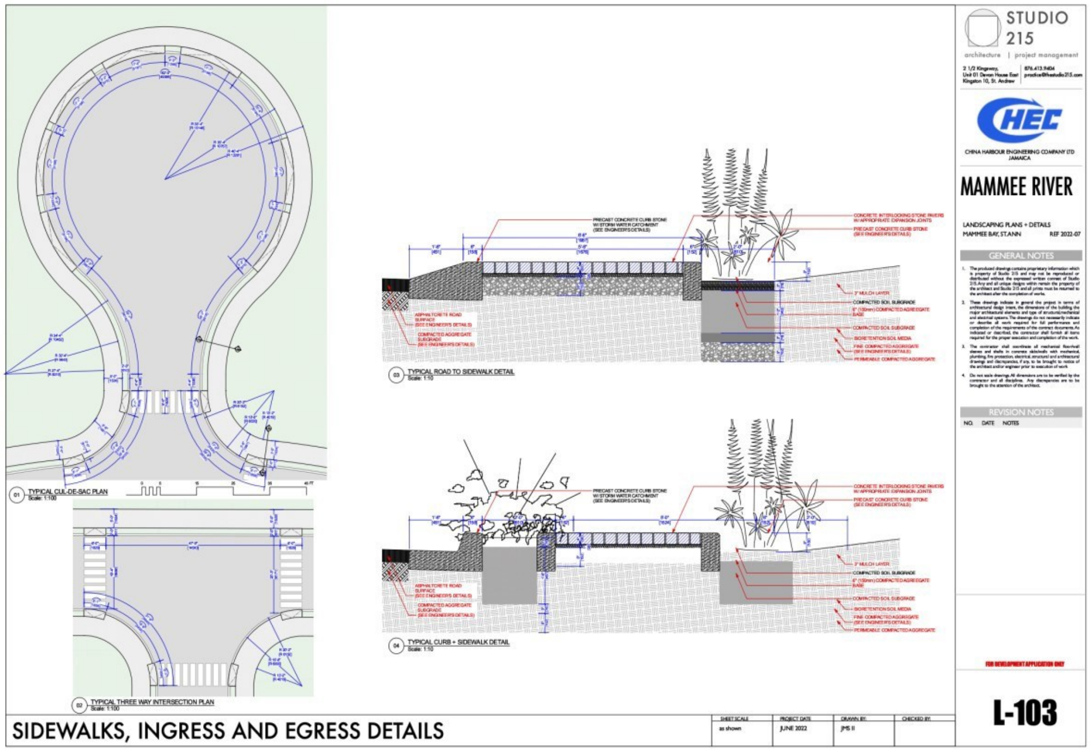

Figure 14-12 Sidewalk & Entrance Schematic

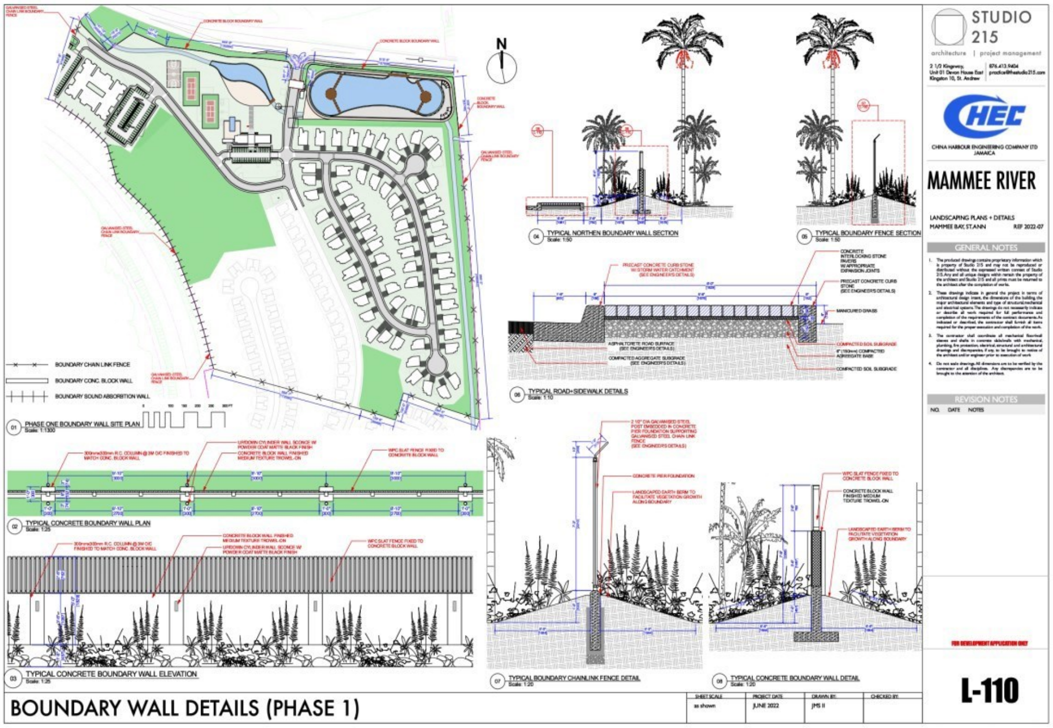

Figure 14-13 Boundary Wall Details

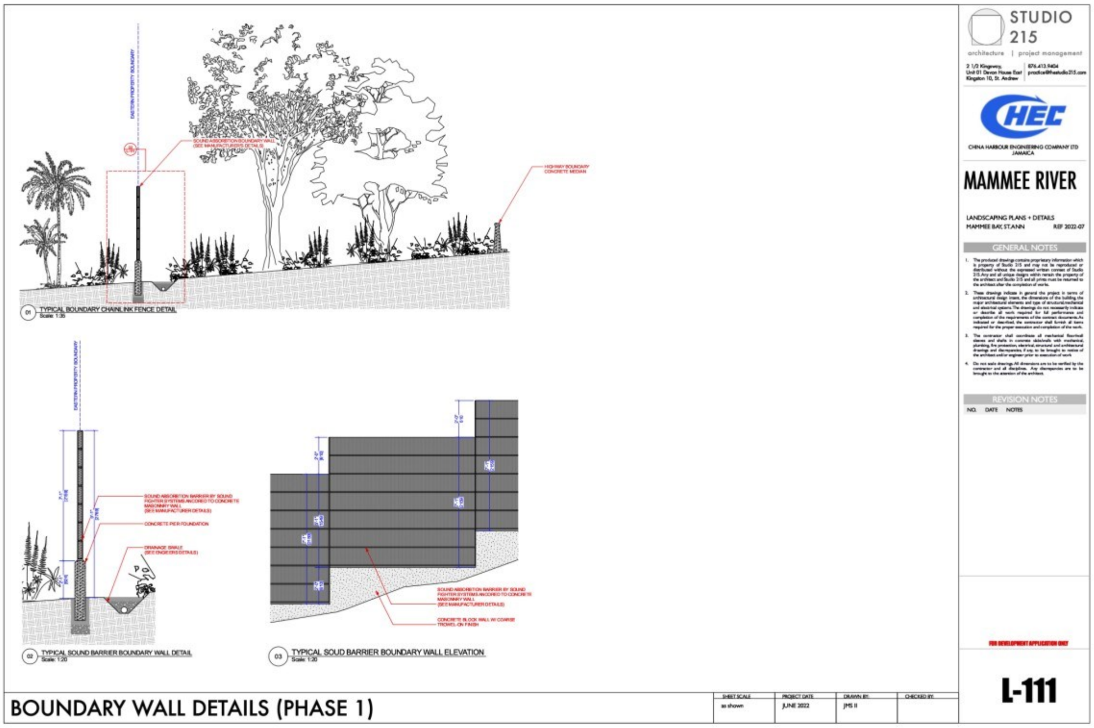

Figure 14-14 Boundary Wall Details 2

G. Drainage Report for Proposed Subdivision Part of Mammee Bay, St. Ann

DRAINAGE REPORT

for

Proposed Subdivision

Part of

Mammee Bay, St. Ann

Prepared by:

PROFESSIONAL ENGINEERS REGISTRATION BOARD
PE/01/0764
RODDY O. BROOKS
JAMAICA

Table of Contents

List of Tables

List of Figures

List of Appendices

Type text

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1 Mammee Bay Subdivision

1.1 Background

The Mammee Bay subdivision is located south of the North Coast Highway (NCH) and east of the Mammee Bay Roundabout and the North-South Highway in Mammee Bay St. Ann (Figure 1-1). The proposed subdivision consists of over 550 residential units. The land is traversed by a number of natural waterways as shown in Figure 1-1.

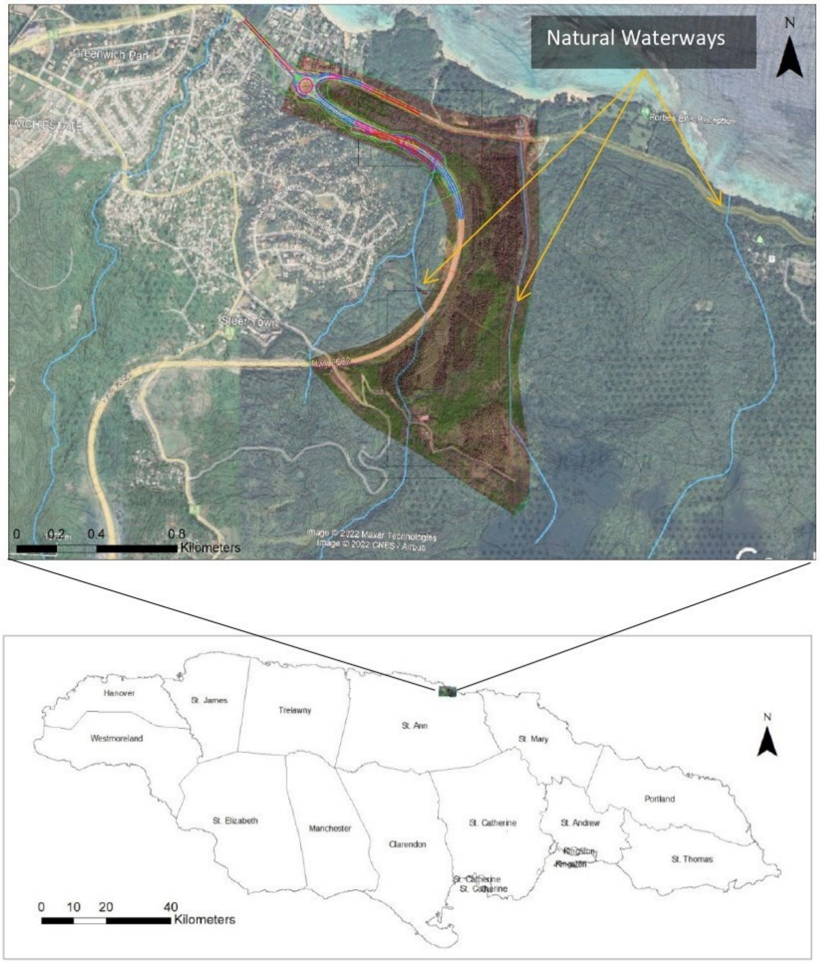

Figure 1-1: Site location of proposed Subdivision

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The land is being developed as per the North-South Highway concession agreement which requires the lands to be developed within a specified period of time or be returned to the government of Jamaica. The subdivision is being developed on hilly terrain and permeable rock hence there is little chance of flooding within the subdivision. Notwithstanding, the subdivision is being developed in a tourist attraction area with the Old Fort Bay beach north of the NCH just a few meters away. The development of the subdivision will reduce the infiltration capacity of the soil and increase runoff towards the north which could impact the beach.

In the recent past with the development of the NCH, sections of the Mammee Bay nearshore and beach areas were impacted by runoff resulting from the construction of the highway. Loose sediments from the construction site as well as material eroded along the water courses were transported to the sea. The situation was exacerbated by the conversion of natural attenuation and filtration areas into channels which further contributed to the loose sediments being transported to the sea and impacting the beach. Aerial view of the impact of the sediment on the beach and nearshore area are shown in Figure 1-2.

The proposed subdivision will therefore have to be developed with special focus on drainage to ensure that the beach and nearshore areas are not impacted during the construction and operational phases of the subdivision.

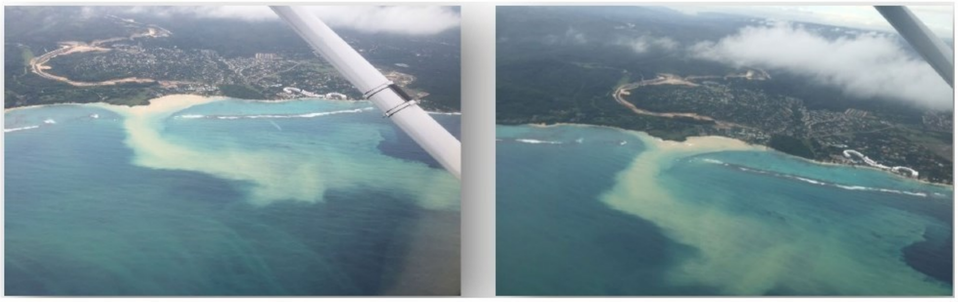

Figure 1-2: Aerial View of the Polluted Mammee Bay Beach and Nearshore Areas (NROCC).

1.2 Objectives

The objective of this drainage assessment is to provide adequate drainage for the proposed subdivision while mitigating any potential impact on the Mammee Bay beach and nearshore areas.

1.3 Scope of Works

The scope of works includes the following:

1. Calculate the design discharge for the subdivision drainage using the 5, 10, 25, 50 and 100-year return period rainfall. Calculate both pre- and post-development peak runoff rates for the watershed areas.
2. Develop measures to control the runoff onsite to mitigate any impact to the beach areas.
3. Determine the required drainage infrastructure to convey and control the design runoffs.

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1.4 Methodology

The approach will be to first delineate and perform a hydrologic assessment of the watershed area to determine the peak flood discharges for the for the return period rainfalls as indicated above. Once the peak discharges are obtained, they will be adjusted for climate change impact by applying a surcharge of 10% to the peak discharges according to the National Works Agency (NWA) drainage guidelines. The 10% surcharge adjustment for climate change impact will then determine the design discharge for drainage design.

1.5 Hydrological and Hydraulic Assessments

1.5.1 Runoff Determination Methods

The hydrologic assessment will be carried out for the pre- and post-development runoffs the 5, 10, 25, 50, and 100-year storm. The Jamaica 2 method, recommended by the NWA for use in Jamaica, will be used in the hydrological analysis for the large watershed areas which extends beyond the boundaries of the subdivision. These large watersheds are presented in Appendix A. This method is based upon the Natural Resources Conservation Service (NRCS) runoff curve number (*CN*) methodology where the *CN* value represents the loss coefficient. It is determined based upon the landuse (Figure 1-3a) and soil types (Figure 1-3b) within the watershed. The higher the *CN* value, the greater the runoff and peak discharge. A changed landuse that promotes increased runoff would therefore be represented by a higher *CN* value. Similarly, modified soil conditions that increase the infiltration rate into the ground and reduce the surface runoff. These principles will be used in the drainage design to determine the required drainage structures and their dimensions so that impact to the beach and nearshore areas can be mitigated.

Peak discharges will be developed for the pre- and post-development conditions. The post-development conditions will be represented as increased *CN* values reflecting the relative impact of the subdivision on the total watershed area.

Within the subdivision, the rational method will be used, which is well suited for small urban catchment areas. The catchment areas within the subdivision are presented in Appendix B. The rational method equation is as given below:

$$Q = kCiA$$

where:

- Q – Peak flow (m^3/s).
- k – Conversion factor equal to 0.00278.
- C – Dimensionless runoff coefficient.
- i – Rainfall intensity (mm/hr).
- A – Catchment area (ha).

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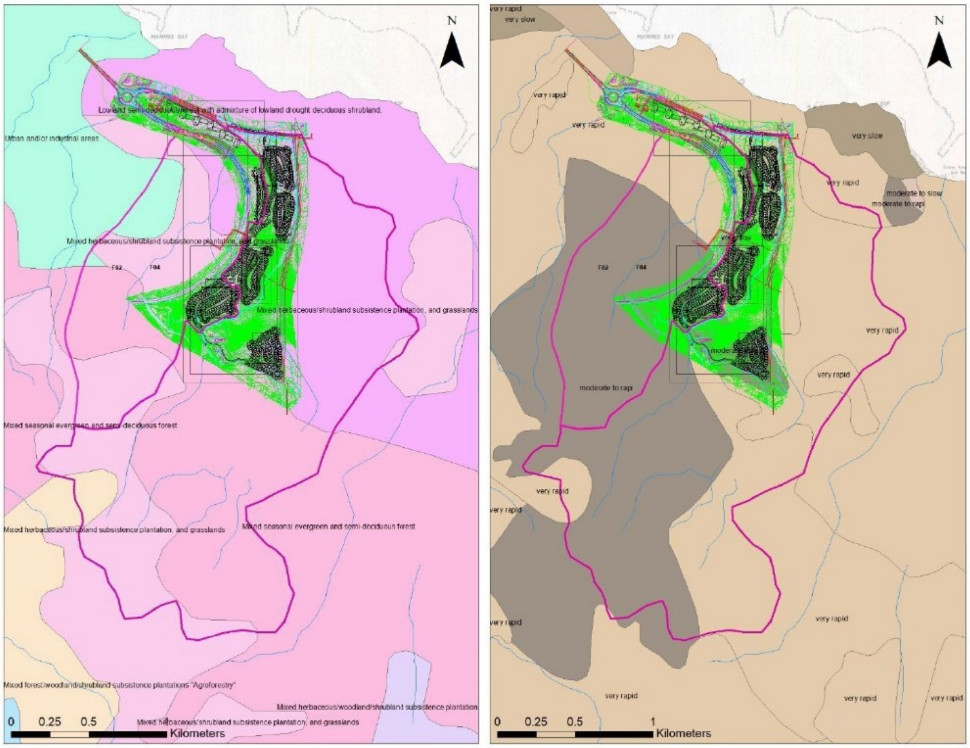

(a) (b)

Figure 1-3: Map showing (a) Landuse and (b) Soil type

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1.5.2 Rainfall

Rainfall data associated with the Rockfield rainfall station (Appendix C) was used in the analysis. The Rockfield rainfall station, based on its location and proximity to the watershed area, was determined to be the most representative of the rainfall likely to impact the area. The rainfall data for the Rockfield rainfall station is presented in Table 1.1.

Table 1.1: Representative rainfall data for the watershed areas

Rainfall Station	**24-hour Return Period Rainfall**				
	5yr	10yr	25yr	50yr	100yr
Rockfield	239	297	373	427	480

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1.5.3 Runoff Calculations for off-site watersheds

The different off-site watersheds are defined based upon the location of proposed drainage structures to facilitate the conveyance of storm runoff associated with the proposed subdivision. These structures are a proposed bridge that crosses the NCH, a culvert that crosses an existing local road within the subdivision, and the upper section of the realignment of one of the natural waterways which is not significantly impacted by the subdivision. The realignment of the natural waterway was necessary to facilitate the development of the subdivision. These drainage elements are shown in Figure 1-4. The sub-catchments for these large off-site watershed areas are shown in Appendix A.

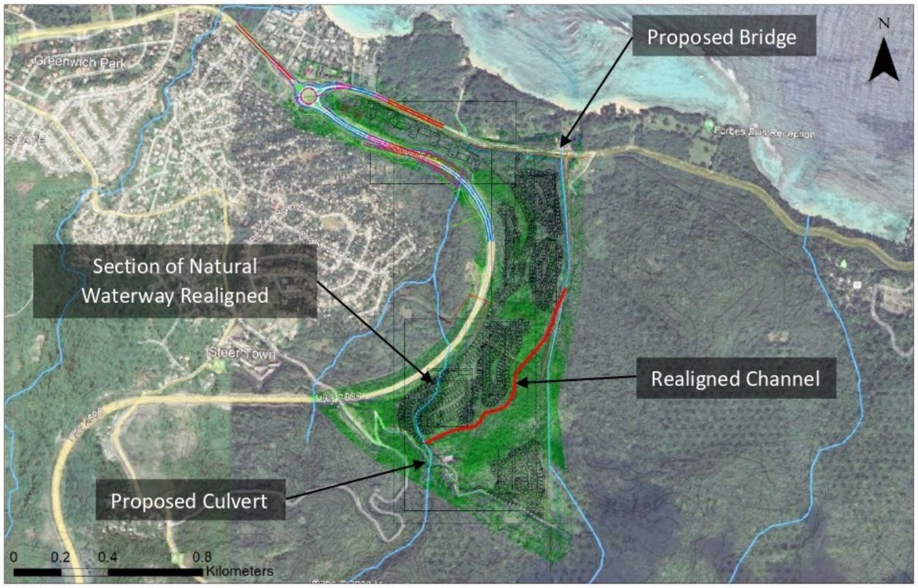

Figure 1-4: Locations of proposed drainage structures

The pre- and post-development watershed characteristics are presented in Table 1.2. The watershed was generally characterized as urban or disturbed forest (Figure 1-3a)) and with a soil infiltration rate of generally rapid (Figure 1-3b) with a soil classification of "A", we obtained a *CN* value of 76 for the urban areas and 36 for the disturbed forest areas. Based on the acreage characterized as either urban or disturbed forest, a weighted *CN* was developed for the watershed. In the post-development scenario where some of the forested areas is converted to urban areas due to the development, the percentage of urban acreage increased with a corresponding decrease in the forested areas. A weighted *CN* value was similarly computed for the post-development scenario. The pre- and post-development peak discharges for the 5, 10, 25, 50, and 100-year return period storm events for the large off-site watersheds are presented in Table 1.3. The Jamaica 2 calculations for the 100-year pre- and post-development are presented in Appendix E as sample calculations.

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Table 1.2: Landuse characteristics pre- and post-development

CATCHMENT			**SOIL CHARACTERISTICS**			**LANDUSE CHARACTERISCTCS**		**LANDUSE COVERAGE**		**Weighted *CN***	
Outfall Location		Area (ha)	Soil Internal Drainage		Classification	Primary Landuse	*CN*	Pre-Dev	Post-Dev	Pre-Dev	Post-Dev
Bridge		353	Very Rapid	60%	A	Urban	74	3%	20%	37.1	43.6
			Moderate to Rapid	40%	A	Disturbed Forest	36	97%	80%		
Channel	Upper	104	Very Rapid	30%	A	Urban	74	0%	6%	36.0	38.3
			Moderate to Rapid	70%	A	Disturbed Forest	36	100%	94%		
	Lower	329	Very Rapid	55%	A	Urban	74	0%	11%	36.0	40.2
			Moderate to Rapid	45%	A	Disturbed Forest	36	100%	89%		
Culvert		85	Very Rapid	15%	A	Urban	74	0%	0%	36.0	36.0
			Moderate to Rapid	85%	A	Disturbed Forest	36	100%	100%		

Table 1.3: Pre- and post-development peak runoff for large off-site watersheds

Structures		**Area**	**Peak Runoff (m^3/s)**									
			100yr		**50yr**		**25yr**		**10yr**		**5yr**	
		ha	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Bridge		353	33.3	48.6	25.0	36.4	17.7	26.4	9.7	15.0	5.4	8.5
Channel	Upper	104	10.5	12.7	7.5	8.9	5.2	6.1	2.8	3.3	1.5	1.8
	Lower	329	33.1	40.2	23.7	28.1	16.4	19.3	8.7	10.3	4.8	5.7
Culvert		85	6.4	6.4	6.4	6.4	4.4	4.4	2.2	2.2	1.2	1.2

The corresponding post-development proposed structures for the large off-site watersheds are presented in Table 1.4. The required dimensions for the drainage structures are also presented. The dimension for the bridge is presented with a "with" and "without" mitigation scenario. Without mitigation means the design runoff will be conveyed through the bridge to the sea. With mitigation means much of the runoff is controlled onsite.

Table 1.4: Post-development proposed structures for large off-site watersheds

			Design Discharge (m^3/s)			**Required Structure Size**
Structure		Area (ha)	100yr	25yr	10yr	
Bridge		353	48.6			7m x 3.0m BC **(without mitigation)** 1200mm PC **(with mitigation)**
Channel	Upper	104		6.1	3.3	1.0mW x 0.6mH (25yr) 0.8mW x 0.6mH (10yr)
	Lower	329		19.3	10.3	1.5mW x 0.9mH (25yr) 1.0mW x 0.9mH (10yr)
Culvert		85		4.4	2.2	Match channel width and height

BC = Box Culvert; PC = Pipe Culvert

1.5.4 Runoff Calculations within the subdivision

For ease of reference, the subdivision was divided into six (6) sections namely: Section A, B, C, D, E, and F. Each section was divided into sub-catchments based on the drainage layout and stormwater pipe connections. The different Sections and their sub-catchments are presented in Appendix B.

The calculated peak discharges for pre- and post-development discharges for the 5, 10, 25, 50, and 100-year storms are presented in Table 1.5. The following parameters were used in the calculations:

A runoff coefficient of 0.30 was used for pre-development conditions and 0.75 was used for post-development conditions (Appendix D). Based on existing literature, the 0.75 runoff coefficient for the proposed subdivision is a conservative estimate for the proposed subdivision. Except for sub-catchments F02 and F04, a time of concentration of 10 minutes was used as the other computed time of concentrations were less than 10 minutes. A time of concentration of 23.9mins were computed for sub-catchments F02 and F04.

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Table 1.5: Calculated peak and design discharges

Mammee Bay - Design Discharge Calculations										
Basin ID	**Drainage Area**	**Watercourse Length**	**Watercourse Slope**	**Runoff Coeff.**		**Shallow Conc. Flow Velocity**	**Tc**	**10yr 24-hour Rainfall**	**10yr Peak Discharge** (i= 208.7mm)	**10yr Design Discharge**
	(ha)	**(m)**	**(m/m)**	**CN**	**C**	**(m/s)**	**(min)**	**(mm)**	**(m^3/s)**	**(m^3/s)**
A01	2.98	200	0.1000		0.75	1.96	10.0	297	1.3	**1.4**
A02	1.39	200	0.0500		0.75	1.39	10.0	297	0.6	**0.7**
A03	1.05	1816	0.0350		0.75	1.16	10.0	297	0.5	**0.6**
A04	1.08	1445	0.0500		0.75	1.39	10.0	297	0.5	**0.6**
A05	2.79	3261	0.0200		0.75	0.88	10.0	297	1.2	**1.3**
A06	4.57	3461	0.0200		0.75	0.88	10.0	298	2.0	**2.2**
						0.00		297		
B01	0.57	1419	0.0500		0.75	1.39	10.0	297	0.2	**0.2**
B02	1.38	430	0.0700		0.75	1.64	10.0	297	0.6	**0.7**
B03	0.57	35	0.0400		0.75	1.24	10.0	297	0.2	**0.2**
B04	2.72	465	0.0400		0.75	1.24	10.0	297	1.2	**1.3**
B05	1.69	333	0.0700		0.75	1.64	10.0	297	0.7	**0.8**
B06	2.36	373	0.1000		0.75	1.96	10.0	297	1.0	**1.1**
B07	4.84	798	0.0400		0.75	1.24	10.0	297	2.1	**2.3**
B08	7.23	1171	0.0400		0.75	1.24	10.0	297	3.2	**3.5**
						0.00		297		
C01	2.04	989	0.0150		0.75	0.76	10.0	297	0.9	**1.0**
C02	0.49	389	0.0150		0.75	0.76	10.0	297	0.2	**0.2**
C03	2.77	1378	0.0500		0.75	1.39	10.0	297	1.2	**1.3**
C04	2.18	1280	0.0500		0.75	1.39	10.0	297	1.0	**1.1**
C05	5.19	2658	0.0500		0.75	1.39	10.0	297	2.3	**2.5**
C06	1.83	452	0.1000		0.75	1.96	10.0	297	0.8	**0.9**
C07	8.06	3110	0.1000		0.75	1.96	10.0	298	3.5	**3.9**
						0.00		297		
D01	1.23	688	0.1000		0.75	1.96	10.0	297	0.5	**0.6**
						0.00		297		
E01	0.95	969	0.0150		0.75	0.76	10.0	297	0.4	**0.4**
E02	0.77	944	0.0100		0.75	0.62	10.0	297	0.3	**0.3**
E03	3.13	1913	0.0100		0.75	0.62	10.0	297	1.4	**1.5**

Mammee Bay - Design Discharge Calculations

Basin ID	Drainage Area	Watercourse Length	Watercourse Slope	Runoff Coeff.		Shallow Conc. Flow Velocity	Tc	10yr 24-hour Rainfall	10yr Peak Discharge (i= 208.7mm)	10yr Design Discharge
	(ha)	(m)	(m/m)	CN	C	(m/s)	(min)	(mm)	(m^3/s)	(m^3/s)
E04	1.02	640	0.0100		0.75	0.62	10.0	297	0.4	**0.4**
E05	4.34	2553	0.0100		0.75	0.62	10.0	297	1.9	**2.1**
E06	1.07	293	0.0100		0.75	0.62	10.0	297	0.5	**0.6**
E07	6.88	2846	0.0100		0.75	0.62	10.0	297	3.0	**3.3**
E08	1.66	2252	0.0200		0.75	0.88	10.0	297	0.7	**0.8**
E09	2.50	1419	0.0100		0.75	0.62	10.0	297	1.1	**1.2**
E10	4.39	3671	0.0150		0.75	0.76	10.0	297	1.9	**2.1**
E11	7.00	2846	0.0100		0.75	0.62	10.0	297	3.1	**3.4**
Culvert	11.39	6517	0.0100		0.75	0.62	10.0	298	5.0	**5.5**
						0		297		
F01	3.17	499	0.0200		0.75	0.88	10.0	297	1.4	**1.5**
F02	143.27	2700	0.1129	36		2.08	23.9	297	3.3	**3.7**
F03	1.21	609	0.0200		0.75	0.88	10.0	297	0.5	**0.6**
F04	145.89	2700	0.1129	36		2.08	23.9	297	3.5	**3.8**

1.5.5 Drainage Requirements

The drainage requirements are based on the design discharges and the slope of the pipe or channel. The slopes of the proposed drainage network vary significantly throughout the subdivision ranging from over 12% to less than 1% and changes several times along a single drainage path. Consequently, the average slopes of the pipes and channel sections were used in the calculations to determine their dimensions. Accordingly, it may appear in some sections that the pipe capacity may be inadequate for the design discharge. This is not the case. Where the pipes have very steep slopes, the flows will have a significantly higher velocity and this velocity (approach velocity) will cause the water to move through the less steep sections with a higher than normal velocity. The actual capacity of the pipe will therefore be higher than the computed capacity using the average slope. A close approximation of the average capacity of the pipe based on the average slope is therefore sufficient to convey the design discharge. The recommended pipe sizes are therefore presented in Table 1.6.

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Table 1.6: Required drainage structures and capacities

Mammee Bay Subdivision - Drainage Structures

Basin ID	Drainage Area	10yr Peak Discharge	Slope	Pipe	Barrels	Capacity
	(ha)	(m^3/s)	(m/m)	D (mm)	no.	(m^3/s)
A01	2.98	1.3	0.1000	**900**	1	1.30
A02	1.39	0.6	0.0500	**750**	1	0.80
A03	1.05	0.5	0.0350	**600**	1	0.50
A04	1.08	0.5	0.0500	**600**	1	0.50
A05	2.79	1.2	0.0200	**900**	1	1.30
A06	4.57	2.0	0.0200	**1200**	1	3.00
B01	0.57	0.2	0.0500	**450**	1	0.20
B02	1.38	0.6	0.0700	**600**	1	0.50
B03	0.57	0.2	0.0400	**450**	1	0.20

Mammee Bay Subdivision - Drainage Structures

Basin ID	Drainage Area	10yr Peak Discharge	Slope	Pipe	Barrels	Capacity
	(ha)	(m^3/s)	(m/m)	D (mm)	no.	(m^3/s)
B04	2.72	1.2	0.0400	**900**	1	1.30
B05	1.69	0.7	0.0700	**750**	1	0.80
B06	2.36	1.0	0.1000	**900**	1	1.30
B07	4.84	2.1	0.0400	**1200**	1	3.50
B08	7.23	3.2	0.0400	**1200**	1	3.50
C01	2.04	0.9	0.0150	**900**	1	1.30
C02	0.49	0.2	0.0150	**450**	1	0.20
C03	2.77	1.2	0.0500	**900**	1	1.30
C04	2.18	1.0	0.0500	**900**	1	7.85
C05	5.19	2.3	0.0500	**1200**	1	3.00
C06	1.83	0.8	0.1000	**750**	1	0.80
C07	8.06	3.5	0.1000	**1200**	1	3.50
D01*	1.23	0.5	0.1000	**-**	-	-
E01	0.95	0.4	0.0150	**600**	1	0.50
E02	0.77	0.3	0.0100	**600**	1	0.50
E03	3.13	1.4	0.0100	**900**	1	1.30
E04	1.02	0.4	0.0100	**600**	1	0.50
E05	4.34	1.9	0.0100	**1200**	1	3.00
E06	1.07	0.5	0.0100	**600**	1	0.50
E07	6.88	3.0	0.0100	**1200**	1	3.00
E08	1.66	0.7	0.0200	**750**	1	0.80
E09	2.50	1.1	0.0100	**900**	1	1.30
E10	4.39	1.9	0.0150	**1200**	1	3.00
E11	7.00	3.1	0.0100	**1200**	1	3.00
Culvert	11.39	5.0	0.0100	**1200**	2	6.00
F01	3.17	1.4	0.0200	**900**	1	1.30
F02	143.27	3.7	0.0400	**1200**	1	3.50
F03	1.21	0.5	0.0200	**600**	1	0.50
F04	145.89	3.8	0.0400	**1200**	1	3.50

*Detention pond recommended.

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1.5.6 Detention Pond

To mitigate, and prevent, if possible, the discharge of runoff onto the beach north of the subdivision is an objective of this drainage design. It is understood that there is very little or no impact to the beach based on existing conditions primarily because the surface runoff currently infiltrates into the ground and disappears. This could change with the proposed subdivision due to reduced infiltration and increase surface runoff. The rock formation is cavernous which permits rapid infiltration into the ground. This will allow an infiltration similar to gravel or karst limestone (Appendix F).

To counter the potential impact on the beach and nearshore area, a detention pond is proposed north of the subdivision as indicated in Figure 1-5. The detention pond consists of an area of up to **150m x 40m** – a base area of 6,000m^2. It is proposed to design the pond in its entirety as a soakaway. With the 6,000m^2 area and an estimated infiltration rate between 0.001m/s and 0.01m/s (Appendix F), a percolation rate ranging between 6m^3/s and 60m^3/s is obtained. On average, a percolation rate of 33m^3/s can be achieved using only graded gravel. The percolation rate can be improved by using a graded rock base overlaid with gravel filter. This would increase the percolation rate above the 33m^3/s achieved only by the graded grave. Notwithstanding the improved percolation that will be achieved by the graded rock base, the more conservative 33m^3/s percolation rate will be used in the assessment of the detention pond capacity and the sizing of the culvert at the crossing of the NCH.

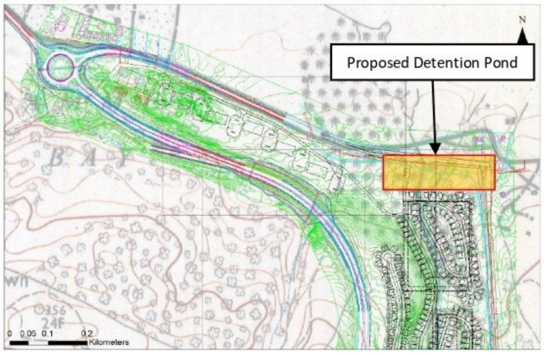

Figure 1-5: Proposed location of primary detention ponds

Table 1.7 shows the net storage volume and discharge for the 100-year storm event into the main detention pond. The computed runoff flow rate is represented as "Q". This is surcharged by 10% (1.1Q) to take account of the potential impact of climate change. The incremental, cumulative and net storage volumes for the computed runoff is shown. With a percolation rate of 33m^3/s, there is a net storage for the 100-year storm of approximately 11,323m^3/s. Tis volume is as a results of the net discharge (1.1Q) and will be stored in the detention pond. With a 6,000m^2 base area, the detention pond will need to have a 2m depth.

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Table 1.7: Net storage volume and discharge into the detention pond for the 100-year rainfall

			Incremental	Cumulative	Net Storage	Net Q	Net 1.1Q	Net Storage
Time	Q	1.1Q	Vol (Q)	Vol (Q)	Vol (Q)			Vol (1.1Q)
(mins)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3/s)	(m^3/s)	(m^3)
0.0	0.0	0.0	0.0	0.0	-9,585.58	-33.00	-33.00	
4.84	0.89	0.98	129.45	129.53	-9,456.13	-32.11	-32.02	
9.68	6.21	6.83	1,031.30	1,161.44	-8,554.28	-26.79	-26.17	
14.52	15.81	17.39	3,197.40	4,360.74	-6,388.18	-17.19	-15.61	
19.36	26.64	29.30	6,164.61	10,529.02	-3,420.97	-6.36	-3.70	
24.21	35.82	39.40	9,071.69	19,606.12	-513.88	2.82	6.40	393.29
29.05	41.76	45.93	11,267.07	30,879.90	1,681.50	8.76	12.93	2,808.21
33.89	44.10	48.51	12,469.71	43,357.03	2,884.13	11.10	15.51	4,131.10
38.73	43.34	47.67	12,699.49	56,064.09	3,113.92	10.34	14.67	4,383.87
43.57	40.30	44.33	12,147.64	68,218.96	2,562.06	7.30	11.33	3,776.82
48.41	35.89	39.47	11,065.28	79,290.82	1,479.70	2.89	6.47	2,586.23
53.25	30.85	33.93	9,692.10	88,988.69	106.52	-2.15	0.93	1,075.73
58.09	25.76	28.33	8,221.28	97,214.87	-1,364.29	-7.24	-4.67	**11,323.18**
62.94	20.99	23.09	6,789.60	104,008.51	-2,795.97	-12.01	-9.91	
67.78	16.75	18.43	5,481.73	109,493.51	-4,103.85	-16.25	-14.57	
72.62	13.13	14.45	4,340.73	113,836.82	-5,244.84	-19.87	-18.55	
77.46	10.14	11.15	3,379.91	117,218.74	-6,205.67	-22.86	-21.85	
82.30	7.72	8.49	2,593.32	119,813.61	-6,992.25	-25.28	-24.51	
87.14	5.81	6.39	1,964.13	121,778.91	-7,621.44	-27.19	-26.61	

			Incremental	Cumulative	Net Storage	Net Q	Net 1.1Q	Net Storage
Time	Q	1.1Q	Vol (Q)	Vol (Q)	Vol (Q)			Vol (1.1Q)
(mins)	(m^3/s)	(m^3/s)	(m^3)	(m^3)	(m^3)	(m^3/s)	(m^3/s)	(m^3)
91.98	4.32	4.75	1,470.54	123,250.33	-8,115.04	-28.68	-28.25	
96.82	3.18	3.50	1,089.68	124,340.66	-8,495.90	-29.82	-29.50	
101.67	2.33	2.56	800.00	125,141.13	-8,785.58	-30.67	-30.44	
106.51	1.68	1.85	582.41	125,723.89	-9,003.16	-31.32	-31.15	
111.35	1.21	1.33	420.78	126,144.92	-9,164.79	-31.79	-31.67	
116.19	0.87	0.95	301.90	126,447.00	-9,283.68	-32.13	-32.05	
121.03	0.62	0.68	215.22	126,662.35	-9,370.36	-32.38	-32.32	
125.87	0.43	0.48	152.53	126,814.97	-9,433.04	-32.57	-32.52	
130.71	0.31	0.34	107.52	126,922.55	-9,478.06	-32.69	-32.66	
135.55	0.21	0.24	75.41	126,998.01	-9,510.17	-32.79	-32.76	
140.39	0.15	0.16	52.64	127,050.68	-9,532.93	-32.85	-32.84	

With the passage of time, the percolation rate will decrease without adequate maintenance. Proper maintenance of the system will therefore be required. If the percolation rate is reduced because of a lack of proper maintenance, the detention pond will still mitigate against most of the major storms and normal regular rainfall events. This is most important as it is the normal regular rainfall that can become a nuisance if it impacts regularly on the beach.

With this proposed detention pond, the proposed bridge crossing the NCH can be reduced to a 1200mm diameter pipe culvert as up to the 100-year storm there is mostly zero outflow from the pond to the culvert. The 1200mm diameter pipe is therefore a conservative recommendation.

A small detention pond is also recommended for sub-catchment D01 to prevent runoff from impacting the residential lots (Figure 1-6). No engineered channel is required. The runoff is minimal as the catchment area remains undisturbed.

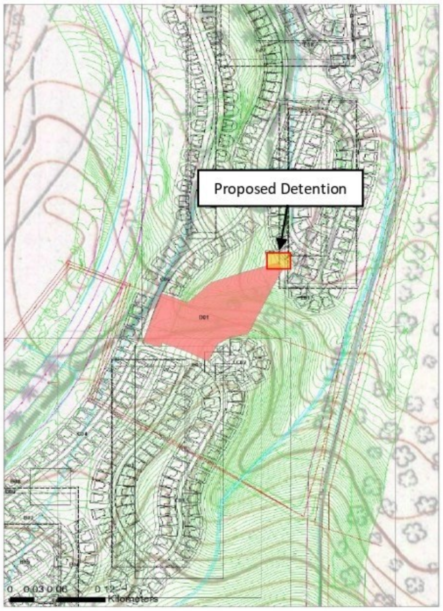

Figure 1-6: Location of proposed detention ponds

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1.6 Conclusions and Recommendations

The main goal of the drainage design is to provide adequate drainage for the subdivision and mitigate impact to the beach area north of the subdivision. To achieve this, a section of the natural drainage path was realigned, and a series of pipe sewers are proposed to control and convey the storm runoff to detention ponds for final discharge. The design also mitigates against scour and erosion from the steep slopes. At the outlet locations where the outlet velocities are high, adequate protection is to be put in place to mitigate against scour and erosion.

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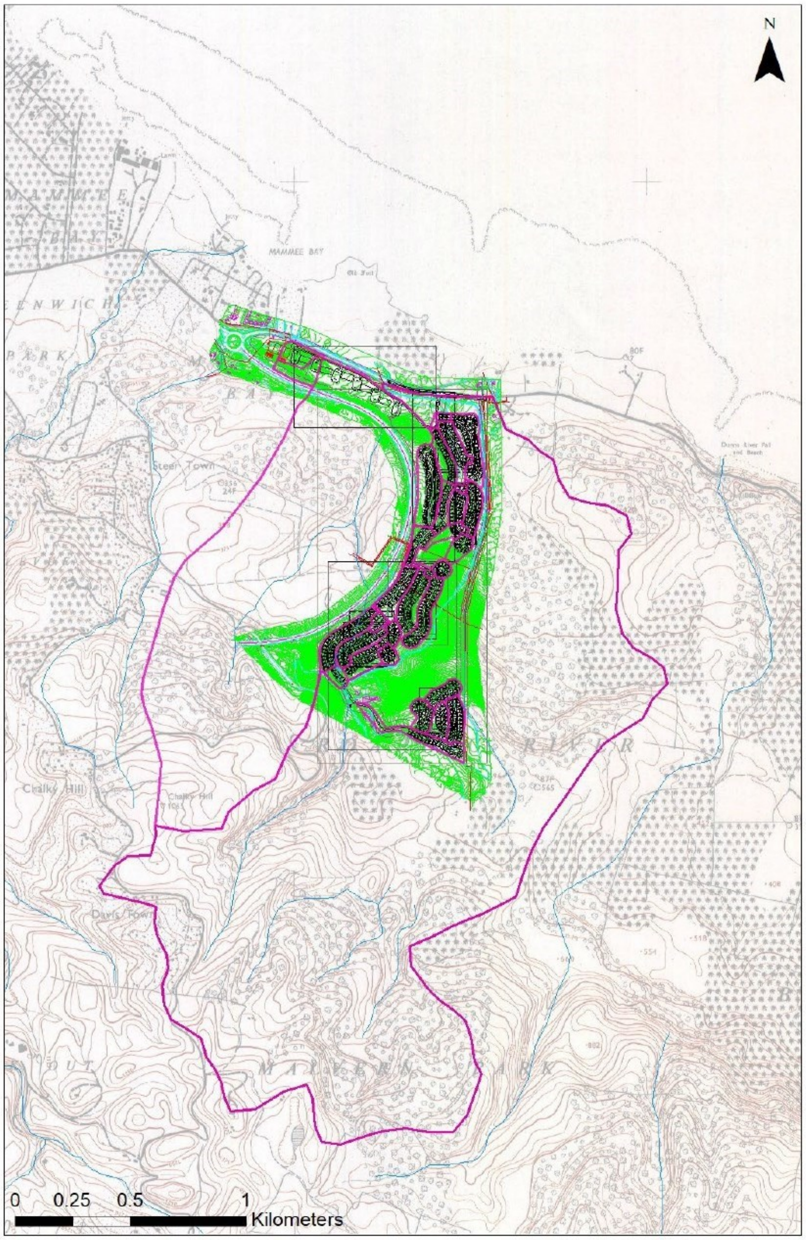
Appendix

Appendix A: Pre-Development offsite watershed areas



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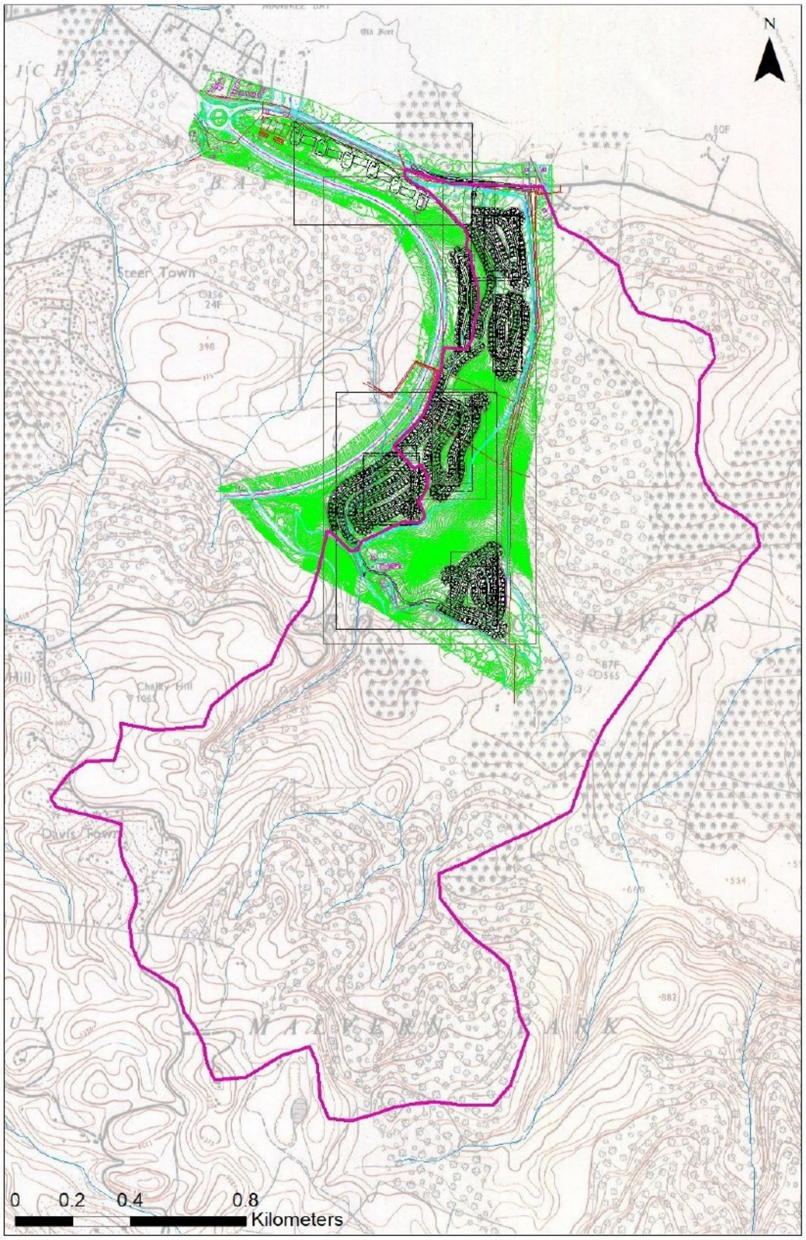
Appendix A1: Post-development watershed area – Proposed Bridge



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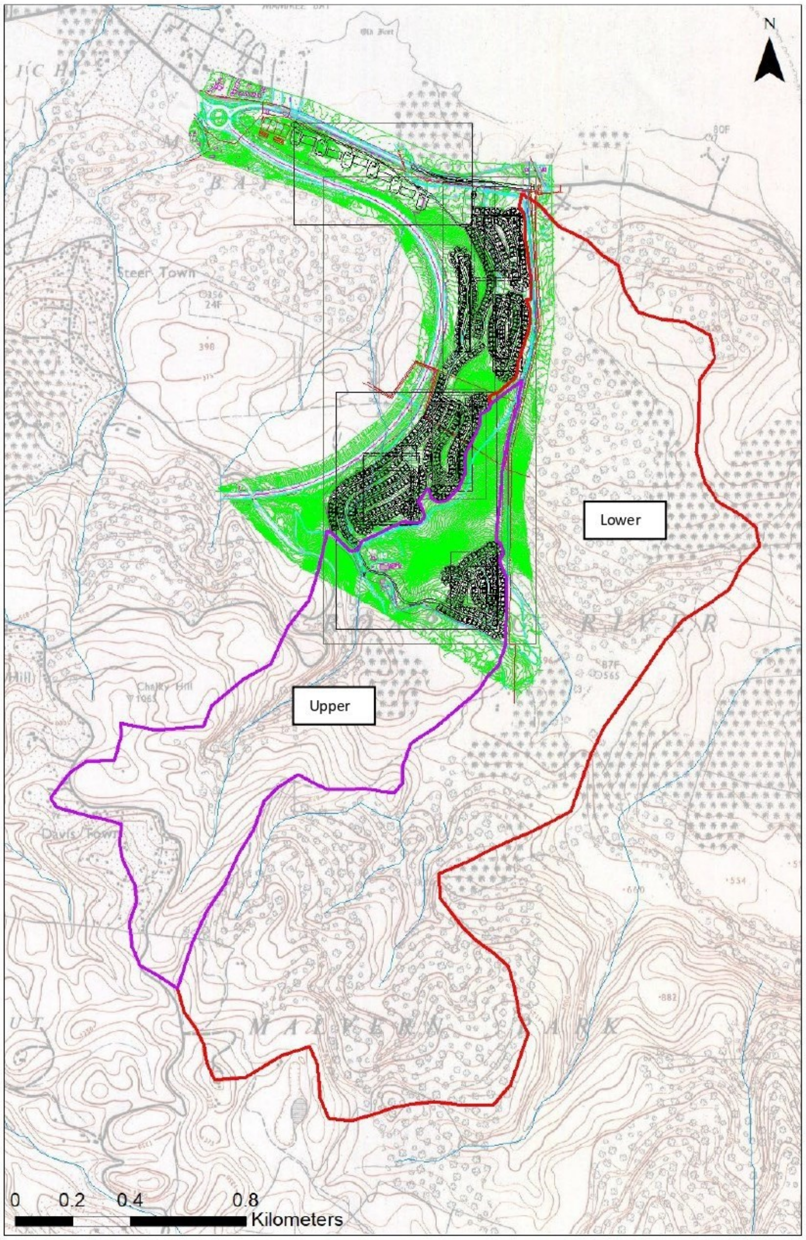
Appendix A2: Post-development watershed area – Realigned channel (Upper & Lower)



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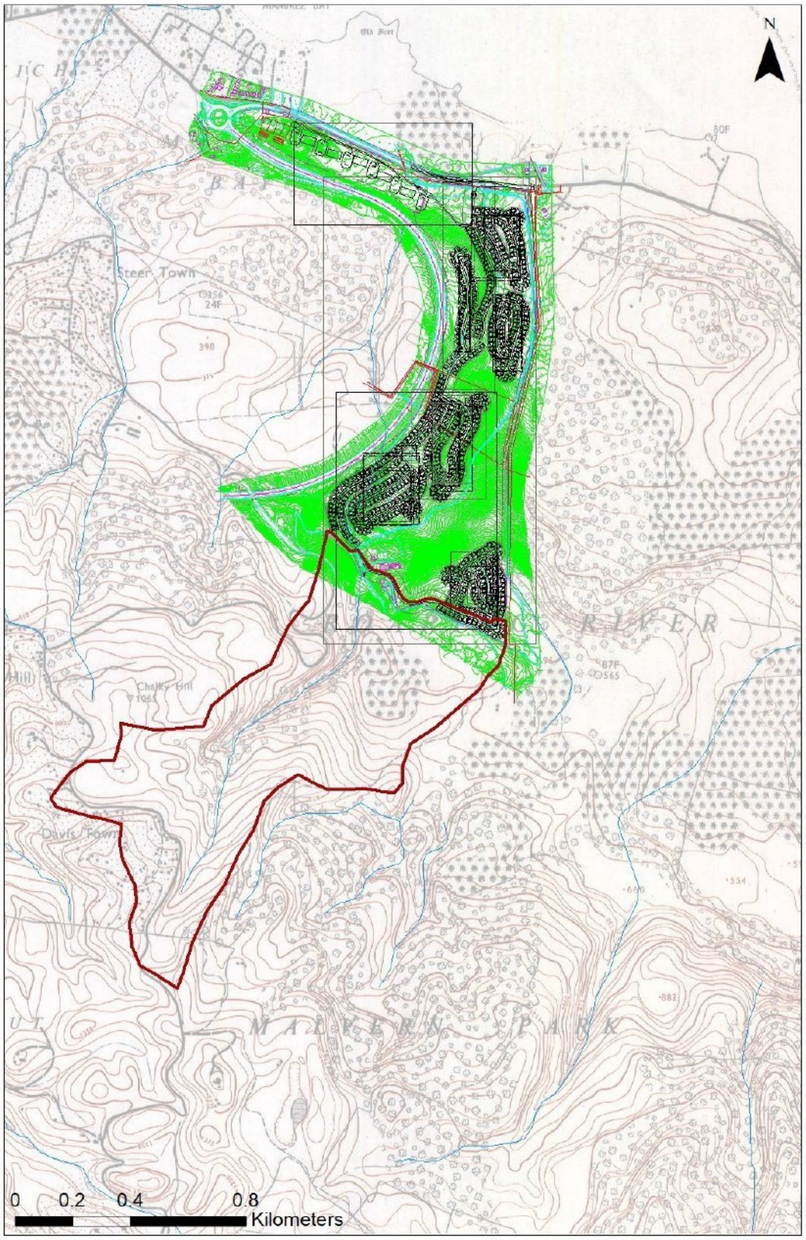
Appendix A3: Post-development watershed area – Proposed culvert crossing (Existing road)



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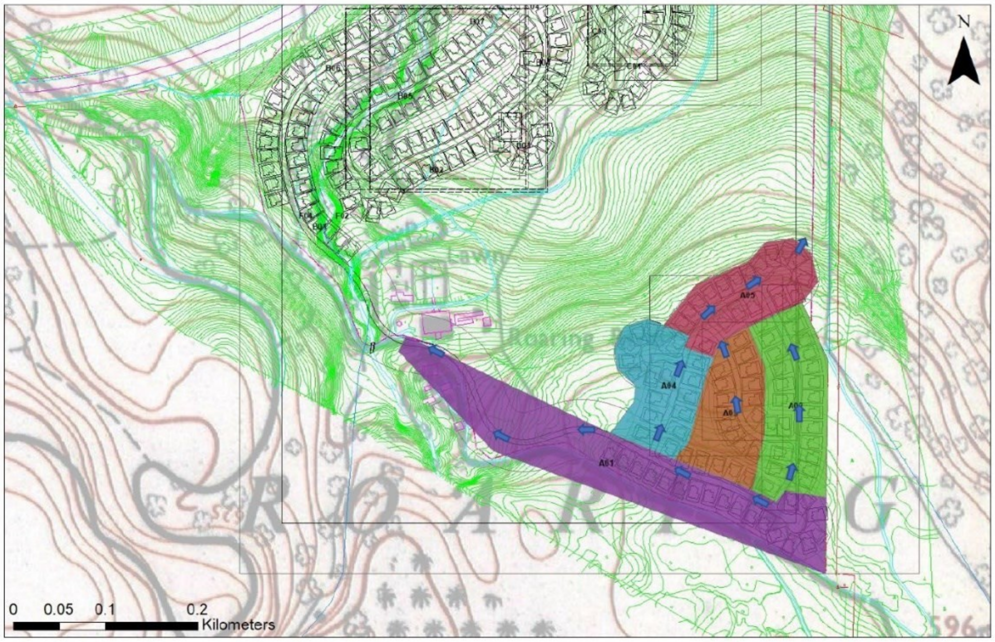
Appendix B: Sub-catchments withing the subdivision

Appendix B1: Section A



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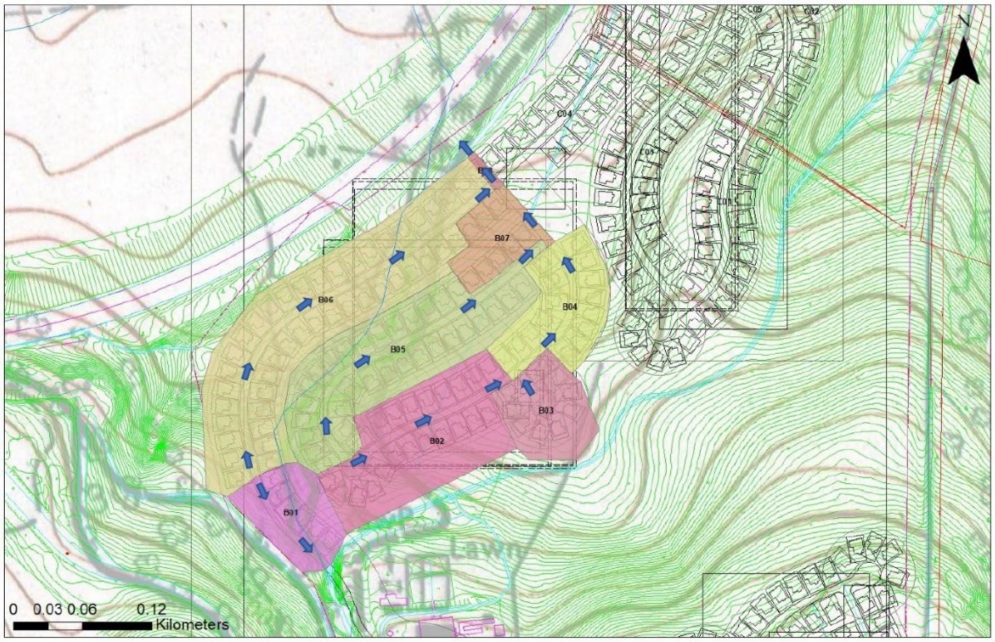
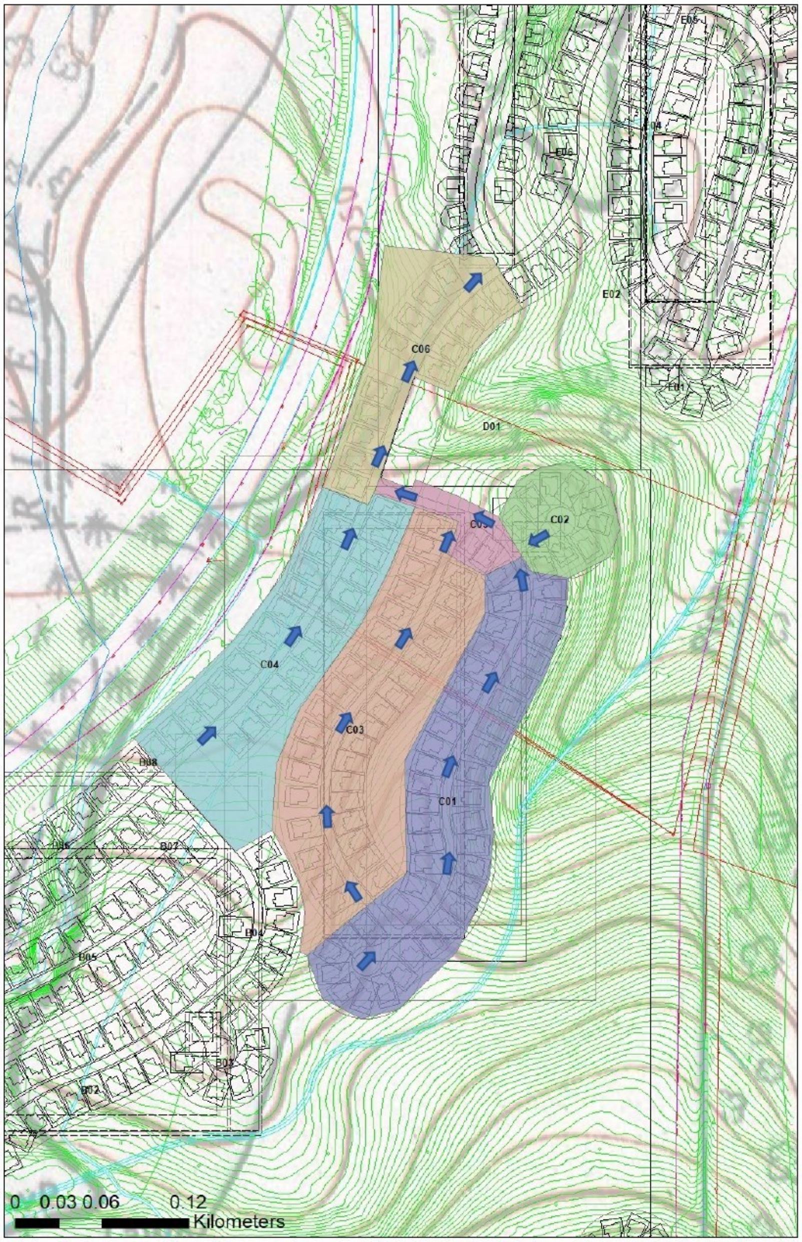
Appendix B2: Section B



Appendix B3: Section C



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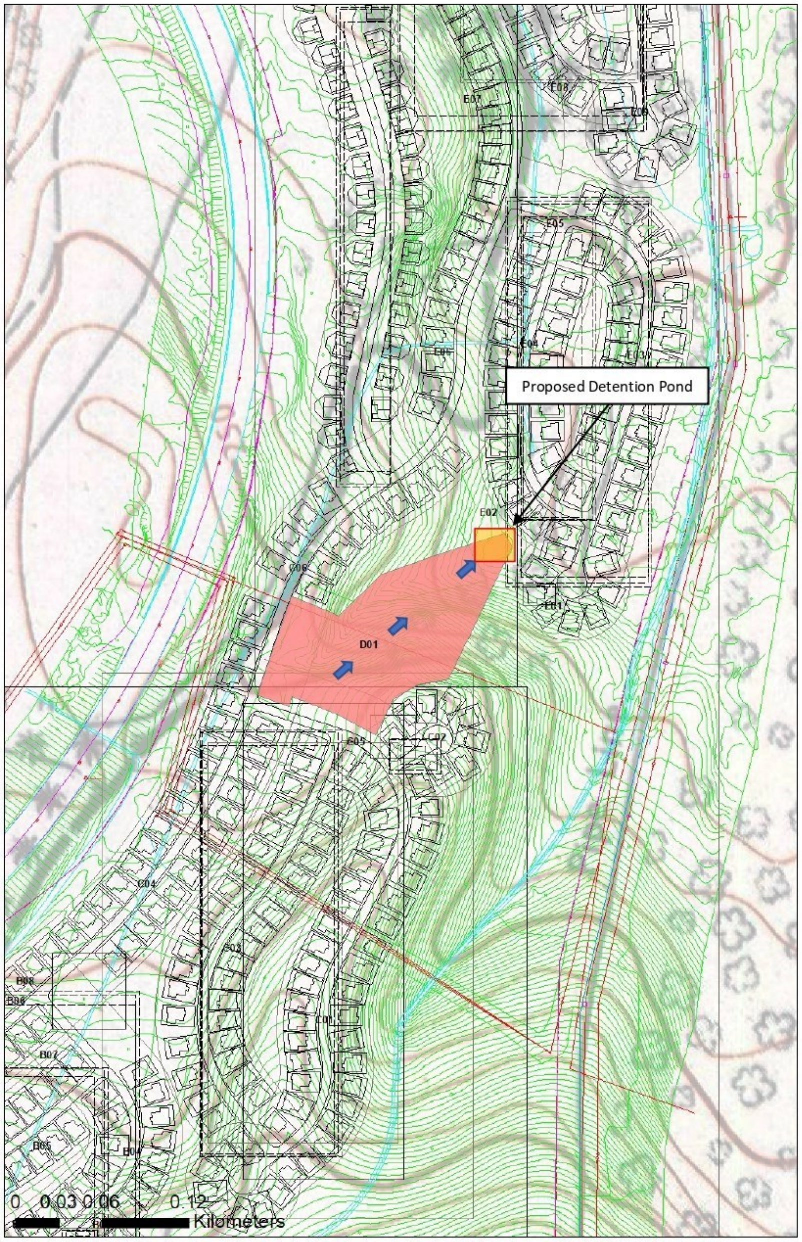
Appendix B4: Section D



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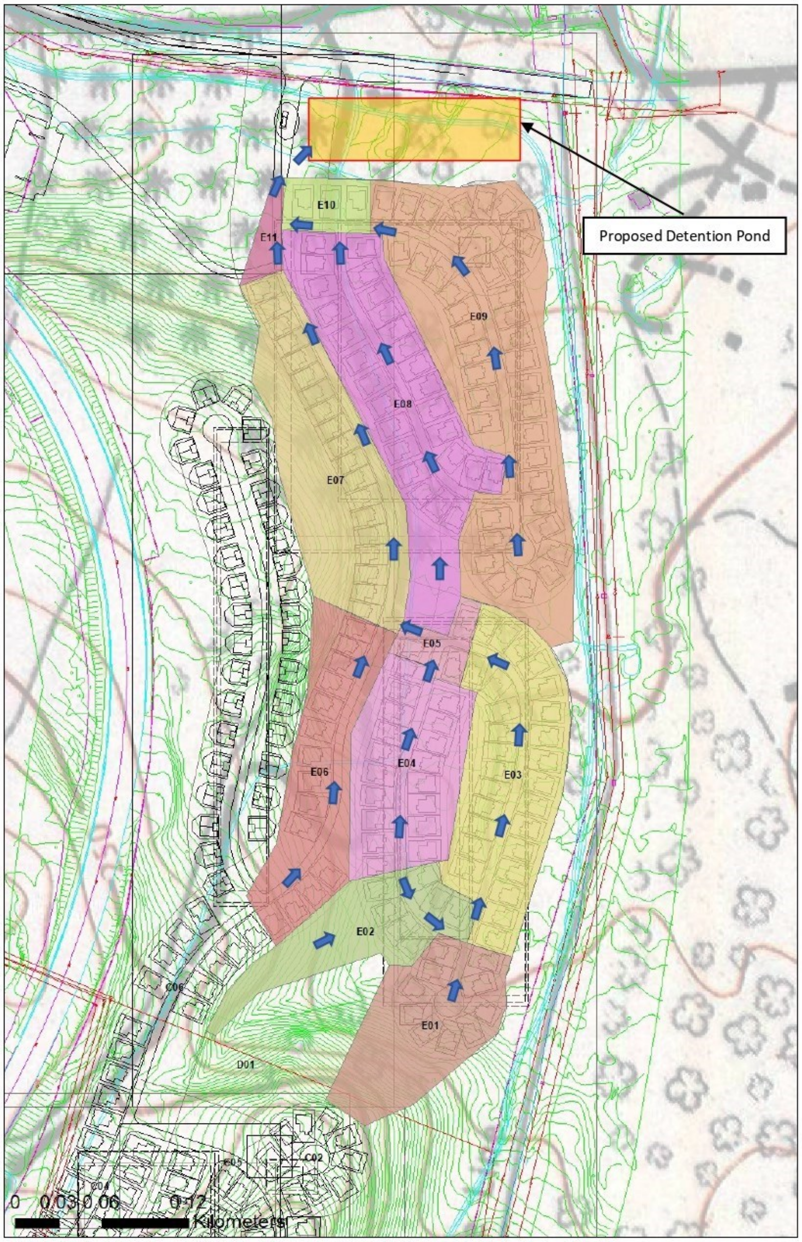
Appendix B5: Section E



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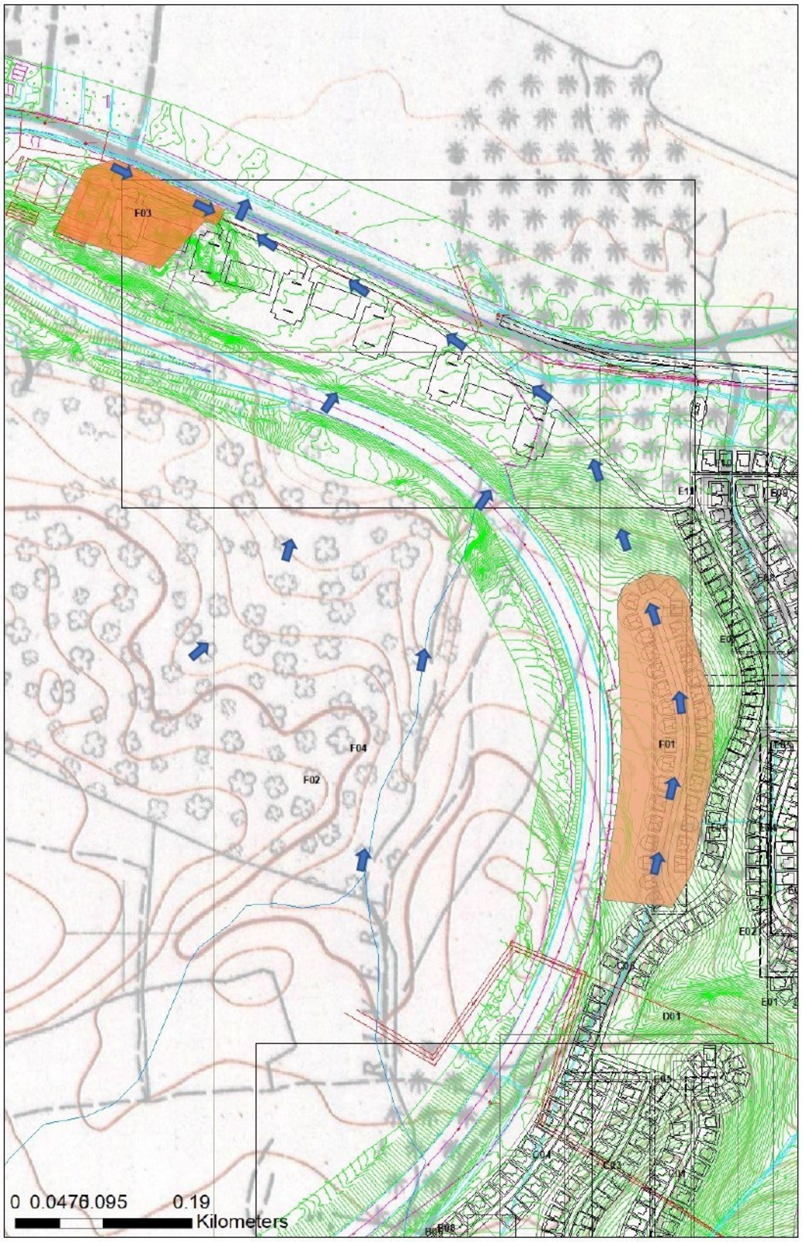
Appendix B6: Section F (i)



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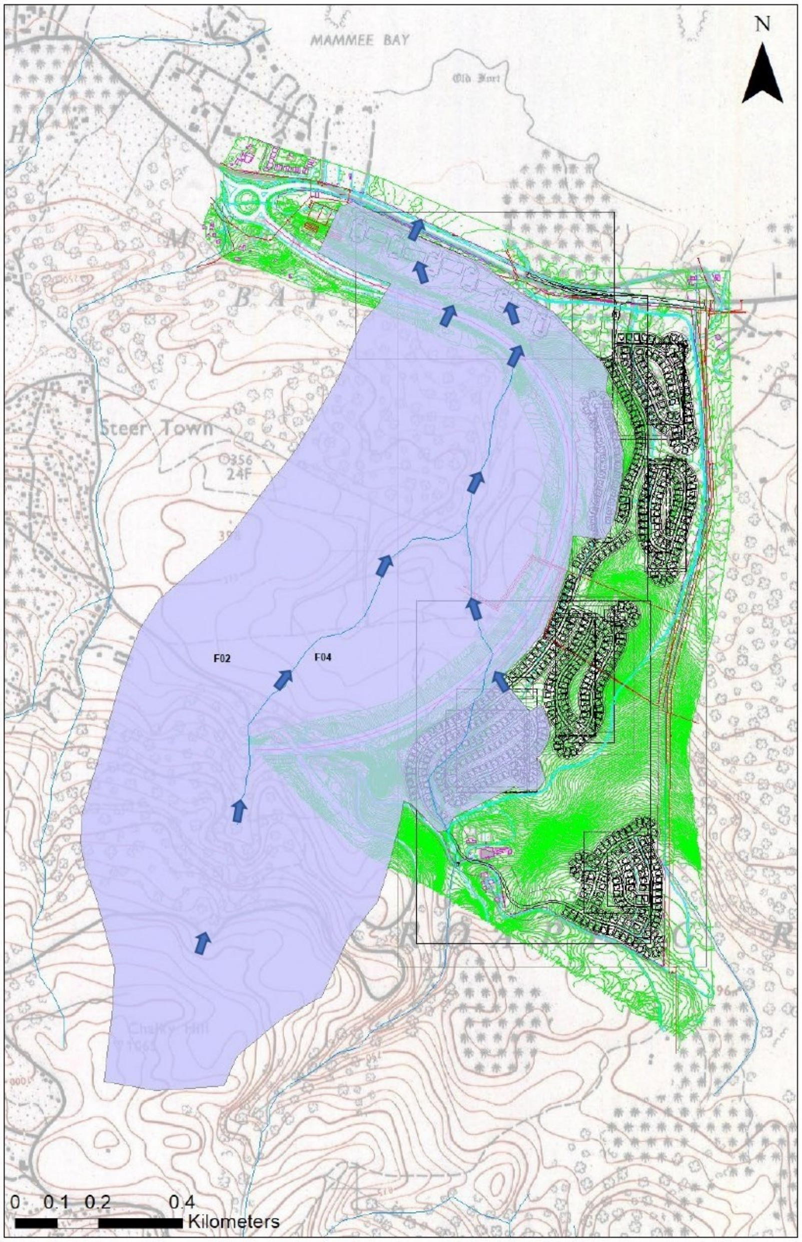
Appendix B7: Section F (ii)



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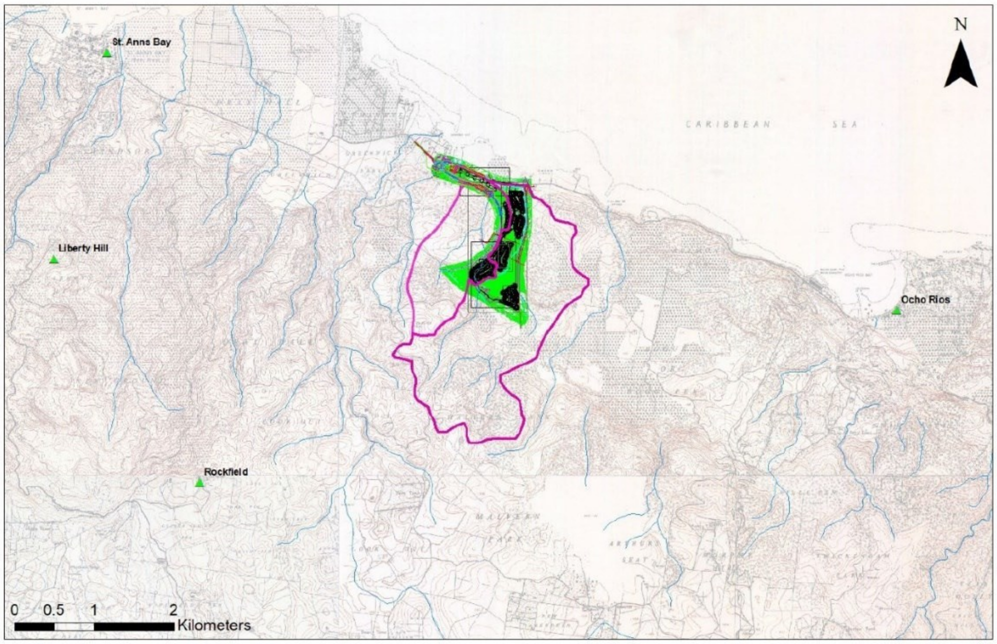
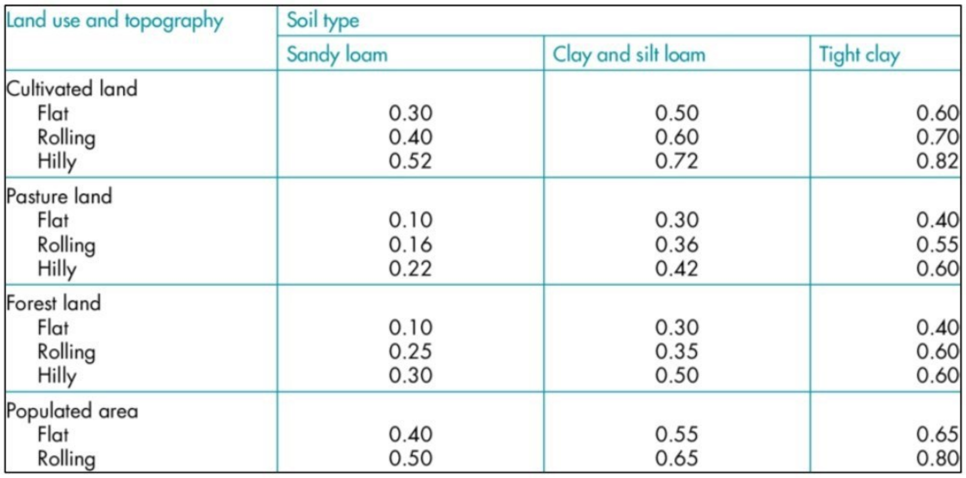
Appendix C: Rainfall stations



Appendix D: Runoff Coefficients based on landuse, topography, and soil type.



Land use and topography	Soil type		
	Sandy loam	Clay and silt loam	Tight clay
Cultivated land			
Flat	0.30	0.50	0.60
Rolling	0.40	0.60	0.70
Hilly	0.52	0.72	0.82
Pasture land			
Flat	0.10	0.30	0.40
Rolling	0.16	0.36	0.55
Hilly	0.22	0.42	0.60
Forest land			
Flat	0.10	0.30	0.40
Rolling	0.25	0.35	0.60
Hilly	0.30	0.50	0.60
Populated area			
Flat	0.40	0.55	0.65
Rolling	0.50	0.65	0.80

Source: https://www.researchgate.net/figure/Rational-method-runoff-coefficients-C-for-different-land-cover-areas-and-soil-types_tbl4_312377244

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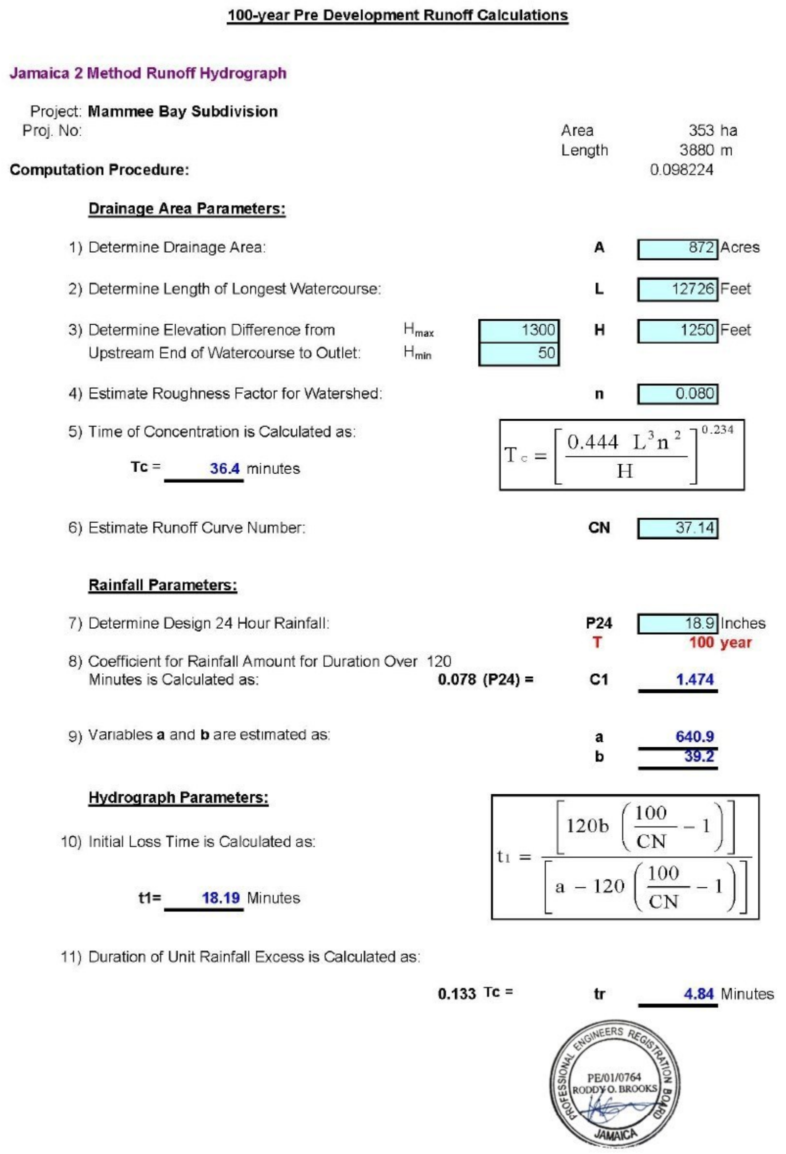
Appendix E: Jamaica 2 calculations sheets for the pre- and post-development runoff calculations



100-year Pre Development Runoff Calculations

Jamaica 2 Method Runoff Hydrograph

Project: **Mammee Bay Subdivision**
Proj. No:

Area	353 ha
Length	3880 m
	0.098224

Computation Procedure:

Drainage Area Parameters:

1) Determine Drainage Area: **A** 872 Acres

2) Determine Length of Longest Watercourse: **L** 12726 Feet

3) Determine Elevation Difference from Upstream End of Watercourse to Outlet: H_{max} 1300, H_{min} 50 **H** 1250 Feet

4) Estimate Roughness Factor for Watershed: **n** 0.080

5) Time of Concentration is Calculated as:

$$T_c = \left[\frac{0.444\ L^3 n^2}{H}\right]^{0.234}$$

Tc = **36.4** minutes

6) Estimate Runoff Curve Number: **CN** 37.14

Rainfall Parameters:

7) Determine Design 24 Hour Rainfall: **P24** 18.9 Inches
T **100 year**

8) Coefficient for Rainfall Amount for Duration Over 120 Minutes is Calculated as: **0.078 (P24) =** **C1** **1.474**

9) Variables **a** and **b** are estimated as: **a** **640.9** **b** **39.2**

Hydrograph Parameters:

10) Initial Loss Time is Calculated as:

$$t_1 = \frac{\left[120b\left(\frac{100}{CN} - 1\right)\right]}{\left[a - 120\left(\frac{100}{CN} - 1\right)\right]}$$

t1= **18.19** Minutes

11) Duration of Unit Rainfall Excess is Calculated as:

0.133 Tc = **tr** **4.84** Minutes

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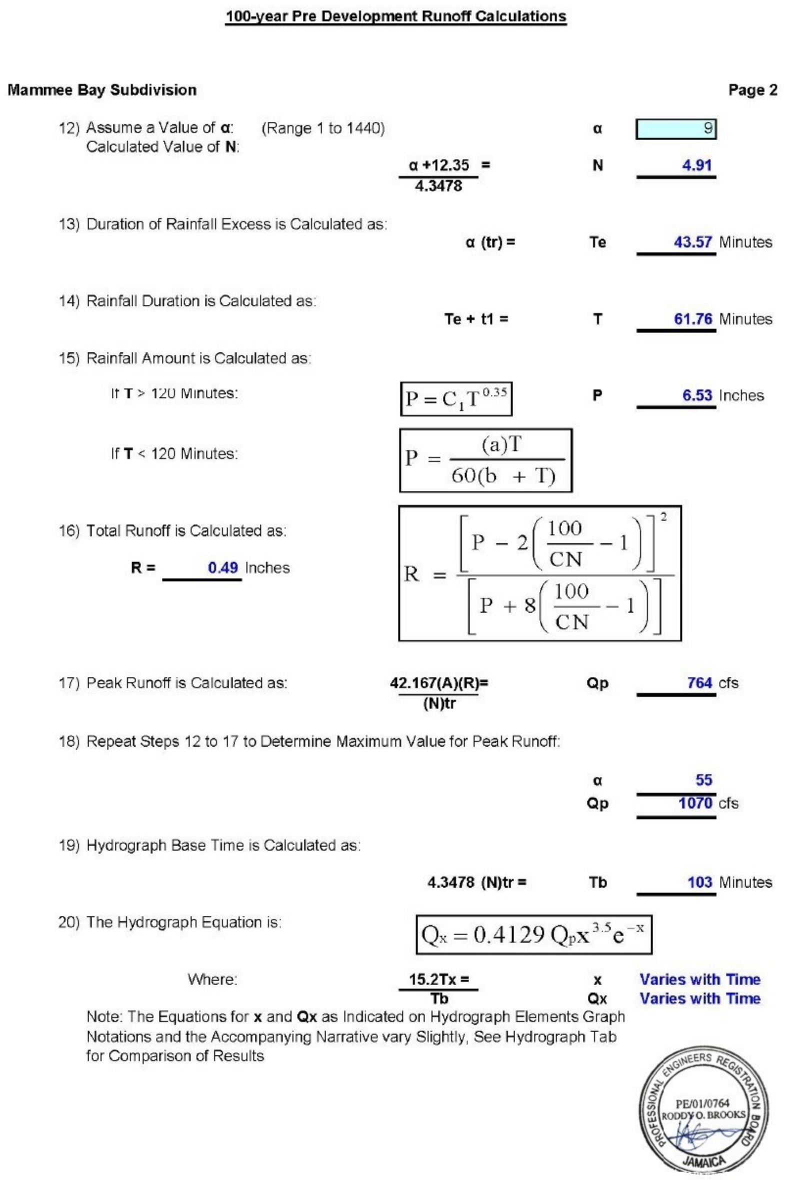
27



100-year Pre Development Runoff Calculations

Mammee Bay Subdivision **Page 2**

12) Assume a Value of **α**: (Range 1 to 1440) **α** 9

Calculated Value of **N**: $\frac{\alpha + 12.35}{4.3478} =$ **N** **4.91**

13) Duration of Rainfall Excess is Calculated as: **α (tr) =** **Te** **43.57** Minutes

14) Rainfall Duration is Calculated as: **Te + t1 =** **T** **61.76** Minutes

15) Rainfall Amount is Calculated as:

If **T** > 120 Minutes: $P = C_1 T^{0.35}$ **P** **6.53** Inches

If **T** < 120 Minutes: $P = \frac{(a)T}{60(b + T)}$

16) Total Runoff is Calculated as:

R = **0.49** Inches

$$R = \frac{\left[P - 2\left(\frac{100}{CN} - 1\right)\right]^2}{\left[P + 8\left(\frac{100}{CN} - 1\right)\right]}$$

17) Peak Runoff is Calculated as: $\frac{42.167(A)(R)}{(N)tr} =$ **Qp** **764** cfs

18) Repeat Steps 12 to 17 to Determine Maximum Value for Peak Runoff:

α **55**

Qp **1070** cfs

19) Hydrograph Base Time is Calculated as: **4.3478 (N)tr =** **Tb** **103** Minutes

20) The Hydrograph Equation is: $Q_x = 0.4129\, Q_p x^{3.5} e^{-x}$

Where: $\frac{15.2Tx}{Tb} =$ **x** **Varies with Time**

Qx **Varies with Time**

Note: The Equations for **x** and **Qx** as Indicated on Hydrograph Elements Graph Notations and the Accompanying Narrative vary Slightly, See Hydrograph Tab for Comparison of Results

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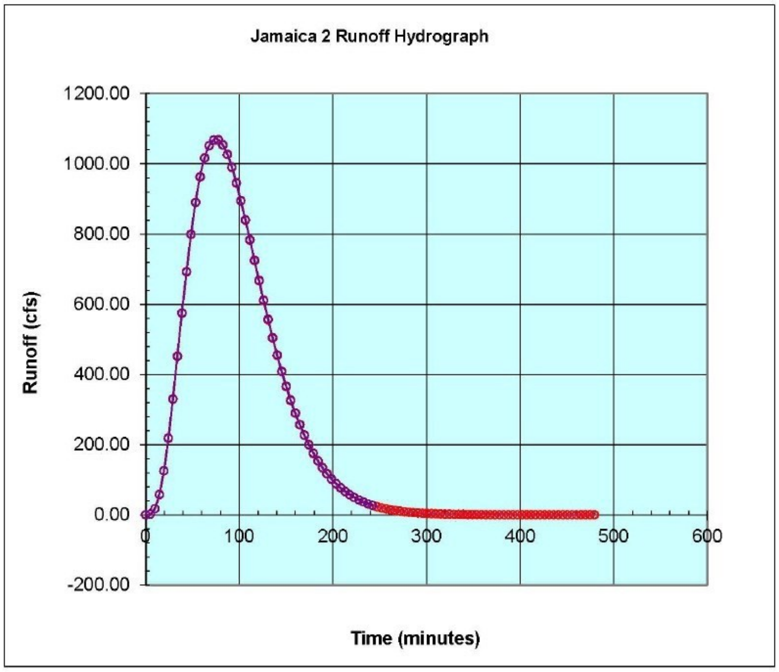
28

100-year Pre Development Runoff Calculations

Mammee Bay Subdivision **Page 3**



Hydrograph Volume:	6614906	ft³	**Duration:**	479	min.
	187313	m³		7.99	hr.
Peak Runoff:	1070	ft³/s			
	30.3	m³/s			
Design Runoff	33.33	m³/s			

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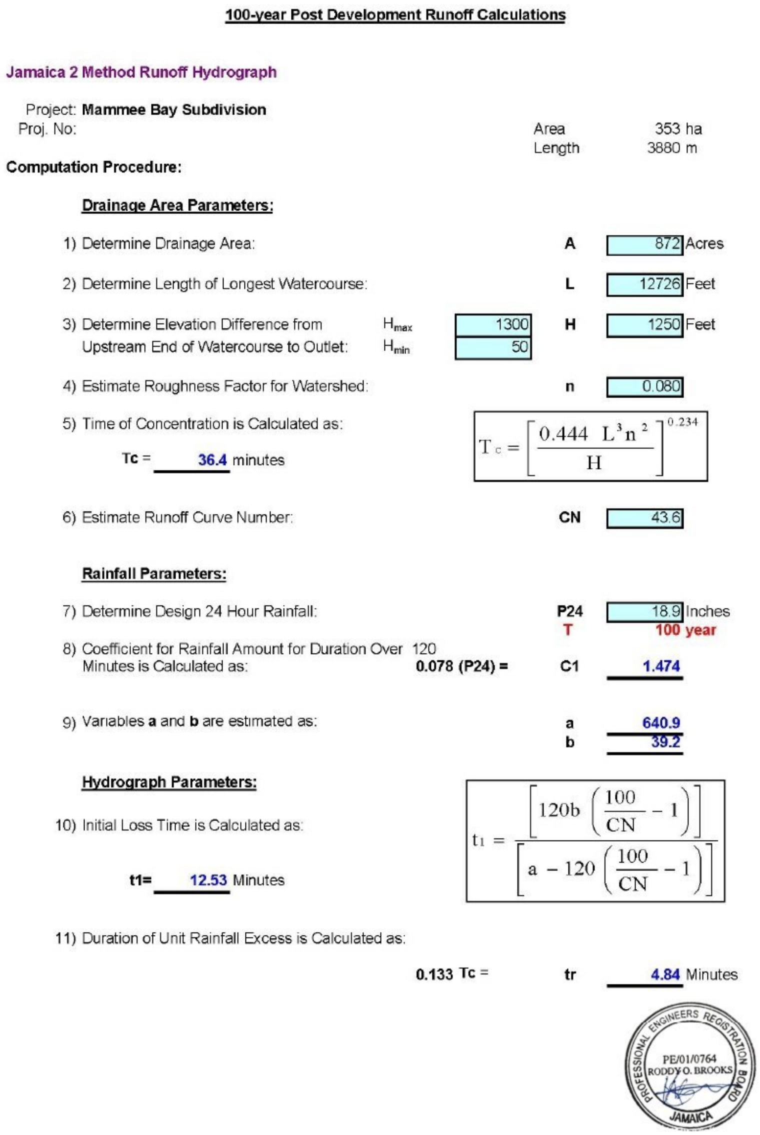

100-year Post Development Runoff Calculations

Jamaica 2 Method Runoff Hydrograph

Project: **Mammee Bay Subdivision**
Proj. No:

Area 353 ha
Length 3880 m

Computation Procedure:

Drainage Area Parameters:

1) Determine Drainage Area: **A** 872 Acres

2) Determine Length of Longest Watercourse: **L** 12726 Feet

3) Determine Elevation Difference from Upstream End of Watercourse to Outlet: H_{max} 1300 H_{min} 50 **H** 1250 Feet

4) Estimate Roughness Factor for Watershed: **n** 0.080

5) Time of Concentration is Calculated as:

$$T_c = \left[\frac{0.444\ L^3 n^2}{H}\right]^{0.234}$$

Tc = **36.4** minutes

6) Estimate Runoff Curve Number: **CN** 43.6

Rainfall Parameters:

7) Determine Design 24 Hour Rainfall: **P24** 18.9 Inches
T **100 year**

8) Coefficient for Rainfall Amount for Duration Over 120 Minutes is Calculated as: **0.078 (P24) =** **C1** **1.474**

9) Variables **a** and **b** are estimated as:
a **640.9**
b **39.2**

Hydrograph Parameters:

10) Initial Loss Time is Calculated as:

$$t_1 = \frac{\left[120b\left(\frac{100}{CN}-1\right)\right]}{\left[a-120\left(\frac{100}{CN}-1\right)\right]}$$

t1= **12.53** Minutes

11) Duration of Unit Rainfall Excess is Calculated as:

0.133 Tc = **tr** **4.84** Minutes

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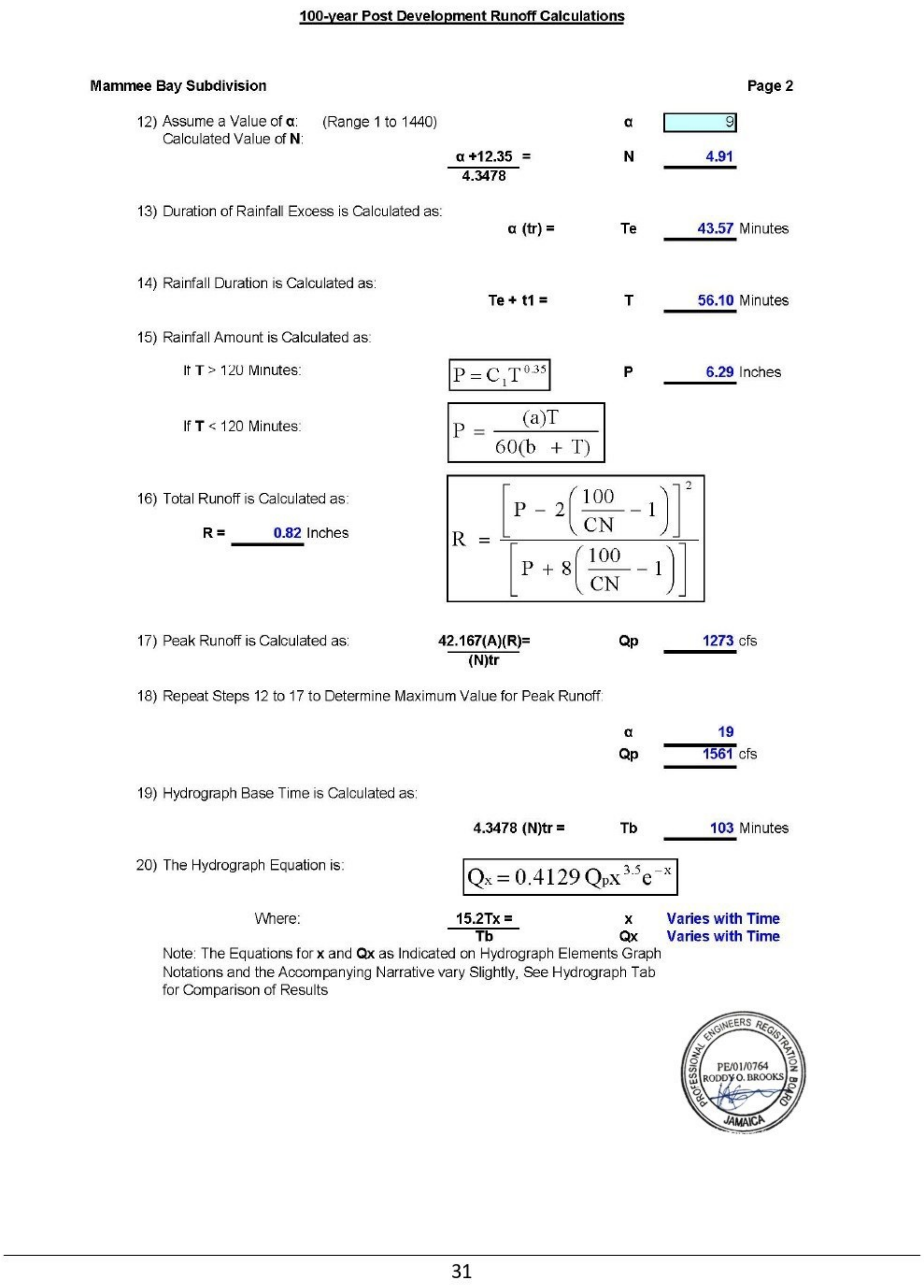
30



100-year Post Development Runoff Calculations

Mammee Bay Subdivision **Page 2**

12) Assume a Value of **α**: (Range 1 to 1440) **α** 9

Calculated Value of **N**: $\frac{\alpha + 12.35}{4.3478} =$ **N** 4.91

13) Duration of Rainfall Excess is Calculated as: **α (tr) =** **Te** 43.57 Minutes

14) Rainfall Duration is Calculated as: **Te + t1 =** **T** 56.10 Minutes

15) Rainfall Amount is Calculated as:

If **T** > 120 Minutes: $\boxed{P = C_1 T^{0.35}}$ **P** 6.29 Inches

If **T** < 120 Minutes: $\boxed{P = \frac{(a)T}{60(b + T)}}$

16) Total Runoff is Calculated as:

R = 0.82 Inches

$$\boxed{R = \frac{\left[P - 2\left(\frac{100}{CN} - 1\right)\right]^2}{\left[P + 8\left(\frac{100}{CN} - 1\right)\right]}}$$

17) Peak Runoff is Calculated as: $\frac{42.167(A)(R)}{(N)tr} =$ **Qp** 1273 cfs

18) Repeat Steps 12 to 17 to Determine Maximum Value for Peak Runoff:

α 19

Qp 1561 cfs

19) Hydrograph Base Time is Calculated as: **4.3478 (N)tr =** **Tb** 103 Minutes

20) The Hydrograph Equation is: $\boxed{Q_x = 0.4129\, Q_p x^{3.5} e^{-x}}$

Where: $\frac{15.2Tx}{Tb} =$ **x** **Varies with Time**

Qx **Varies with Time**

Note: The Equations for **x** and **Qx** as Indicated on Hydrograph Elements Graph Notations and the Accompanying Narrative vary Slightly, See Hydrograph Tab for Comparison of Results

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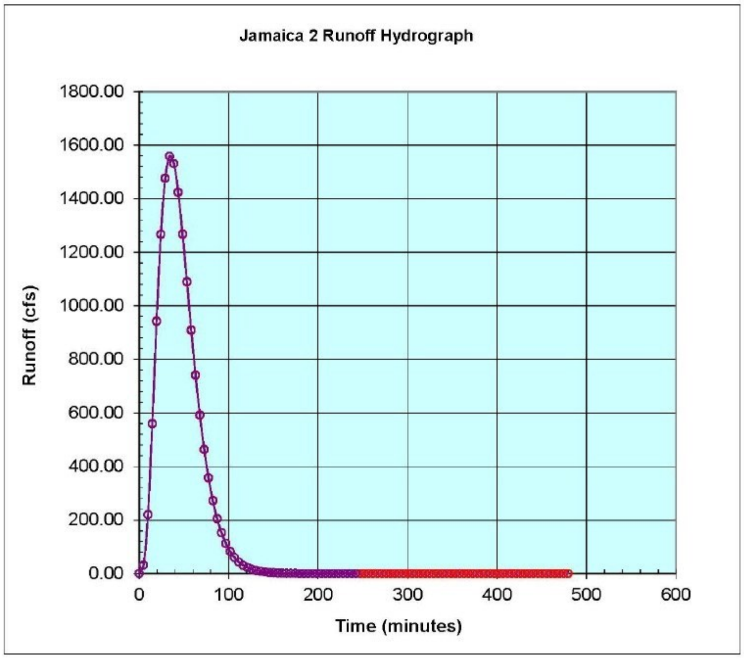
100-year Post Development Runoff Calculations

Mammee Bay Subdivision

Page 3



Hydrograph Volume:	4490886 ft^3 127168 m^3	**Duration:**	479 min. 7.99 hr.
Peak Runoff:	1561 ft^3/s 44.2 m^3/s		
Design Runoff	48.62 m^3/s		

33

1166.078 116607.8

37200

79407.77

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Appendix F: Typical infiltration rates for soils and rocks

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Soil Infiltration Rates for Soakaways

The performance of the soakaway depends largely on the infiltration rate of the surrounding soils. Infiltration rate describes the rate at which water is able to infiltrate through the unsaturated soils surrounding the soakaway.

Minimum Soil Infiltration Rates

Some guides specify a minimum infiltration rate of around $1x10^{-6}$ m/s. Soakaways constructed in soils with infiltration rates lower than this value will generally be very slow to empty and therefore will not comply with the requirement for soakaway emptying time. However, for very small catchments they could still be used. Note that even where infiltration rates are too low for soakaways to handle the design storm runoff, they can still be useful for intercepting the first 5mm of rainfall or as part of attenuation storage.

Infiltration Rate from Soil Types

The infiltration rate is dependent on the physical properties of the soil. Generally the more open the macrostructure, the higher the infiltration rate.

For this reason homogenous clays are generally unsuited to soakaways as they can have very low infiltration rates. Soils with a clay content of more than 20% are generally unsuitable for infiltration.

Similarly some silts are also largely unsuitable, though this depends on the particle size. Soils with a clay/silt content greater than 40% are likely to be unsuitable. However, due to the smaller particle size of silty soils, they are less prone to becoming blocked by sediments entering the soakaway. As the sediments are likely to be a similar particle size to the silts, the sediment does not have a big impact on the soil infiltration rate. The designer may use this fact to justify a smaller factor of safety.

Sandy soils are usually suitable. However care must be taken that the sand layers do not clog up with sediments and the layer will remain stable in saturated conditions as the storm water infiltrates through the medium. Also, in the UK sandy layers often include significant quantities of clay which can reduce their infiltration rate significantly.

Gravel layers can be very suitable as their large particle size can lead to a high porosity and corresponding high infiltration rates. Gravel layers are however seldom homogenous and variable particle sizes and sand horizons can significantly reduce the infiltration rate. Gravel layers are also often relatively thin and also often do not extend a great distance horizontally which reduces their effectiveness at infiltrating large volumes of water. Similar to sands, in the UK gravelly layers often include significant quantities of clay which can reduce their infiltration rate significantly.

Typical Soil Infiltration Rate Values

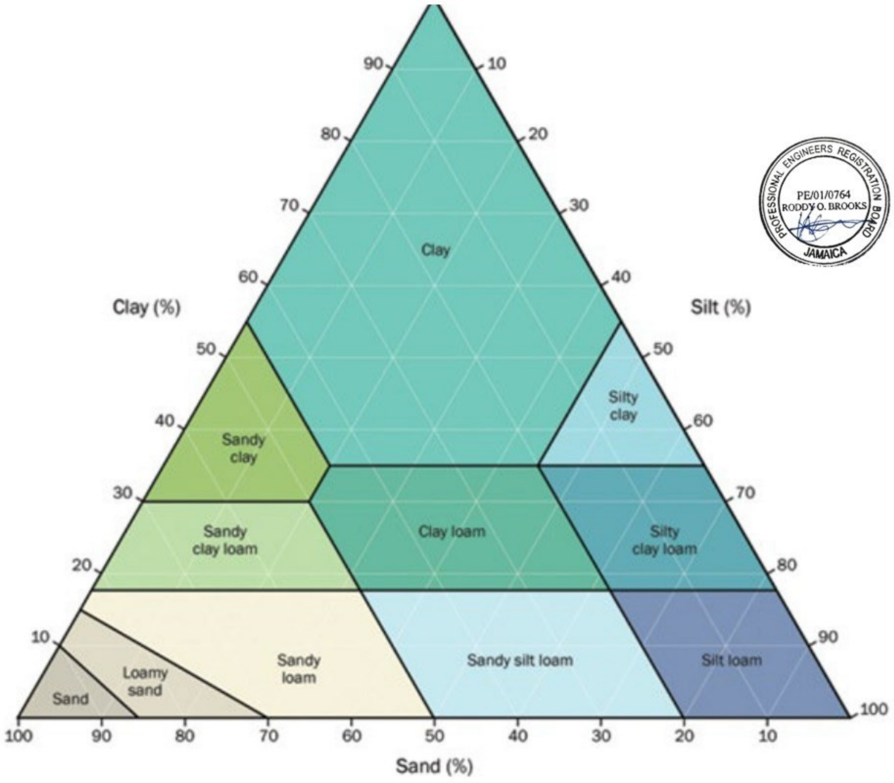
For the purposes of preliminary design and feasibilities it is sometimes required to undertake an outline soakaway design before any detailed site investigation works have been undertaken. For these purposes typical design infiltration rates have been compiled. Typical values have been compiled based on a number of different soil classification systems including soil texture, USCS classifications and soil gradings.

Soil Texture

The soil texture classification system shown in the CIRIA SUDS Manual is not the same as the standard used in site investigation reports, though it does include a note of the equivalents, see below.

Soil Texture	ISO 14688-1	Lower (m/s)	Upper (m/s)
Gravel	Sandy GRAVEL	$3x10^{-4}$	$3x10^{-2}$
Sand	Slightly silty slightly clayey SAND	$1x10^{-5}$	$5x10^{-5}$
Loamy Sand	Silty slightly clayey SAND	$1x10^{-4}$	$3x10^{-5}$
Sandy Loam	Silty clayey SAND	$1x10^{-7}$	$1x10^{-5}$
Loam	Very silty clayey SAND	$1x10^{-7}$	$5x10^{-6}$
Silt Loam	Very sandy clayey SILT	$1x10^{-7}$	$1x10^{-5}$
Sandy Clay Loam	Very clayey silty SAND	$3x10^{-10}$	$3x10^{-7}$
Silty Clay Loam	-	$1x10^{-8}$	$1x10^{-6}$
Clay	-	0	$3x10^{-8}$
Till	-	$3x10^{-9}$	$3x10^{-5}$

The SUDS Manual also includes a guide to the soil classification used, shown below.



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USCS Classification

There are also typical infiltration rates which have been compiled for the USCS soil classification system. Details of the classification system and typical infiltration rates are given below.

	USCS Classification	**Lower (m/s)**	**Upper (m/s)**
GW	Well Graded Gravels	10^{-5}	10^{-3}
GP	Poorly Graded Gravels	5x10^{-5}	10^{-3}
GM	Silty Gravels	10^{-8}	10^{-4}
GC	Clayey Gravels	10^{-8}	10^{-6}
SW	Well Graded Sands	5x10^{-6}	5x10^{-4}
SP	Poorly Graded Sands	5x10^{-7}	5x10^{-6}
SM	Silty Sands	10^{-9}	10^{-6}
SC	Clayey Sands	10^{-9}	10^{-6}
ML	Inorganic Silts (Low Plasticity)	10^{-9}	5x10^{-7}
CL	Inorganic Clays (Low Plasticity)	10^{-9}	10^{-8}
OL	Organic Silts (Low Plasticity)	10^{-9}	10^{-6}
MH	Inorganic Silts (High Plasticity)	10^{-10}	10^{-9}
CH	Inorganic Clays (High Plasticity)	10^{-11}	10^{-9}
OH	Organic Clays (High Plasticity)	0	0
PT	Peat	0	0

Soil Gradings

The soil gradings values are shown on the graph below. Note the Infiltration Rate is shown in in/hr.

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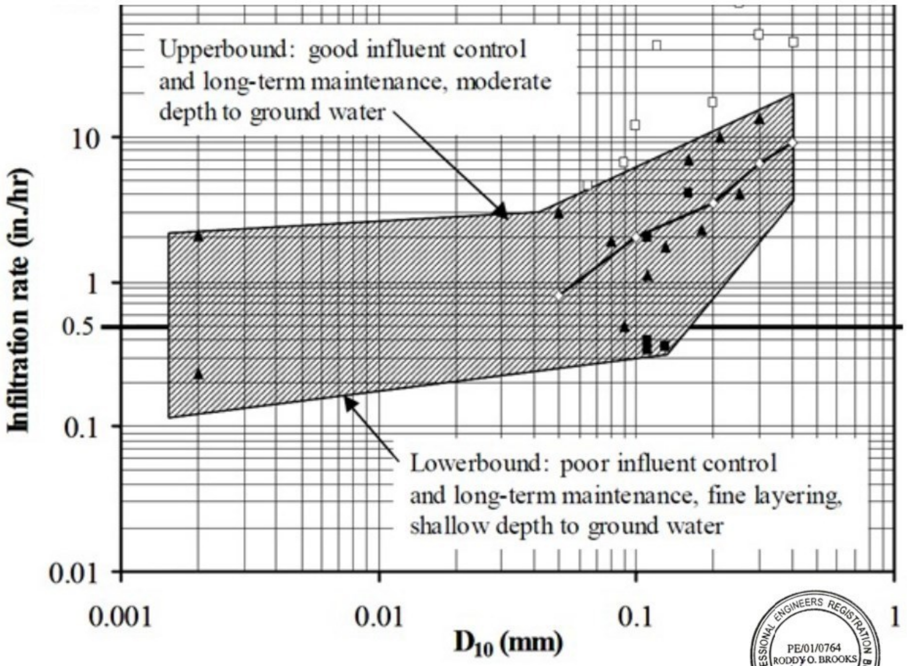

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Rock

The permeability of rock layers is dependent on the precise lithology and structure of the formations. This can be quite different in the vertical and horizontal directions. In sedimentary formations of interbedded layers for example, the horizontal infiltration rate may be much higher than the vertical rate.

The overall infiltration rate is then largely dependent on the level of interconnection achieved through fractures and fissures between the layers with high infiltration rates. Where there is significant fracturing in an otherwise homogenous lithology, in some sandstones and granites for example, the infiltration rate will depend entirely by the number and size of the fractures which can be accessed by the soakaway. Examples of this are shown below.

Natural geological systems can be very complex with a number of different factors contributing to the infiltration rate achieved. Detailed investigation work will be required to estimate the infiltration rate at design stage. This can take the form of a falling or rising head test undertaken in accordance with BS 5930. This can be done when boreholes are installed for site investigation purposes. Ideally this should be done at each soakaway location as the lithology can be complex and variable. In practice it may also be prudent to test installed soakaways to ensure that they meet the required performance.

Similar typical infiltration values have been compiled for common rock formations. The actual infiltration rate achieved will depend on the homogeneity of the rock and whether any fractures or fissures are present.

Rock	Lower (m/s)	Upper (m/s)
Chalk	10^{-5}	10^{-3}
Karst	10^{-6}	10^{-2}
Limestone	10^{-9}	10^{-6}
Sandstone	10^{-10}	10^{-6}
Siltstone	10^{-11}	10^{-8}
Salt	10^{-12}	10^{-10}
Anhydrite	10^{-13}	10^{-8}
Shale	10^{-13}	10^{-9}
Permeable Basalt	10^{-7}	10^{-2}
Factured Igneous Rock	10^{-9}	10^{-4}
Factured Metamorphic Rock	10^{-9}	10^{-4}
Weathered Granite	10^{-6}	10^{-5}
Weathered Gabbro	10^{-7}	10^{-6}
Basalt	10^{-11}	10^{-7}
Unfactured Igneous Rock	10^{-14}	10^{-10}
Unfactured Metamorphic Rock	10^{-14}	10^{-10}

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H. Geotechnical Analysis

GEOTECHNICAL INVESTIGATION REPORT

MAMMEE BAY HOUSING DEVELOPMENT
MAMMEE BAY, ST. ANN

REVISED FINAL REPORT

Prepared for:
China Harbour Engineering Company Limited
6-8 Courtleigh Corporate Centre
5 St Lucia Ave
Kingston 5

Prepared by:
Environmental Solutions Limited
7 Hillview Avenue
Kingston 10

GEOTECHNICAL INVESTIGATION REPORT FOR THE MAMMEE BAY HOUSING DEVELOPMENT, MAMMEE BAY, ST. ANN

Prepared for:

China Harbour Engineering Company Limited
6-8 Courtleigh Corporate Centre
5 St Lucia Ave
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Report prepared by:

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Geo-Technics Limited

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Revised Final Report Completion Date: July 5, 2023

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ESL undertakes to maintain confidentiality of all materials and data collected, analyses undertaken and reports presented as a necessary part of the Consultant/Client relationship.

TABLE OF CONTENTS

List of Plates

List of Figures

List of Tables

1 INTRODUCTION

1.1 Background

China Harbour Engineering Company Limited (CHEC) requested Environmental Solutions Limited (ESL), to undertake a geotechnical investigation to support their environmental permit application for a proposed residential subdivision at Mammee Bay, St Ann. The proposed subdivision is a mixed development comprising single family and multifamily residential units as well as a commercial area. The subdivision plan comprises 833 residential Lots upon which single family detached units, townhouses and apartments are proposed. To support the construction of the aforementioned units, site specific geotechnical data are required to guide foundation designs and to identify any geotechnical risks to the project.

The purpose of the investigation is to determine the geotechnical characteristics of the rock/soil on the site, determine the presence of groundwater as well as to evaluate engineering parameters to assist in the foundation design of the structures. The study will provide the following:

- A comprehensive geological description of the site
- A determination of the geotechnical characteristics of rock/soil on the site based on field investigation and laboratory analysis
- A determination of the bearing capacity of the rock/soil on the site, and relevant parameters to support foundation design
- Identification and determination of the depth of groundwater (if encountered during the drilling exercise).
- A determination of the percolation rates onsite for wastewater and storm water disposal
- A final geotechnical report indicating the geological and engineering characteristics of the site which will be used to assist the engineer in foundation design.

1.2 Authority and Access

ESL was contracted to conduct the geotechnical investigation and were supported by their associate, Geo-Technics Limited. Authority to proceed with the investigation was granted by Mr. Colin Henriquez from CHEC.

Access to the site is taken along the St Ann's Bay to Ocho Rios Main Road and along a minor road leading from the A1 Road at Steer Town to the Roaring River Greathouse. Internal access on the site was facilitated via a motorable track. Of note, extensive site clearance was undertaken using a backhoe to prepare internal access roads.

1.3 Scope of Work

A. ***Desk Study***: Review of geology maps, remote sensing imagery, technical reports and plans/drawings for the site and surrounding areas.

B. ***Field Work***: Conduct field assessment of site and surrounding areas to gather qualitative and quantitative information that will not be provided by drilling exercise. This also include**s a** geological survey including evidence of geological faults.

C. ***Subsurface Site Investigation***:

i. ***Borehole Drilling:*** A total of Fourteen (14) boreholes (BH) will be drilled at the site. Four boreholes will be drilled to a depth of 12.2m (40 ft) each while Ten (10) boreholes will be drilled to depth of 7.6m (25 ft) each. The boreholes will be properly sited below the footprint of the respective structures proposed onsite. Standard Penetration Tests (SPT) will be performed in each of the 6 boreholes using a truck-mounted rotary drill rig with split spoon sampler attachment. Field data from SPT will be used to assist in determining bearing capacity of soil.

ii. **Test Pit Excavation:** Nine (9) Test Pits will be excavated onsite to manually observe and log the soil profile at shallow foundation depths and to corroborate the types of soil observed in the test pits with borehole data at shallow foundation depths. The Tests Pits will be excavated using a backhoe excavator to a depth of 3.0m (10 ft) deep.

D. ***Groundwater/Water Table***: In instances where ground water is encountered during the drilling process, its depth will be measured during and 24 hours after drilling to determine the static ground water level.

E. ***Percolation Test:*** Percolation Tests will be performed in six (6) percolation boreholes (PB) to depth of 4.5m (15 ft) and 7.6m (25 ft) where possible. The tests will determine the percolation rate in different strata at the subsurface to assist with design of storm water drainage and wastewater disposal system.

Laboratory Test: Will be conducted on samples taken from drill holes. Physical and chemical tests will be conducted. The Physical tests include Grain Size Distribution and Atterberg Limits test and moisture content. The Chemical tests will include a sulphate test. The sulphate test is used to determine if the presence of sulphate in the soil could negatively impact construction material for foundation (likely impact of sulphate attack especially on concrete foundation). Where required, the percentage of carbonate in rock samples will be assessed to determine the aggregate potential of the geological material for construction.

F. ***Analysis of the data***: The information from geological data, drilling exercise (including SPT test), percolation test and laboratory tests will be analysed in order to determine the geotechnical characteristic of the rocks/soil for engineering construction and make recommendations for the design of the building foundations, and storm water/wastewater systems.

G. ***Preparation of Geological and Geotechnical Report***: A geotechnical report will be prepared which will provide information on the subsurface characteristics of the rock/soil, depth to groundwater identified and determine bearing capacity of the soil for foundation deign purposes. The type of foundation recommended for the structures will also be presented and design considerations for stormwater/wastewater system based on percolation test will be included.

1.4 Significant Assumptions

While this report provides an overview of geotechnical findings and potential concerns, the assessment is limited by the availability of information at the time of the assessment and the location of the boreholes and percolation holes. It is possible that variations may occur in the subsurface horizontally and vertically which could not be identified. The conclusions and recommendations that are presented in this report are based on a scope of work authorized by the Client. Note, however, that virtually no scope of work, no matter how exhaustive, can identify all conditions above and below ground.

1.5 Use Reliance and Disclaimer

This assessment was performed utilizing methods and procedures consistent with international standards such as the ASTM Standards and the British Standards. The independent conclusions represent the best professional judgment of the Environmental Professionals based on the conditions that existed, the information and data available during the course of this assignment and the project designs and plans provided. The findings and conclusions developed are based on the information provided and may be limited in usage if the information, particularly those related to the designs, change.

2 SITE DESCRIPTION

2.1 Site Characteristics

The site proposed for the residential development is located at Mammee Bay, St Ann **(Figure 2.1),** approximately 4.5km west of Ocho Rios. The site is bounded to the east by the Jamaica North-South Highway (also known as the Edward Seaga Highway) Toll Road, and to the north by the St Ann's Bay to Ocho Rios Main Road. The property comprises approximately 167 acres of gently to moderately sloping terrain **(Plate 2.1** and Plate 2.2**)**. Site access was taken via the St Ann's Bay to Ocho Rios Main Road, while internal access roads were prepared using a backhoe excavator to facilitate access to the borehole location **(Plate 2.3).**

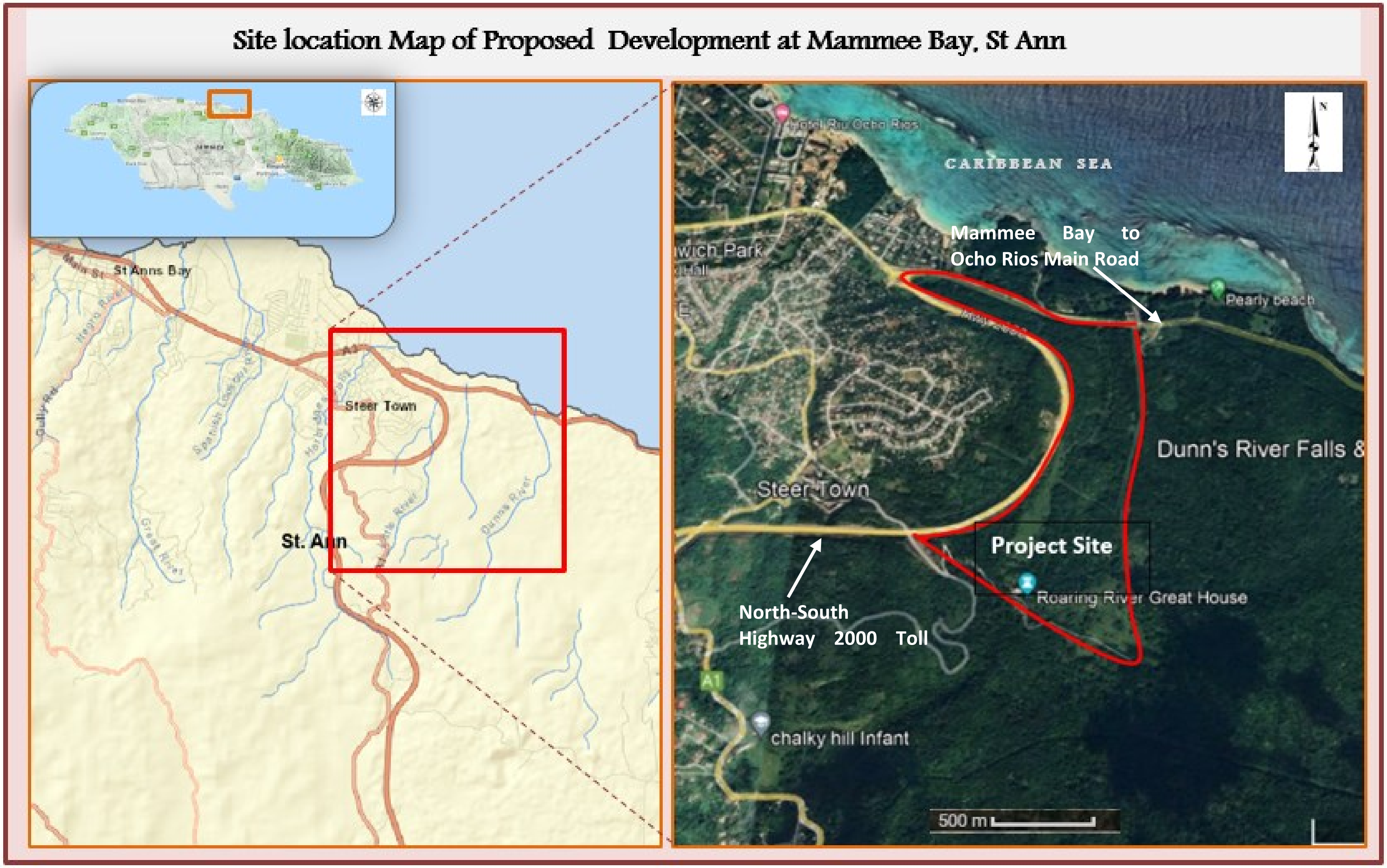
There are several streams on the site, the most notable is a small stream which appears to be a tributary of the Roaring River which meanders along the northern boundary section of the property where it flows in a general northerly direction. Additionally, there is an earth drain constructed across the northern section of the property to take stormwater from the Jamaica North-South Highway.

The northern and north-eastern sections of the site are moderately to thickly vegetated while the southern section consists of grass and scrubland vegetation. Near the southern end of the site is the Roaring River Great House. It is our understanding that the Great House will be kept as part of the new development of the site.

Plate 2.1: Gently sloping southern section of the site with grassland vegetation in the foreground.

Plate 2.2: Gently sloping southern section of the site.

Plate 2.3: Gently sloping northern section of the site. Note unpaved access road prepared to facilitate access to boreholes and the surrounding moderate to thick vegetation.



Site location Map of Proposed Development at Mammee Bay, St Ann

Figure 2.1: Site Location Map of proposed subdivision of lands at Mammee Bay, St. Ann

2.2 Geology

2.2.1 Lithology

A review of the 1:50,000 Geological Sheet 04 (Ocho Rios, St Ann) indicates that the site is predominantly underlain by Travertine to the north and south respectively, while the Coastal Formation (Mp) was displayed within the central section of the site, and an isolated outcrop of the Montpelier Formation (Mm) illustrated towards the southern section of the property **(Figure 2.2).**

Notwithstanding, ground truthing of the property and test pit observation indicates the gently sloping south-eastern section of the site is dominated by deposits of travertine; a yellowish brown, weakly cemented calcium carbonate rich material formed from the precipitation of calcium carbonate from mineralized water.

Geological mapping also reveals that the north-western section of the site is underlain by Elevated Reef (Ql) deposits of the Coastal Limestone Group. This geological formation is exposed as an elevated limestone hillock encountered towards the north-western section of the property. Outcrops of the Elevated Reefs (Ql) were found to be comprised of competent rock material, evident as moderately strong, massive to poorly bedded coralline limestone.

Geological Mapping of the property further indicates the southern section of the site which abuts the North-South Highway is underlain by limestones of the Montpelier Formation (Mm). The Montpelier Formation (Mm) is comprised of cream white, well bedded, weak to moderately weak chalky limestone. Exposed outcrops were limited to occasional exposures at the surface as the limestone was largely draped by topsoil throughout the southern section of the site.

2.2.2 Geological Structure

A review of the 1:50,000 Geology Sheet indicates the site is impacted by a northeast to southwest trending fault which dissects the central section of the site. Of note, this fault is relatively young, and does not appear to be seismically active. Nonetheless, this fault line represents a zone of weakness along which displacements can be induced and minor tremors may occur. In addition, minor faults generally induce the jointing and fracturing of rocks, thereby reducing the overall rock mass quality.

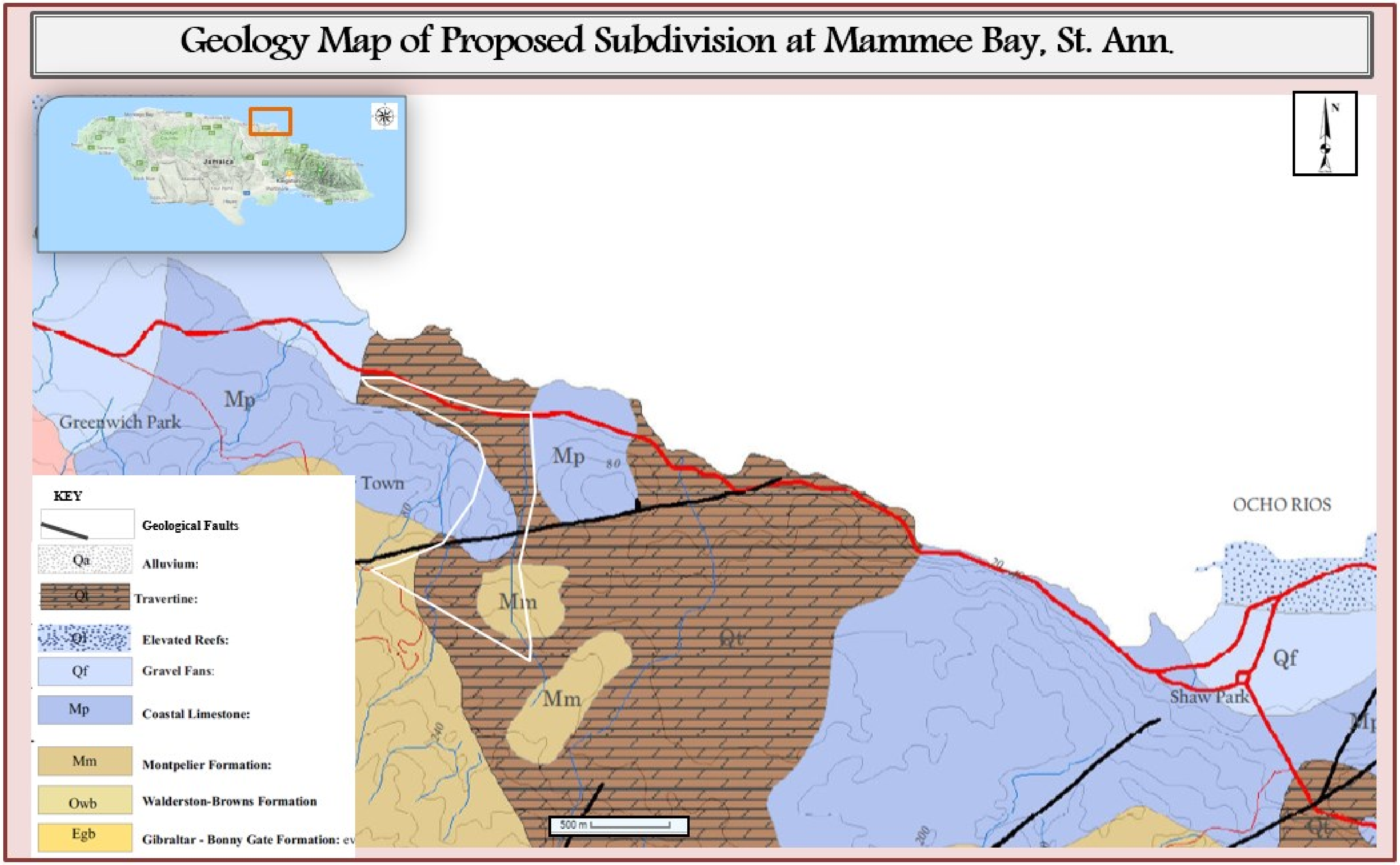


Figure 2.2: Geology of proposed subdivision site at Mammee Bay, St Ann (MGD 1:50,000 Metric Geology Sheet 04, 1998)

2.2.3 Seismic Hazard

Information obtained from the International Building Code (IBC) Peak Spectral Site Response maps for Jamaica is shown in **Figure 2.3**. The map below indicates that the spectral acceleration for short and long periods (0.2 second and 1 second) for the maximum considered earthquake with a 5% probability of exceedance in 50 years, is 0.5g and 0.225g respectively in Mammee Bay, St Ann.

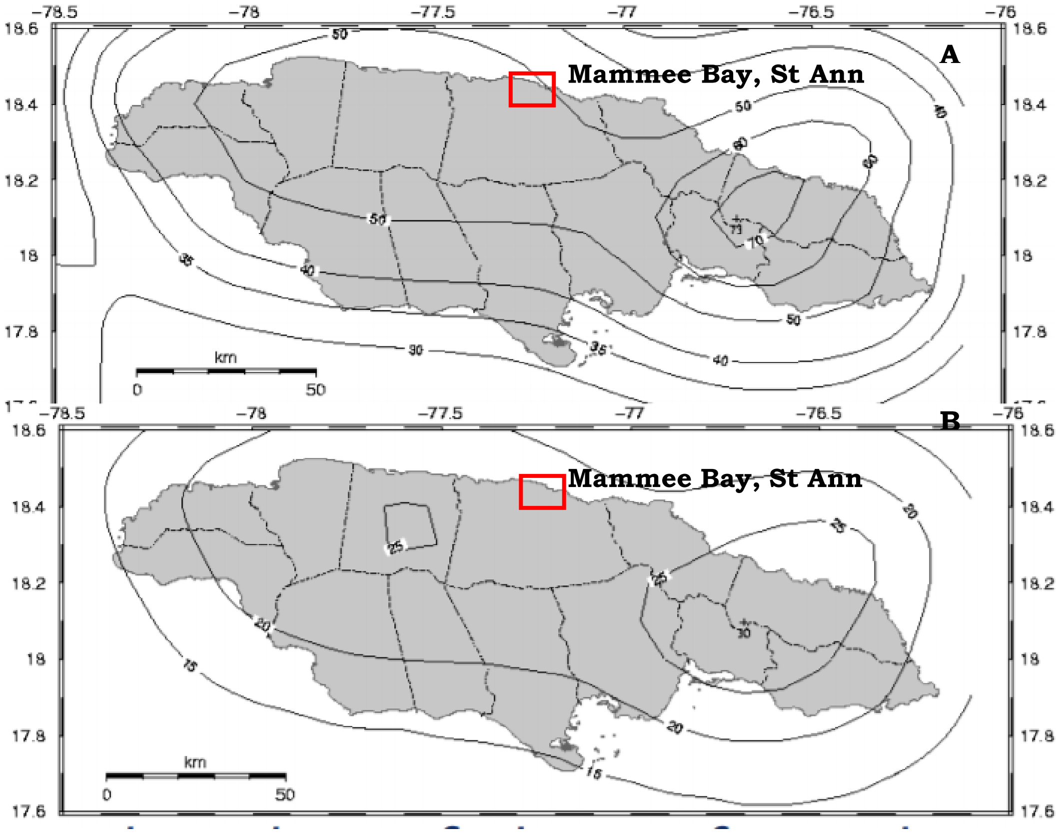


Figure 2.3: IBC based Site Spectral Response map for 0.2s short period and 1.0s long period waves for the Mammee Bay site in red boxes (Adapted from: Earthquake Unit, UWI)

3 FIELD TESTS

3.1 Drilling Exercise

3.1.1 Borehole Location

A total of Fourteen (14) boreholes were drilled at the site. Four (4) boreholes, namely, BH-2 to BH-5 were drilled to a depth of 12.2m (40 ft) each, while Ten (10) boreholes were drilled to depths of 7.6m (25 ft) each (BH-1; BH-6 to BH-14). The boreholes were sited below the footprint of the respective residential blocks proposed for various purposes (commercial complex, townhouses, apartments etc.). The borehole location plan is presented in **Figure 3.1**. **Table 3.1** presents a list of the borehole locations and their type, depths and supporting infrastructure.

In addition, three (3) percolation boreholes were drilled to a depth of 4.5m (15 ft), from which percolation tests were conducted.

Table 3.1: Tabulated Borehole data for proposed Mammee Bay, Subdivision

Borehole Number	Borehole Depth	Borehole Type	Supporting Infrastructure
1*	2.7m (9 ft)	Geotechnical	Commercial Block C
2 *	10m (33 ft)	Geotechnical	Apartment Block B
3	12.2m (40 ft)	Geotechnical	Apartment Block B
4	12.2m (40 ft)	Geotechnical	Apartment Block B
5	12.2m (40 ft)	Geotechnical	Apartment Block B
6	7.6m (25 ft)	Geotechnical	Townhouse Units Block E
7	7.6m (25 ft)	Geotechnical	Townhouse Units Block D
8	7.6m (25 ft)	Geotechnical	Detached Units Block A
9	7.6m (25 ft)	Geotechnical	Townhouse Units Block D
10*	6.1m (20 ft)	Geotechnical	Townhouse Units Block E
11	7.6m (25 ft)	Geotechnical	Detached Units Block F
12	7.6m (25 ft)	Geotechnical	Detached Units Block F
13	7.6m (25 ft)	Geotechnical	Detached Units Block G
14	7.6m (25 ft)	Geotechnical	Detached Units Block J

*Boreholes terminated before reaching the required depth due to refusal.

3.1.2 Drilling Method

The boreholes were advanced using a Rotary Drill Rig with a split spoon sampler and auger stem attachment **(Plate 3.1).** Disturbed samples were collected at 0.75m (2.5 ft) intervals to a depth of 10 ft (3m), thereafter samples were to be collected at 1.5m (5 ft) intervals to the end of the boreholes.

Plate 3.1: Onsite drilling operations undertaken by Truck Mounted Rotary Drill Rig

3.1.3 Standard Penetration Test (SPT)

Standard Penetration Tests (SPT) were performed in all geotechnical boreholes proposed for the collection of geotechnical data. The Standard Penetration Test (SPT) is a field test conducted in the boreholes which gives an indication of the penetration resistance of the soil. The tests are generally more accurate in non-cohesive soils, such as sand and gravel, which are normally present under drained conditions, relative to cohesive soils (silt and clay) where the penetration resistance is recorded under undrained conditions.

The SPT is done by driving a 5.1cm (2 inches) outer diameter split spoon sampler 30.5cm (12 inches) into the ground by means of a 64kg (140 lbs) hammer falling freely over a vertical distance of 76.2cm (30 inches). The procedure involves driving the sample tube 15.2 cm (6 inches) into the ground, which is removed, then recording the number of blows required to advance the sample tube a further 30.5 cm (12 inches) into the soil. The number of blows recorded is referred to as N-value which is related to the relative density and angle of shear resistance for non-cohesive (coarse grain) soils. The samples were then collected, recorded and carefully placed into labelled plastic bags and taken to the soils' laboratory for testing **(Plate 3.2)**.

In instances where refusal is attained, drilling continues until the auger tool becomes difficult to penetrate the subsurface rock/soil. Auger penetration in tandem with refusal from the SPT provides useful information to estimate the strength grade of the rock in the absence of coring the rock.

Plate 3.2:Split Spoon Sample Collection of Soil taken at Mammee Bay, St Ann

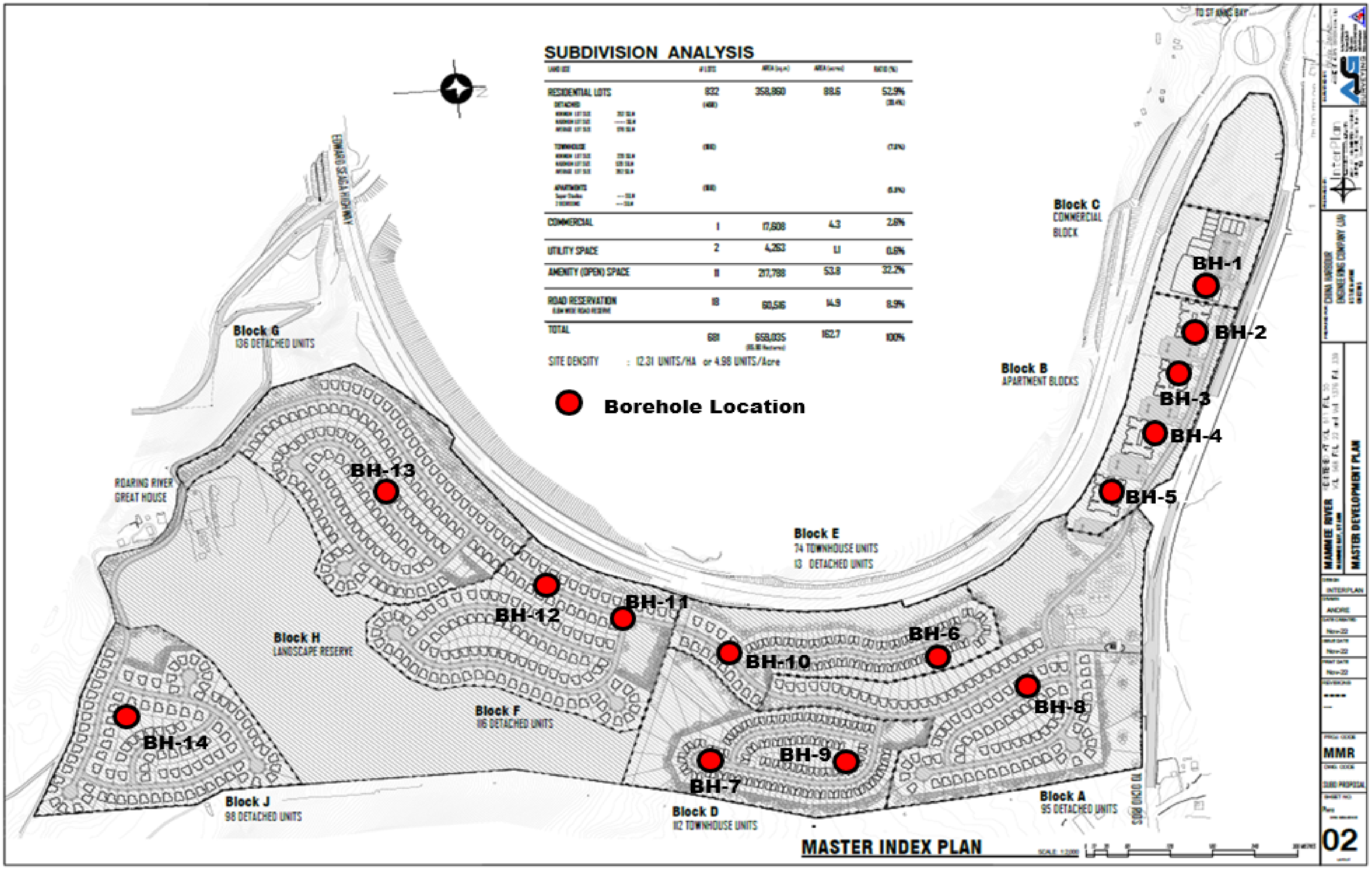


Figure 3.1: Site layout plan showing borehole locations relative to proposed residential blocks.

3.2 Percolation Test

The purpose of the percolation test is to determine the infiltration rates of the soil onsite and to assess the suitability of the site for storm water and/or wastewater disposal systems. Percolation tests were conducted in Five (5) Percolation Borehole located onsite **(Figure 3.2)**. These percolation holes were designated as PB-1 to PB-5. The methodology for the percolation test procedure is outlined below.

3.2.1 Percolation Test Methodology

i. Five percolation tests were conducted. One Percolation Borehole (PB-5) was drilled to a depth of 4.6m (15 ft), with a standard diameter of 7.6cm (3 inches). Percolation borehole (PB-4) was drilled to 2.73m (9 ft), as the groundwater level at that location was approximately 3m (10 ft). Percolation test holes 1, 2 and 3 were conducted in geotechnical boreholes 12, 11 and 9, each drilled to a depth of 7.6m (25 ft).

ii. The percolation test holes were filled with clean water to the top of the hole and left overnight to soak to full saturation before the percolation rate was recorded.

iii. The Percolation tests were conducted the following day by refilling the existing borehole with clean water and observing the time taken for the water level to fall by 7.62cm (3 inches) until a constant drop in water level was attained.

iv. The percolation rate was determined by the time taken for water to fall 7.62cm (3 inches) in the borehole.

v. The final percolation rate was thereafter calculated using the time taken in minutes for the water level in the borehole to fall 25mm (1 inch) and recorded in minutes per inch (min/inch).

Plate 3.3: Filling of percolation test borehole for percolation test at Mammee Bay site, St. Ann.

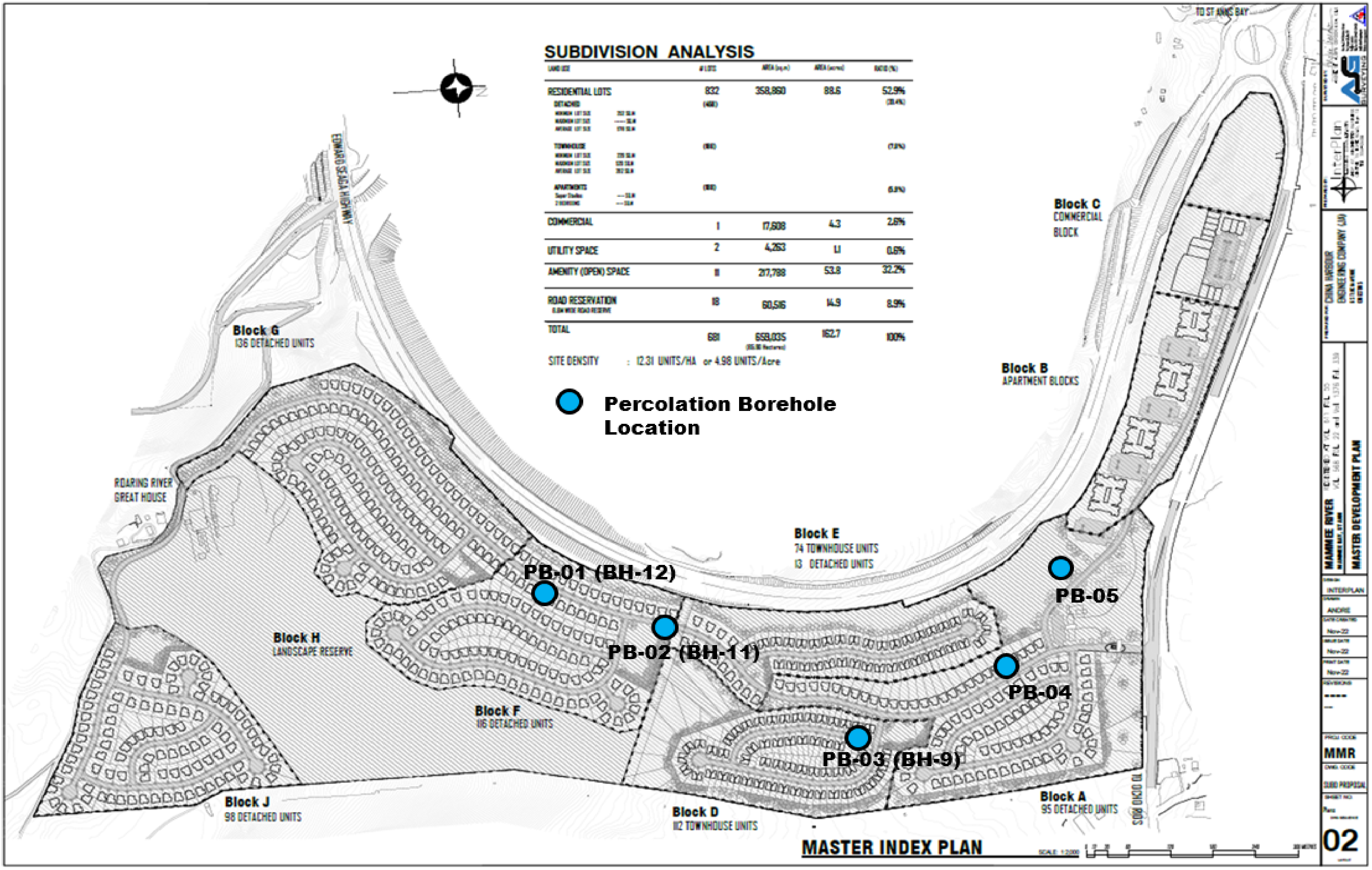


Figure 3.2: Site layout plan showing Percolation borehole locations relative to proposed infrastructure.

3.3 Test Pit Evaluation

The subsoil condition onsite was evaluated by means of Nine (9) test pit excavations which enabled manual observation, field sampling and logging of the foundation soils. Test pit excavation proposed for Block J was abandoned as the backhoe developed mechanical problems on the last day of the field investigation.

The methodology used to assess the engineering characteristics of soils via test pit excavation is outlined below.

3.3.1 Methodology

i. Nine (9) test pits were excavated onsite to a depth of 3.0m (10 ft), with an opening 1.2m (4 ft) wide and a length of 2.4m (8 ft). The test pits were excavated using a CASE 580 Backhoe (**Plate 3.4** and **Plate 3.5).**

ii. The test pits were evenly distributed across the site to complement the boreholes in Block A and Blocks E to Block G (**Figure 3.3**).

iii. The walls of the test pit were examined, and the soil type was classified on the bases of behavioural characteristics from field tests performed. Soil from the test pits was examined and described using established soil sample identification procedures, which involves visual and manual examination of soil samples with respect to texture, structure, bedding, grading, relative density, plasticity etc. Soil description was done in accordance with the Unified Soil Classification System (USCS).

iv. Disturbed soil samples were also collected at shallow foundation depth and subsequently submitted for laboratory testing.

v. Once the physical examination of the test pit was completed and soil samples obtained, the open excavations or test pits were thereafter backfilled.

vi. Test pit logs are presented in **Appendix 5.**

Plate 3.4: Backhoe excavator used for test pit excavation at the Mammee Bay Project Site.

Plate 3.5: Test pit excavated at Mammee Bay project site comprising yellowish brown calcareous Sand and Silt.

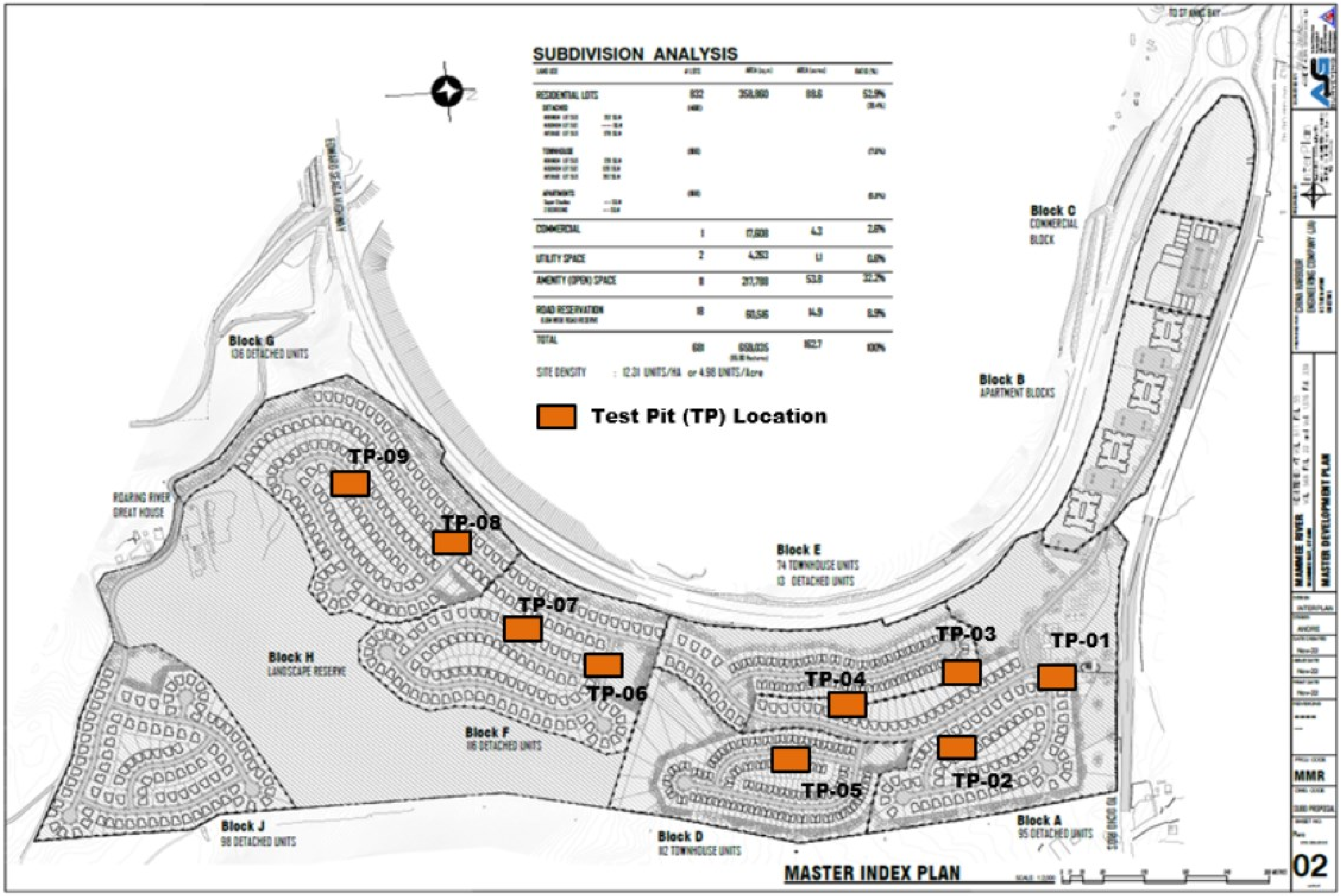


Figure 3.3: Test pit locations distributed across the Mammee Bay Housing Site. Test pit for Block J was abandoned due to mechanical problems with the equipment.

4 FIELD TEST RESULTS

4.1 Subsurface Drilling

4.1.1 Summary of Soil Description

The site is comprised of a combination of fine-grained calcareous Silt and Clay and coarse grained Calcareous Sand and Gravel, underlain by strong to moderately strong Limestone rock material. A detailed breakdown of soils encountered onsite is as follows:

i. **Calcareous SAND and GRAVEL:** The site is dominated by Coarse-Grained Calcareous Sand and Gravel with varying proportions of Silt and Clay at shallow foundation depth. Of note, coarse grained soils (Sand and/or Gravel) were dominant at shallow foundation depth in all boreholes drilled onsite.

ii. **Fine Grained SILT and CLAY:** Fine Grained Calcareous Silts and Clays with varying proportions of Sand and Gravel were encountered onsite at various depths in boreholes 3, 4, 6, 8, 9, and 10.

iii. **LIMESTONE ROCK**: Moderately weak to Strong LIMESTONE was encountered in boreholes 1, 7, 10, 12 and 13 drilled onsite at varying depths. Refusal was commonly encountered in limestone rock and in many instances, the recovery of soil samples was limited.

4.1.2 Groundwater

Groundwater was not encountered in the majority of boreholes drilled during the field investigation. **Table 4.1** shows the boreholes in which groundwater was encountered and the depth at which the groundwater was recorded on the site during the drilling.

Table 4.1: Tabulated Groundwater depth for Boreholes at Mammee Bay, St Ann

Borehole ID	Borehole Depth	Borehole Type	Groundwater Information
BH-1*	2.7m (9 ft)	Geotechnical	No Groundwater
BH-2*	10m (33 ft)	Geotechnical	No Groundwater
BH-3	12.1m (40ft)	Geotechnical	No Groundwater
BH-4	12.1m (40ft)	Geotechnical	No Groundwater
BH-5	12.1m (40ft)	Geotechnical	No Groundwater
BH-6	8.0m (25ft)	Geotechnical	4.5m (15ft)
BH-7	8.0m (25ft)	Geotechnical	No Groundwater
BH-8	8.0m (25ft)	Geotechnical	3.0m (10ft)
BH-9	8.0m (25 ft)	Geotechnical	No Groundwater
BH-10*	6.1m (20 ft)	Geotechnical	1.8m (6 ft)
BH-11	8.0m (25 ft)	Geotechnical	No Groundwater
BH-12	8.0m (25 ft)	Geotechnical	No Groundwater
BH-13	8.0m (25 ft)	Geotechnical	No Groundwater
BH-14	8.0m (25 ft)	Geotechnical	No Groundwater

*Boreholes terminated before reaching the required depth due to refusal.

4.1.3 Consistency of Cohesive Soils

Cohesive soil consisting of calcareous silt and clays were encountered in BH-3, BH-4, BH-6, BH-8, BH-9, and BH10. Based on the SPT soil tests, the consistency of the fine grain soil onsite ranges from firm to hard silt and clay.

4.1.4 Relative Density of Non-Cohesive Soil (Coarse Grain Soil)

The non-cohesive or coarse grain soils encountered at the project site consists of very loose to very dense calcareous Sand and Gravel with varying proportions of silt and clay. This type of soil was found to be dominant at shallow foundation depth onsite.

4.1.5 Presumptive Profile of Subsurface Soil/Rock

The presumptive profile was prepared using information obtained from subsurface drilling, laboratory testing and the classification of soils. The presumptive profiles for the subsurface soils at the proposed Mammee Bay subdivision are shown in **Figure 4.1** to **Figure 4.4**. The cross sections for the presumptive profiles were taken from boreholes 1-3 and boreholes 3-5 on the north to north-western section; boreholes 7, 8 and 9 towards the central section; and boreholes 11, 12 and 13 in the southern section of the project site.

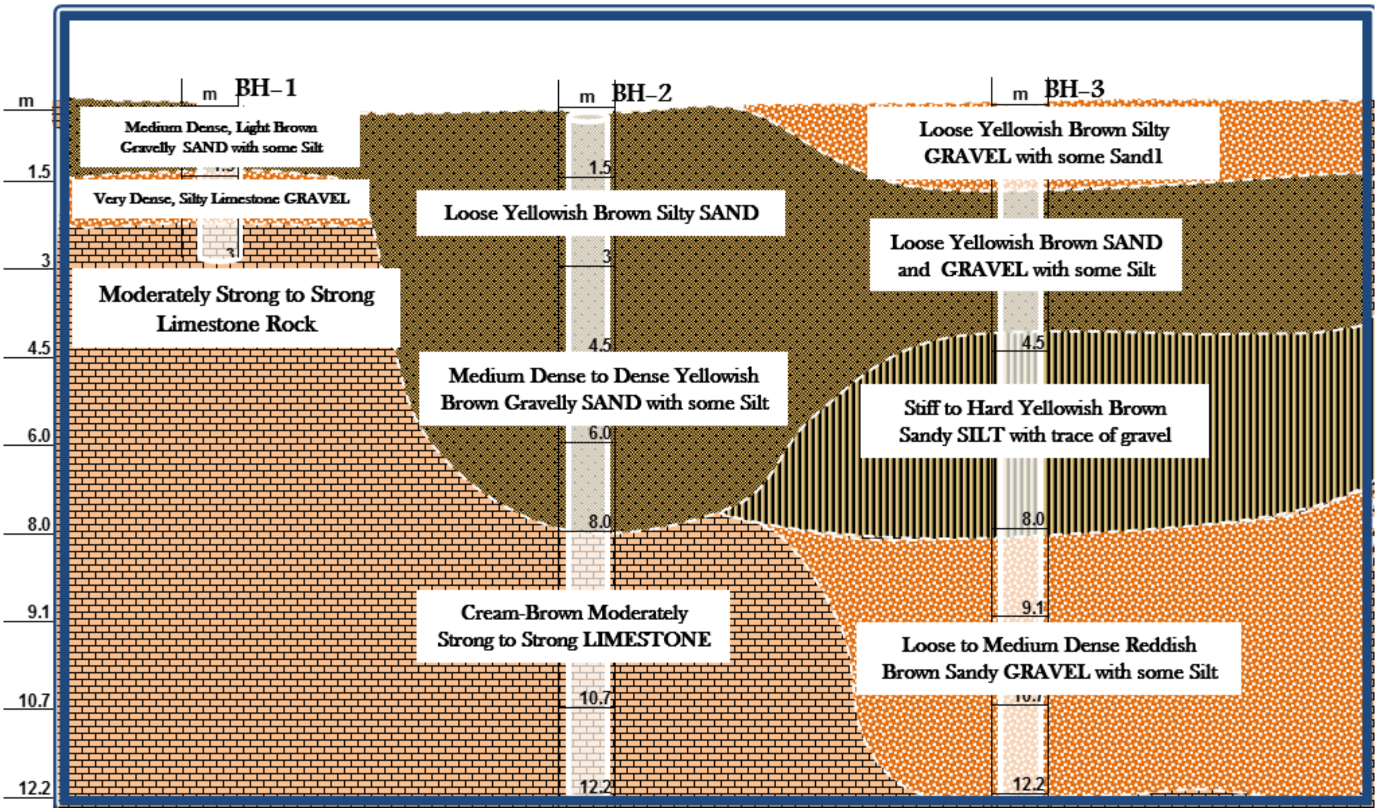


Figure 4.1: Presumptive profile of subsurface taken from BH 1-3 at Mammee Bay, St Ann. (NB: Not drawn to Scale)

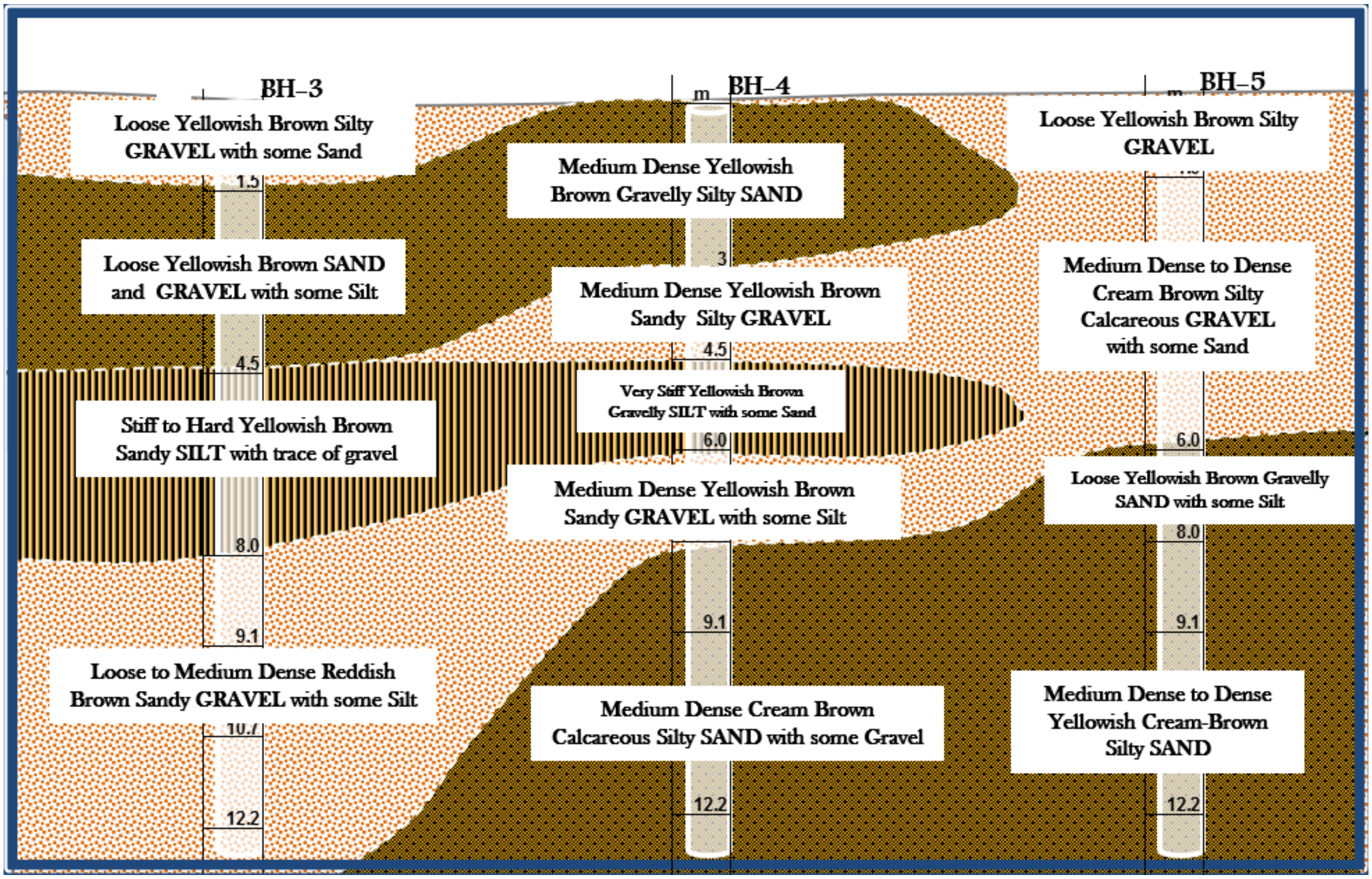


Figure 4.2: Presumptive profile of subsurface taken from BH 3-5 at Mammee Bay, St. Ann.
(NB: Not drawn to Scale)

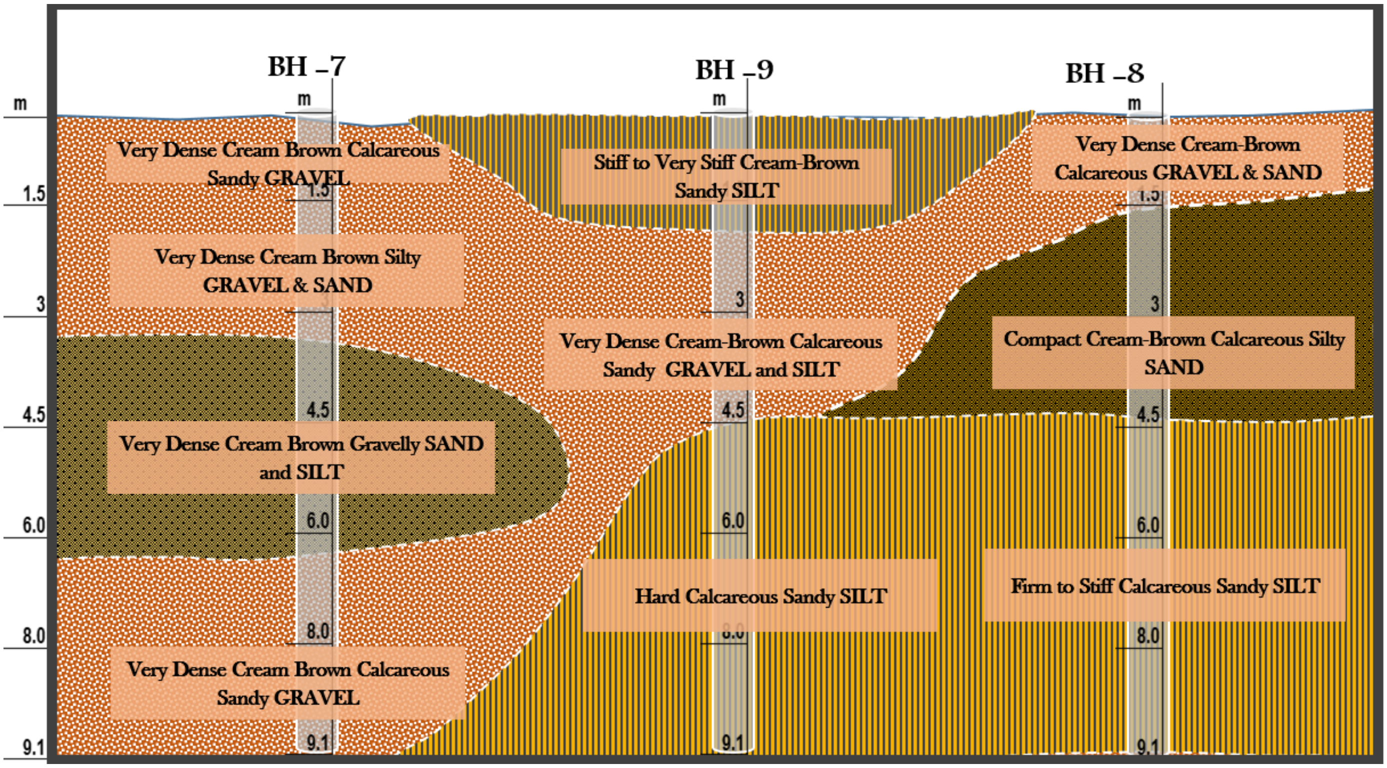


Figure 4.3: Presumptive profile of subsurface taken from BH 7-9 at Mammee Bay, St. Ann. (NB: Not drawn to Scale)

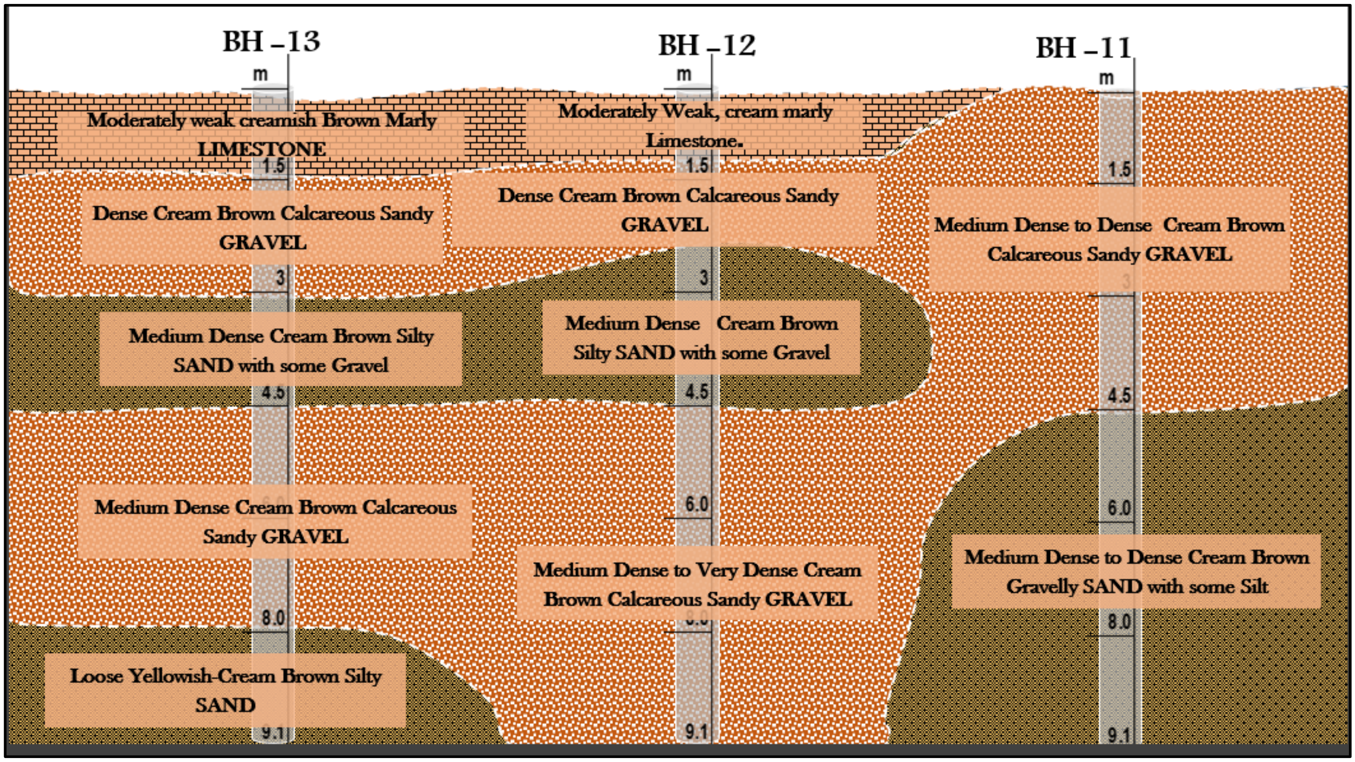


Figure 4.4: Presumptive profile of subsurface of taken from BH 11-13 at Mammee Bay, St Ann. (NB: Not drawn to Scale)

4.2 Percolation Test Results

The percolation test results indicate a rate ranging from 1 min/inch in PB-3 to 4.75 min/inch in PB-2 for the site. Percolation tests were conducted in 4 of the 5 percolation test holes. Percolation test conducted in PB-4 was aborted as the hole could not be filled due to rapid dissipation of water in the hole. The results of the percolation test are presented in **Table 4.2**.

Table 4.2: Tabulated Percolation Test Result for Mammee Bay Housing Development St Ann

Borehole Number/ ID	Borehole Depth		Percolation Rate (Min/inch)	Rate: Inch/min	*Flow Rate: (Cubic Inch/Min)	ϕ Flow Rate: Liter per day
	m	ft				
PB-1 (BH-12)	8	25	1.8	0.55	6.9	86.69
PB-2 (BH-11)	8	25	4.75	0.21	2.38	56.17
PB-3 (BH-9)	8	25	1	1.0	12.56	157.75
PB-4	2.9	9	Rate Very Rapid (Water dissipated rapidly and borehole could not be filled)			
PB-5	4.5	15	2.5	0.4	5.02	118.47

*Percolation boreholes with diameters of 4 inches

ϕ Conversion from Cubic Inch/Min to Litres/day, multiply by 23.6

5 LABORATORY TEST RESULTS

Fine grained or cohesive soils comprising inorganic Silt and Clay were selected for the Atterberg Limits Tests. Atterberg Limits Tests were conducted on Six (6) fine grained soil samples to determine the plasticity of the fine grain fraction of the soil. The test was done using the ASTM D4318 method. The purpose of the test is to classify the fine grain soil, determine its plasticity and predict its behaviour under loading conditions.

Coarse grained soils were subjected to Grain Size Distribution Test. Twenty-Nine (29) Grain Size Distribution (wet sieve) analyses were performed on coarse-grained soils collected from borehole drilled onsite. The purpose of the sieve analysis is to classify soils and determine the particle size distribution of the samples based on their grading curves.

5.1 Classification of Cohesive Soils (Atterberg Limits Test)

The results of Atterberg Limits tests show that the fine grain fraction in the soil samples consists of Silt of Intermediate to High Compressibility (MI) and Clay soils of Intermediate Compressibility (CI). A summary of the Atterberg Limits test results is provided in **Table 5.1** and detailed laboratory results are presented in **Appendix 2**. The Plasticity Chart for the fine grain soils is presented in **Appendix 3.**

Table 5.1: Atterberg Limits Test result for soils at Mammee Bay, St Ann

BOREHOLE ID	DEPTH		ATTERBERG LIMITS TEST			SOIL CLASSIFICATION (COHESIVE SOILS)
	m	ft	LL%	PL%	PI%	
BH-4	12.1	40	39.7	31.74	7.96	The SILT Soil is of Intermediate Compressibility (MI)
BH-5	9.1	30	42.8	35.31	7.49	The SILT Soil is of Intermediate Compressibility (MI)
BH-6	1.5	5	38.1	21.46	16.64	The CLAY Soil is of Intermediate Compressibility (CI)
BH-9	7.6	25	57.6	38.48	19.12	The SILT Soil is of High Compressibility (MH)
BH-10	4.5	15	34.8	17.57	17.23	The CLAY Soil is of Intermediate Compressibility (CI)
BH-11	6.0	20	37.1	18.38	18.72	The CLAY Soil is of Intermediate Compressibility (CI)

5.2 Grain Size Distribution Analysis

The Grain Size Distribution Analysis was conducted on Twenty-Nine (29) samples taken from boreholes drilled on the site. The results of the analyses are presented in **Table 5.2** and detailed laboratory results are presented in **Appendix 4.**

Table 5.2: Classification of Coarse Grain Soils based on Grain Size Distribution Analysis (ASTM Soil Classification)

BOREHOLE ID	DEPTH		PERCENT GRAIN SIZE			SOIL CLASSIFICATION (COARSE GRAIN SOILS)
	m	ft	Silt %	Sand %	Gravel %	
BH-1	1.5	5	26	36	38	Silty SAND and GRAVEL
BH-1	0.75	2.5	10	59	31	Gravelly SAND with some Silt
BH-3	1.5	5	21	17	62	Silty GRAVEL with some Sand
BH-3	2.27	7.5	18	40	42	SAND and GRAVEL with some Silt
BH-3	4.5	15	31	31	38	Sandy SILT with trace of GRAVEL
BH-4	1.5	5	26	54	20	Silty Gravelly SAND
BH-4	2.27	7.5	31	31	38	Silty Sandy GRAVEL
BH-4	4.5	15	60	15	25	Gravelly SILT with some Sand
BH-5	0.75	2.5	29	10	61	Silty GRAVEL with some Sand
BH-5	1.5	5	24	16	60	Silty GRAVEL with some Sand
BH-5	4.5	15	23	37	40	Silty SAND and GRAVEL
BH-6	3	10	50.4	47.4	2.2	CLAY & SAND with trace of Gravel
BH-6	7.6	25	13.5	43.8	42.7	SAND & GRAVEL with some Clay
BH-7	3	10	33.7	31.6	34.7	Silty Sandy GRAVEL
BH-7	4.5	15	46.8	29.8	23.4	Gravelly, Sandy SILT
BH-8	0.75	2.5	7	43.9	49.1	GRAVEL & SAND
BH-8	3	10	34.7	59.7	5.6	Silty SAND with trace of Gravel

BOREHOLE ID	DEPTH		PERCENT GRAIN SIZE			SOIL CLASSIFICATION (COARSE GRAIN SOILS)
	m	ft	Silt %	Sand %	Gravel %	
BH-9	1.5	5	67.3	22.1	10.6	Sandy SILT with some Gravel
BH-9	3	10	48.7	24.6	26.7	Sandy, Gravelly SILT
BH-9	4.5	15	27.6	20.5	51.9	Silty Sandy GRAVEL
BH-10	0.75	2.5	38.4	32.6	29	Gravelly SAND & CLAY
BH-10	2.2	7.5	26.2	25.8	48	Sandy Clayey GRAVEL

5.3 Chemical Analysis

5.3.1 Calcium Carbonate Test

A total of four (4) samples were collected at the Mammee Bay site to determine the percentage of calcium carbonate in the geological material. The tests were conducted at the Mines and Geology Division Laboratory **(Appendix 6)**. The tests were done using the Acid Titrimetric method. The results show that calcium carbonate in the rock/soil sample range from 90.1 percent to 94.9 percent and is an indication that the material can be used as base coarse aggregate for road construction, including fill.

5.3.2 Sulphate Test

Four (4) Sulphate tests (Acid Digestion Test using Barium Sulphate: BS 1377) were conducted on disturbed soils at the Mines and Geology Division Laboratory. The disturbed soil was obtained from samples collected from test pits at average depths from 1.2m (4 ft) to 1.5m (5 ft). The test pit locations were from the northern and central sections of the site. The results show that the percentage of sulphate (SO_3) in the soil are less than 0.01 percent, indicating that the sulphate content is very low **(see Appendix 7)**.

6 DISCUSSION OF RESULTS

6.1 General Comments

Information provided by the client includes a site location map, subdivision plans showing proposed residential development arranged into ‘Blocks’ and architectural/engineering drawings for the diverse types of housing development for the site. The proposal is to construct 3-4, storey apartment blocks on the north and north-western section of the site, 2-storey townhouses towards the centre and detached units in the north, centre and toward the south within the project area. There is also a commercial block proposed towards the northwest tip of the site. However, it is our understanding that the design concept could change during the developmental stage.

6.2 Foundation Soil/Rock

6.2.1 Shallow Foundation Depth

Information obtained from field exploration and laboratory testing indicates that the type of soil at shallow foundation depth varies along different sections of the site. The types of soil at shallow foundation are presented in **Table 6.1**. Given loading intensities expected for the apartments, detached units and townhouses, the depth of soil influenced by foundation pressure from the structures is in the order of 3.3m-3.6m (11 ft - 12 ft).

Table 6.1: Soil/rock description at various locations at the Mammee Bay Housing site based on borehole and laboratory data at shallow foundation depth.

Borehole #	Location	Soil/Rock Description	Residential Type/Block
BH-2, BH-3, BH-5	Northern	Loose Silty SAND and Silty and Sandy GRAVEL	Apartment/ Block B
BH-1	North-western	Medium dense gravelly SAND, Dense silty Calcareous GRAVEL and Moderately Strong LIMESTONE	Commercial/ Club House, Block C
BH-7, BH-12 BH-13	Central, Southern	Dominated by Limestone caprock at depth from 1.5m (5ft) to 3.5m below ground level.	Detached Units (Blocks D, F, G)
***BH-10**	Central	Loose Gravelly SAND and CLAY; Very Loose Sandy and Clayey GRAVEL	Townhouse Units/ Block E
BH-6, BH-8-9 BH-11, BH-14	Northern, Central and Southern	Dominated by Medium Dense to Dense SAND and GRAVEL with various proportions of Silt	Townhouses, Detached Units/ Blocks A, E, D, F, J

**BH 10 drilled within 10m from gully with groundwater at depth of 1.8m (6 ft) corresponding to the invert of the gully.*

6.2.2 Deep Foundation Soil

The foundation soil/rock at depth greater than 4.5m (15 ft) based on borehole data consists predominantly of medium dense to dense calcareous Sand and Gravel with varying proportions of silt, Moderately Strong Limestone, Stiff to hard sandy Silt and occasional thin layers of loose Sand and Gravel.

6.3 Percolation Test Results.

The results of the percolation tests conducted in five (5) Percolation Boreholes show that the percolation rates vary from 1min per inch in PB-1 to 4.75 min per inch in PB-2. In PB-4, the hole could not be filled for measurements to be conducted as the water dissipated rapidly in the hole. This revealed that the absorptive property of the soil at the site is very good and is satisfactory for storm drainage and a wastewater system.

6.4 Groundwater Depth

Groundwater was encountered in only 3 of the 14 boreholes drilled at the Mammee Bay project site. Groundwater was observed during drilling in boreholes 6, 8 and 10 at depths of 4.5m (15 ft), 3m (10 ft) and 1.8m (6 ft) respectively. Boreholes 6 and 8 are approximately 450m and 600m from the northern coastline and 48m (160 ft) and 60m (200 ft) above msl. Similarly, boreholes 1-5, which are approximately the same distance from the coastline as boreholes 6 and 8, did not encounter groundwater in boreholes drilled to depth of 12.1m (40 ft). It implies that groundwater encountered in boreholes 6 and 8 were due to ‘perched’ groundwater which is a saturated zone above the regional water table, separated by an impermeable zone.

Groundwater was also encountered in borehole 10, located within the central section of the site (Block E) and further south of boreholes 6 and 8, (at a higher elevation), which was drilled approximately 10m from the edge of a small gully. This area was chosen due to the difficulty to access a drill site in the area. The relatively high groundwater level of 1.8m (6 ft) is likely attributable to the proximity of borehole 10 to the gully, as the groundwater depth corresponds to the depth of the bottom of the gully. It indicates that borehole 10 was drilled within the narrow flood plain of the gully at that location. It is therefore our opinion that the groundwater encountered does not reflect the regional groundwater in the area nor perched groundwater experienced in boreholes 6 and 8.

6.5 Test Pits

The ease or difficulty of excavation of the test pits is an indication of the strength of the geological material at the site. Test Pits 2 and 4 (Blocks A and E respectively) were abandoned after excavating to depth of 0.75m (2 ft) as a result of the hardness of the limestone at the shallow subsurface. The other test pits were relatively easily excavated and the geological material is dominated by yellowish brown Sand and calcareous silty Sand and weathered limestone. When combined with data from the boreholes at shallow depth, there is some consistency with the type of soil observed in the test pits. However, there is some variation in the ease of excavation in the test pits across the site and the refusal attained from boreholes at the shallow subsurface drilled on site. It therefore implies that excavation for construction purposes will vary from location to location.

Block A (Borehole 8 and Test Pit 2) however, shows a slight departure as refusal was attained due to the presence of moderately weak limestone at the surface, while Test Pit 2 was abandoned as a result of the difficulty to excavate the rock at the surface. There is likely to be less variation in the ease of excavation within Block A.

7 GEOTECHNICAL ANALYSIS

7.1 Determination of Bearing Capacity

The approach taken in determining the bearing capacity of the soils at Mammee Bay for residential development, will be to estimate the bearing capacity for each residential block (Block A and Blocks C - J). The apartments (Block B) are dealt with separately as there are boreholes for each apartment block with varying geotechnical characteristics.

The soil bearing capacity was determined from the N-Values obtained from SPT tests conducted onsite. The average of the lowest set of N-Values over the depth of influence of foundation pressure on the soil (3m-3.5m/10 ft-11.5 ft) for each residential block will be used to estimate the soil bearing capacity.

Using **Bowles Equation** for bearing capacity of soil for pad footing, which was modified from Meyerhof's equation (1956, 1974) for computing **allowable bearing capacity** for a maximum 25mm (1 inch) settlement, the equation is given by:

$$q_a\ (kPa) = \frac{N_{55}}{0.08}\left(\frac{B+0.3}{B}\right)^2\left(1+0.33\frac{D_f}{B}\right)$$

Where N_{55} is a corrected N-Value standardized to an energy ratio from loss of energy during SPT given by:

$$N_{55} = N \times \frac{N_{70}}{N_{55}}$$

B = Width of Foundation

D_f = Depth of Foundation

7.1.1 Estimating Bearing Capacity for Commercial Area, Townhouses and Detached Houses

The average of the lowest N-Values determined for each residential block, the respective N_{55} values and their boreholes are presented in **Table 7.1**.

Table 7.1: Lowest Average N-Values and N-55 calculated for each residential and commercial block at Mammee Bay Housing Site St Ann.

Borehole No	Type of Development	Block	Ave N-Value	Lowest N-55 Value
BH-1	Commercial/Club-house	C	57	**72**
BH 8	Detached Units	A	24	**30**
BH-7, BH-9	Townhouse Units	D	44	**56**
BH-6, BH-10	Townhouse + Detached Units	E	3	**4**
BH-11, BH-12	Detached Units	F	35	**45**
BH-13	Detached Units	G	29	**37**
BH-14	Detached Units	J	35	**45**

Given a foundation depth of 900mm (3 ft) and widths of 1.2m and 1.5m (4 ft and 5 ft respectively), the allowable bearing pressures were computed from the equation and are presented in **Table 7.2** to represent varying ground conditions on the site.

Table 7.2: Computed Allowable Bearing Capacity for 0.9m Foundation Depth and widths of 1.2m and 1.5m and maximum 25mm Settlement for residential and commercial developments in Blocks A, C D-J, Mammee Bay, St Ann.

Borehole No./ Block	Soil Type	Lowest Ave N_{55}	Width B (m)	Allowable Bearing Pressure (qa)	
				kPa	**psf**
BH 1: Block C Commercial, Clubhouse	Medium Dense-Very Dense Gravelly SAND and Calcareous GRAVEL; Moderately Strong to Strong LIMESTONE	72	1.2	1,751	36,771
			1.5	1,552	32,592
BH 8 Block A	Medium Dense to Dense Silty SAND and GRAVEL	30	1.2	778	16,336
			1.5	690	14,490
BH9 Block D	Stiff to Very Stiff Sandy SILT; Very Dense Calcareous Sandy GRAVEL	56	1.2	1,362	28,602
			1.5	1,207	25,347
BH 10 Block E	Loose Gravelly SAND and CLAY; Very Loose, Clayey and Sandy GRAVEL	4	1.2	97	2,037
			1.5	86	1,806
BH-12 Block F	Moderately Weak Marly LIMESTONE; Dense, Calcareous Sandy GRAVEL; Medium Dense Silty SAND	45	1.2	1,094	22,974
			1.5	970	20,370
BH 13 Block G	Moderately Weak Marly LIMESTONE; Dense, Calcareous Sandy GRAVEL; Medium Dense Silty SAND	37	1.2	900	18,900
			1.5	798	16,758
BH 14 Block J	Medium Dense to Dense Calcareous Sandy GRAVEL	45	1.2	1094	22,974
			1.5	970	20,370

7.1.2 Estimating Bearing Capacity for Apartment Structures

The 3-storey blocks were analysed separately as they provide a distinct footprint on which boreholes were drilled to gather subsurface geotechnical data for foundation design consideration. For ease of identification, the apartment blocks were assigned Apartment Blocks 1-4 from west to east on the north to north-western section of the site.

Given a foundation depth of 900mm (3 ft) and widths of 1.2m, 1.5m and 1.8m (4 ft, 5 ft and 6 ft respectively), the allowable bearing pressures were computed from the equation and are presented in **Table 7.3** to represent varying ground conditions on the site. It should be noted that the allowable bearing pressures for Apartment Blocks 1 and 2 were based on foundation widths of 1.5m and 1.8m based on the low N-values recorded beneath the footprint of the structures. The allowable bearing pressures are computed and presented in **Table 7.3**.

Table 7.3: Computed Allowable Bearing Capacity for 0.9m Foundation Depth and widths of 1.2m, 1.5m and 1.8m for maximum 25mm Settlement for Apartment Blocks 1-4 in area zoned as Block B at Mammee Bay, St Ann.

Borehole No./ Apartment Block B	Soil Type	Ave N55	Width B (m)	Allowable Bearing Pressure (qa)	
				kPa	psf
BH 2: Apartment Block 1	Loose Silty SAND	9	1.5	194	4,074
			1.8	178	3,738
BH 3: Apartment Block 2	Loose Silty GRAVEL w/s Sand; Loose SAND and GRAVEL	9	1.5	198	4,074
			1.8	178	3,738
BH4: Apartment Block 3.	Medium Dense Gravelly Silty SAND; Medium Dense Sandy, Silty GRAVEL	27	1.2	656	13,776
			1.5	582	12,222
BH 5: Apartment Block 4	Loose, Calcareous Silty GRAVEL; Medium Dense to Dense Calcareous Silty GRAVEL w/s Sand	23	1.2	559	11,739
			1.5	496	10,416

The soils at shallow foundation depth for apartment blocks 1 and 2 (BH-2 and BH-3) recorded low N-Values based on SPT tests and were classified as loose to very loose coarse grain soils consisting of Sand and Gravel as well as sandy Silt. Based on the type of soil beneath the footprint of the 3-storey structures, a raft foundation is proposed as an alternative foundation for Apartment Blocks 1 and 2. The average of the lowest set of N-Values over the depth of influence of foundation loading on the soil (3m-3.6m/10 ft-12 ft) will be used to estimate the bearing capacity of the soil.

Using **Bowles Equation** for computing the bearing capacity of coarse grain soil, which is modified from Meyerhof's equation (1956, 1974) for computing **allowable bearing capacity** for a raft foundation for a maximum 25mm (1 inch) settlement, the equation is given by:

$$q_a = \frac{N_{55}}{0.08}\left(\frac{H_a}{25}\right) * \left(1 + 0.33\frac{D}{B}\right) \qquad kPa$$

Where N_{55} is the corrected N- value given by:

$$N_{55} = N \times \frac{N_{70}}{N_{55}}$$

H_a = the allowable settlement in mm

B = Width of Raft Foundation

D = Depth of Foundation

The average of the lowest N-Values is calculated from Boreholes 2 and 3 for Apartment Block 1 and Block 2, which recorded similar N-Values of 7. This corresponds to an N-55 of 9 which is used in the Bowles Equation for estimating the allowable bearing capacity of the soil using a raft foundation.

Given that preliminary drawings or designs for the Apartment structure was not provided by the client, the allowable bearing capacity for the soils at Apartment Block B based on a raft foundation can be estimated as follows:

Apartment Blocks 1 and 2: $\boldsymbol{q_a}$ = 112.5 × $\left(1 + 0.33\frac{D}{B}\right)$ kPa for a maximum 25mm settlement

$\boldsymbol{q_a}$ = 112.5 × 1.2 × $\left(1 + 0.33\frac{D}{B}\right)$ kPa for a maximum 30mm settlement

$\boldsymbol{q_a}$ = 112.5 × 1.6 × $\left(1 + 0.33\frac{D}{B}\right)$ kPa for a maximum 40mm settlement

7.2 Foundation Settlement

As shown in **Table 7.2**, the allowable bearing pressure values estimated from Bowles equation for 25mm settlement for the residential structures indicate that total settlement would be kept within tolerable limits for a proposed 1.2m to 1.5m wide footing placed at a depth of 0.9m. Settlement is expected to be short-term as most of the settlement would take place during construction as the soil within the influence of soil pressure from building loads would be under drained conditions.

Apartments 1 and 2 in the Block B zone is expected to undergo some settlement that could exceed tolerable limits of 25mm (1inch) using pad foundation as the soil is loose to very loose, having low N-Values. The structure should be designed with some amount of rigidity to minimize ground settlement. An option that should be strongly considered is the design of raft foundation to distribute the load over a wide area beneath the building footprint in order to reduce settlement to within tolerable limits.

8 RECOMMENDATIONS

8.1 Foundation Consideration

It is recommended that pad and/or strip foundations be used for commercial structure, townhouses and detached units at Mammee Bay Housing Development in St Ann. It is also recommended that pad/strip foundations be used for Apartment Blocks 3 and 4 within the Block B zone. However, the design engineer will have the option for the design of raft foundation for Apartment Blocks 1 and 2 (BH-2 and BH-3) in the same zone and this is the preferred option.

It is assumed that bending moments at the base of the foundation column is negligible.

8.2 Bearing Capacity

The allowable bearing pressures presented in **Table 7.2** and Table 7.3 provide a guide for the structural engineer to determine the design loads for the structures. The bearing capacities determined for the soil and rock are generally high throughout the site except on the northern section in the vicinity of proposed Apartment Blocks 1 and 2 where the allowable bearing capacity of the soil is low at shallow foundation depth.

Similarly, the allowable bearing capacity for the soil in the vicinity of Borehole 10 (Block E) is also very low. However, this is due to the proximity of the drill hole within the narrow flood plain of a gully at the site. It does not reflect the subsurface site conditions within Block E.

8.3 Settlement Considerations

Total settlement of the soil/rock is expected to be kept within tolerable limits of 25mm (1 inch) for single storey detached units and townhouses and Apartment Blocks 3 and 4 (Block B). It is also recommended that differential settlement is kept within 75% of total settlement (Terzaghi and Peck 1969) and that settlement between adjacent columns does not exceed 20mm, assuming pad foundations is used for the single and 2-storey structures.

For raft foundation, maximum settlement can be tolerated by up to 50mm (2 inches). However, we do not anticipate that settlement will exceed 40mm (1.6 inches) for the Apartment Blocks 1 and 2 in Block B residential zone. It is also recommended that differential settlement is kept within a tolerable limit of 40mm.

8.4 Storm Water/Wastewater System

The percolation rates recorded for the soil in 5 percolation boreholes indicate that absorptive property of the soil/rock is high to very rapid. It implies that the percolation rate is good for the discharge of stormwater/ wastewater systems. However, the Mammee Bay site is approximately 230m from the northern coastline of the Caribbean Sea and there is the potential for pollution of the coastal environment if the wastewater is contaminated. Additionally, regional groundwater elevation is expected to be reasonably high, given the proximity of the site to the coastline. The potential for groundwater contamination is high if wastewater is directly discharged into the subsurface.

Where there is discharge from wastewater systems which are likely to contain pollutants, then this must be treated to tertiary level to prevent/minimize contamination at discharge points.

8.5 Site Excavation and Grading

The site slopes gently upward at the northern and central sections and then moderately towards the southern section of the property. However, at the north-western tip, in the vicinity of proposed commercial centre/club-house, there is an elevated area of moderately strong rock which will require site grading to accommodate the commercial centre and any other development proposed at that section of the site.

Rock excavation via ripping may prove a challenge in Moderately Strong Limestone. Hence, the use of hydraulic hammer or pneumatic drill may prove to be the best option for excavation at that location. Blasting is not recommended due to the risk of fly rock which could negatively impact the motoring public as the area is close to the Mammee Bay - Ocho Rios Main Road.

For the rest of the site, the ease of excavation for site preparation and foundation construction purposes will vary from location to location. Based on information from borehole 8 and Test Pit 2, (Block A) it can be expected that ‘rippability’ of the surface material will pose a greater challenge given that some areas will contain limestone that will be difficult to excavate. Pneumatic drill would be useful to assist with excavation of the material at the site.

8.6 Material as Subgrade for Subdivision Road

The geological material on site is satisfactory for use as subgrade material for the subdivision road in the development. However, areas consisting of clay will need to be excavated and replaced with base coarse material.

The following is recommended to prepare the subgrade for the placement of base coarse aggregate:

- The topsoil must be removed and stored safely for further use where necessary.
- All trees, log cuttings and perishable material should be removed for the full width of the roadway.
- Cleared debris should be removed from the site in a satisfactory manner**.**
- Trees, shrubs and perishable material should not be buried during the site clearing process**.**
- All organic material, roots and stumps of trees should be removed for the full width of the roadway including areas for embankment slopes and drainage ways.

8.7 Base Course Aggregate

The chemical test conducted on the limestone shows that the percentage of calcium carbonate is high ranging from 90.2 to 94.9 percent. The relatively high calcium carbonate indicates that the material can be used as base course aggregate for the construction of subdivision roads at the site and for other construction applications.

It will be necessary to develop a grading profile for the proposed roadways in the development to determine the volume of cut and fill for construction purposes. This will determine the need to import fill if there is an imbalance between cut and fill at the site.

8.8 Percentage of Sulphate and Implications

The sulphate tests conducted in the soil obtained from chemical analysis show that the percentage of sulphate in the soil at the Mammee Bay subdivision site is less than 0.01 percent. Sulphate in soil and groundwater can aggressively attack underground structures such as concrete foundations, steel and timber.

A Classification of Sulphate content in soils based on percentage of sulphate content, which was developed by Building Research Station Digest (1981) and updated by Tomlinson (1991) shows that the sulphate content is low. It implies that there is no particular precaution that is necessary to prevent aggressive attack on construction material based on the guidelines set out in **Appendix 8.**

8.9 Setback from Gully Course

Subsurface data from borehole 10 in Block E shows that the soil conditions may vary considerably close to the gully course and may not be satisfactory for construction. It recommended that there should be a minimum setback of 15m-20m for residential buildings from gully courses, unless additional geotechnical investigation is carried out to justify a reduced setback. The setback would also help to reduce flooding as it is expected that additional stormwater discharge will be sent into the gullies from the new development.

8.10 Seismic Design Considerations

The International Building Code (IBC) adopted for Jamaica recommends that the Peak Spectral Acceleration for short and long periods (0.2 second and 1 second) for the maximum considered earthquake with a 5% probability of exceedance in 50 years, is 0.45g and 0.175g respectively on the project site at Mammee Bay, St Ann.

9 CONCLUSION

The geotechnical investigation conducted at the Mammee Bay Housing Development site in Mammee Bay, St. Ann includes a geological evaluation, subsurface soil description and classification, Standard Penetration Test (SPT), percolation tests, and laboratory and geotechnical analyses of the rock/soils. The results indicate that the foundation soil at shallow foundation depths is suitable for the construction of apartment blocks, townhouses, detached units and a commercial block proposed for construction at the site.

Normal pad and/or strip foundation is recommended as the bearing capacities of the soil are high and will readily accept structural loads to be imposed on the subsurface soil. The exception to this is on the north-north-western section (Apartment Blocks 1 and 2/Block B) where the bearing capacity is relatively low. In this instance pad/ strip foundation can be a considered with the design of a stiffened structure. Alternatively, the preferred option is a raft foundation design to spread the load widely and evenly over the foundation soil thereby allowing settlement to be kept within tolerable limits of 25mm.

Laboratory test results show that the coarse grain soils are well graded soils which are satisfactory for engineering purposes, while the fine grain soil primarily exhibits intermediate compressibility. Similarly, chemical analyses shows that the percentage of calcium carbonate in the limestone is high, which allows the rock to be used for base course application. Sulphate content in the soil is very low and therefore the potential for sulphate attack on foundation construction material is negligible.

Groundwater is not considered a part of the regional groundwater table but as perched water above the natural water table. The perched groundwater will have little or no impact on construction given that they were encountered below a depth of 3m (10 ft) and confined to the north-eastern to eastern section of the site.

Percolation tests conducted shows that the infiltration rates of the soil are high to very rapid and that the soil is good for discharge of stormwater/wastewater. However, care should be taken that discharge from wastewater systems must be treated to tertiary as the site is located close to the Caribbean coastline.

A setback of 15m-20m is recommended for building structures from the edge of gullies as the soil could be unsuitable for construction especially if located in the narrow flood plain. Additionally, the setback will also assist in reducing the potential for flooding which is likely to increase following construction.

Significant site grading will be required for construction of the commercial block/clubhouse on the north-western section of the site given that there is an elevated section of moderately strong limestone rock that area.

The Mammee Bay site is generally suitable for the development of residential units and there are no major concerns that were identified based on the geotechnical investigation conducted.

10 REFERENCES

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3. Craig R. F. (1987). Soil Mechanics. Fourth Edition. Publisher VNR International
4. Google Earth Pro. V 7.3.3.7786. (January 3, 2021a). 2 Caledonia Avenue, St. Andrew, Jamaica. 17°59’41.11”N, -76°47’02.39”W, Eye alt 647m. Maxar Technologies 2021. [April 28, 2021]
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APPENDIX 1- BOREHOLE LOGS

GEO-TECHNICS LTD - FIELD BOREHOLE LOG SHEET

BORE HOLE **No.1** SHEET 1 OF 1

PROJECT: **Mammee Bay Residential Development**
LOCATION: **Mammee Bay, St. Ann**
DATE: 02-Feb-2023 SURFACE ELEVATION:

TYPE OF BORING
SOLID STEM AUGER ☐ ROTORY DRILLING x
HOLLOW STEM AUGER WASH BORING
TEST PIT

DIA. OF BORING:

STANDARD PENETRATION TEST

● unc. Compr. Str. (T/ft. 2) 1 2 3 4 5 6
WP W WL
—x —x — CONE PENETRATION N - VALUE 10 20 30 40 50 60

DEPTH (m)	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
	1									▩	**Medium Dense, Light Brown Gravelly SAND with some Silt**	
	2											
	3	1	SS	D	100	4	5	5	**10**			
	4											
1.5	5											
	6	2	SS	D	30	5	51/2"		**Refusal**	▦	**Very Dense, Silty Limestone GRAVEL**	
	7									▤	**Moderately Strong to Strong LIMESTONE rock**	
	8	3	SS	D	0	51/1"			**Refusal**			
	9											
3	10										**Borehole 1 terminated at 2.7m (9 ft).**	
	11											
	12											
	13										**NB: Limestone is hard and difficult to penetrate.**	
	14											
4.5	15											
	16											
	17											
	18											
	19											
6.0	20											
	21											
	22											
	23											
	24											
8.0	25											
	26											
	27											
	28											

SOIL SYMBOLS
▤ SHATTERED BEDROCK
▨ FILL
▥ PEAT ORGANIC
▧ CLAY
▥ SILT
▩ SAND
▦ GRAVEL
▦ BOULDER
▨ SEA SHELL
▤ LMSTN
▩ GRANODIORITE

SAMPLE CONDITION	SAMPLE TYPE	LABORATORY TEST SYMBOLS		OTHER SYMBOLS		DRILLING COMPANY
D - DISTURBED	SS - SPLIT SPOON	A - ATTERBERGE LIMITS	M - MECH. ANALYSIS	▼	STABILISED GROUNDWATER	HILL-BETTY (ENGINEERING) LTD.
L - LOST	TW - THIN WALL SHELBY	C - CONSOLIDATION	S - SHEAR	▽	GROUNDWATER LEVEL DURING DRILLING	29 BURLINGTON AVENUE
F - FAIR	BS - BAG SAMPLE	D - DENSITY	T - TRIAXIAL			KINGSTON, JAMAICA
G - GOOD	WS - WASH SAMPLE	H - HYDROMETER		GW	GROUNDWATER LEVEL	
	RC - ROCK CORE					

GEO-TECHNICS LTD - FIELD BOREHOLE LOG SHEET

BORE HOLE No.2 **SHEET** 1 **OF** 2

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 01-Feb-2023 **SURFACE ELEVATION:**

TYPE OF BORING

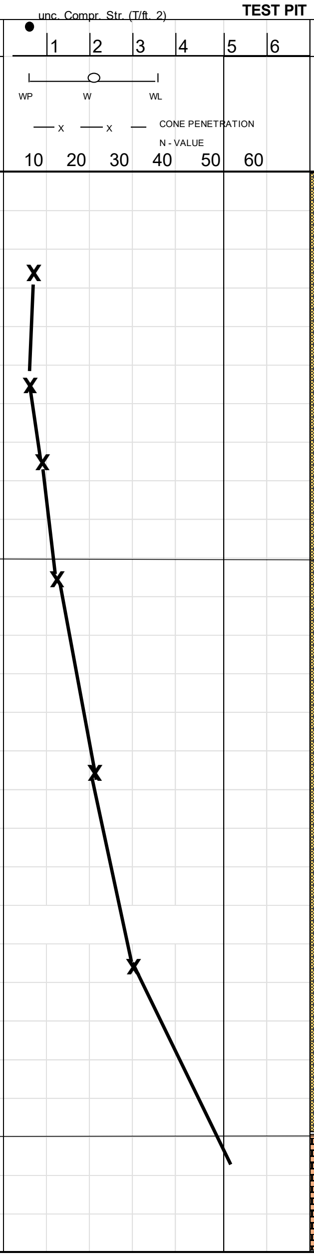
SOLID STEM AUGER ☐ **ROTORY DRILLING** x

HOLLOW STEM AUGER **WASH BORING**

TEST PIT

DIA. OF BORING:

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15 m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									▨	**Loose Yellowish Brown Silty SAND**	
		2											
		3	1	SS	D	100	4	3	4	**7**			
		4											
1.5		5											
		6	2	SS	D	100	4	2	4	**6**			
		7											
		8	3	SS	D	100	4	4	5	**9**			
		9											
3		10											
		11	4	SS	D	100	6	6	6	**12**	▨	**Medium Dense to Dense Yellowish Brown Gravelly SAND with some Silt**	
		12											
		13											
		14											
4.5		15											
		16	5	SS	D	100	9	10	11	**21**			
		17											
		18											
		19											
6.0		20											
		21	6	SS	D	100	16	17	13	**30**			
		22											
		23											
		24											
8.0		25											
		26	7	SS	D	100	3	51/2"		**Refusal**	▦	**Moderately Strong Brown Limestone Rock**	
		27											
		28											



SOIL SYMBOLS

SHATTERED BEDROCK, FILL, PEAT ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
≡ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY
HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 2** SHEET 2 OF 2

PROJECT: **Mammee Bay Residential Development**

LOCATION: **Mamme Bay, St. Ann**

DATE: 01-Feb-2023 SURFACE ELEVATION:

TYPE OF BORING

SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	unc. Compr. Str. (T/ft. 2) ● 1 2 3 4 5 6 WP W WL CONE PENETRATION N - VALUE 10 20 30 40 50 60	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		29										▦		
9.1		30										▦		
		31	8	SS	D	10	51/2"			Refusal		▦	**Moderately Strong Limestone Rock**	
		32										▦		
		33										▦		
		34											**Borehole 2 terminated at 10m (33 ft). Refusal encountered.**	
10.7		35												
		36												
		37												
		38												
		39												
12.1		40												
		41												
		42												
		43												
		44												
13.7		45												
		46												
		47												
		48												
		49												
15		50												
		51												

SOIL SYMBOLS ▦ SHATTERED BEDROCK ▨ FILL ▤ PEAT ORGANIC ▧ CLAY ▥ SILT ▩ SAND ▦ GRAVEL ▒ BOULDER ▒ SEA SHELL LMSTN ▦ GRANODIORITE ▒

SAMPLE CONDITION	SAMPLE TYPE	LABORATORY TEST SYMBOLS		OTHER SYMBOLS		DRILLING COMPANY
D - DISTURBED	SS - SPLIT SPOON	A - ATTERBERGE LIMITS	M - MECH. ANALYSIS	▼	STABILISED GROUNDWATER	HILL-BETTY (ENGINEERING) LTD.
L - LOST	TW - THIN WALL SHELBY	C - CONSOLIDATION	S - SHEAR	≡	GROUNDWATER LEVEL	29 BURLINGTON AVENUE
F - FAIR	BS - BAG SAMPLE	D - DENSITY	T - TRIAXIAL		DURING DRILLING	KINGSTON, JAMAICA
G - GOOD	WS - WASH SAMPLE	H - HYDROMETER		GW	GROUNDWATER LEVEL	
	RC - ROCK CORE					

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE No. 3 SHEET 1 OF 2

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 01-Feb-2023 SURFACE ELEVATION:

TYPE OF BORING

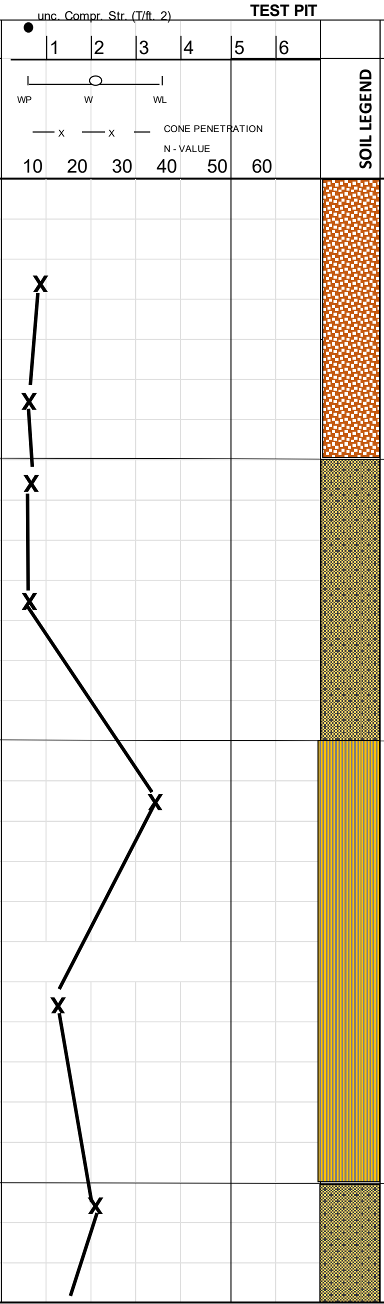
SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									Loose Yellowish Brown Silty GRAVEL with some Sand	
		2										
		3	1	SS	D	100	3	3	6	**9**		
		4										
1.5		5										
		6	2	SS	D	100	3	2	4	**6**		
		7										
		8	3	SS	D	100	3	3	4	**7**	Loose Yellowish Brown SAND and GRAVEL with some Silt	
		9										
3		10										
		11	4	SS	D	100	3	2	4	**6**		
		12										
		13										
		14										
4.5		15									Stiff to Hard Yellowish Brown Sandy SiILT with trace of gravel	
		16	5	SS	D	100	13	18	16	**34**		
		17										
		18										
		19										
6.0		20										
		21	6	SS	D	100	7	6	6	**12**		
		22										
		23										
		24										
8.0		25										
		26	7	SS	D	100	9	10	11	**21**	Medium Dense Brown Sandy GRAVEL with some Silt	
		27										
		28										



SOIL SYMBOLS SHATTERED BEDROCK · FILL · PEAT ORGANIC · CLAY · SILT · SAND · GRAVEL · BOULDER · SEA SHELL · LMSTN · GRANODIORITE

SAMPLE CONDITION	SAMPLE TYPE	LABORATORY TEST SYMBOLS		OTHER SYMBOLS	DRILLING COMPANY
D - DISTURBED	SS - SPLIT SPOON	A - ATTERBERGE LIMITS	M - MECH. ANALYSIS	▼ STABILISED GROUNDWATER	HILL-BETTY (ENGINEERING) LTD.
L - LOST	TW - THIN WALL SHELBY	C - CONSOLIDATION	S - SHEAR	≡ GROUNDWATER LEVEL DURING DRILLING	29 BURLINGTON AVENUE
F - FAIR	BS - BAG SAMPLE	D - DENSITY	T - TRIAXIAL		KINGSTON, JAMAICA
G - GOOD	WS - WASH SAMPLE	H - HYDROMETER		GW GROUNDWATER LEVEL	
	RC - ROCK CORE				

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 3** SHEET 2 OF 2

PROJECT: **Mammee Bay Residential Development**

LOCATION: **Mammee Bay, St. Ann**

DATE: 01-Feb-2023 SURFACE ELEVATION:

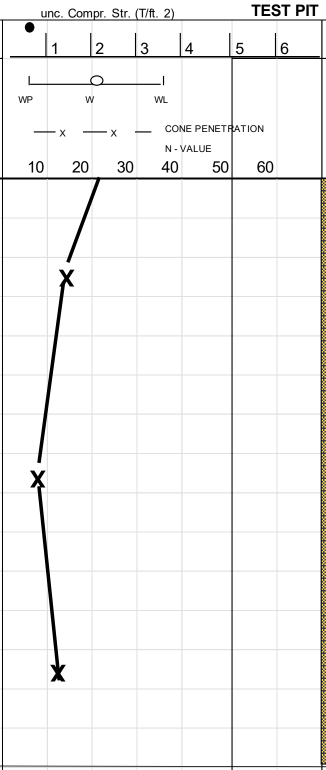
TYPE OF BORING

SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		29									▨	**Loose to Medium Dense Reddish Brown Sandy GRAVEL with some Silt**	
9.1		30											
		31	8	SS	D	100	8	7	7	**14**			
		32											
		33											
		34											
10.7		35											
		36	9	SS	D	100	3	4	4	**8**			
		37											
		38											
		39											
12.1		40											
		41	10	SS	D	100	8	6	6	**12**			
		42											
		43											
		44										**End of borehole 3 at 12.1m (40 ft)**	
13.7		45											
		46											
		47											
		48											
		49											
15		50											
		51											

SOIL SYMBOLS

- SHATTERED BEDROCK
- FILL
- PEAT ORGANIC
- CLAY
- SILT
- SAND
- GRAVEL
- BOULDER
- SEA SHELL
- LMSTN
- GRANODIORITE

SAMPLE CONDITION

D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE

SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS

A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS

▼ STABILISED GROUNDWATER
≡ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 4** SHEET 1 OF 2

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 31-Jan-2023 SURFACE ELEVATION:

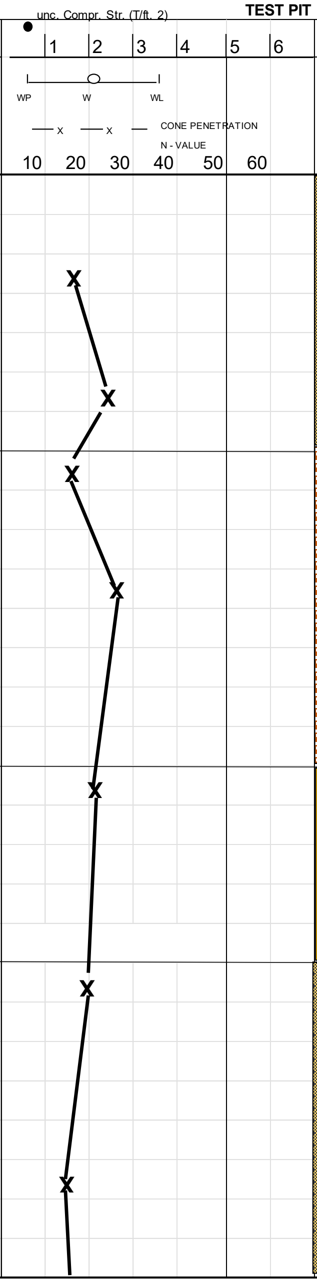
TYPE OF BORING

SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									**Medium Dense Yellowish Brown Gravelly Silty SAND**	
		2										
		3	1	SS	D	100	10	9	8	**17**		
		4										
1.5		5										
		6	2	SS	D	100	5	10	14	**24**		
		7										
		8	3	SS	D	100	8	9	7	**16**	**Medium Dense Yellowish Brown Sandy Silty GRAVEL**	
		9										
3		10										
		11	4	SS	D	100	9	11	15	**26**		
		12										
		13										
		14										
4.5		15										
		16	5	SS	D	100	13	12	9	**21**	**Very Stiff Yellowish Brown Gravelly SILT with some Sand**	
		17										
		18										
		19										
6.0		20										
		21	6	SS	D	100	10	11	9	**20**	**Medium Dense Yellowish Brown Sandy GRAVEL with some Silt**	
		22										
		23										
		24										
8.0		25										
		26	7	SS	D	100	10	8	7	**15**		
		27										
		28										

SOIL SYMBOLS

▦ SHATTERED BEDROCK ▩ FILL ▤ PEAT ORGANIC ▨ CLAY ▥ SILT ▦ SAND ▦ GRAVEL ▦ BOULDER ▦ SEA SHELL ▦ LMSTN ▦ GRANODIORITE

SAMPLE CONDITION

- D - DISTURBED
- L - LOST
- F - FAIR
- G - GOOD

SAMPLE TYPE

- SS - SPLIT SPOON
- TW - THIN WALL SHELBY
- BS - BAG SAMPLE
- WS - WASH SAMPLE
- RC - ROCK CORE

LABORATORY TEST SYMBOLS

- A - ATTERBERGE LIMITS
- C - CONSOLIDATION
- D - DENSITY
- H - HYDROMETER
- M - MECH. ANALYSIS
- S - SHEAR
- T - TRIAXIAL

OTHER SYMBOLS

▼	STABILISED GROUNDWATER
☰	GROUNDWATER LEVEL DURING DRILLING
GW	GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE No. 4 SHEET 2 OF 2

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 31-Jan-2023

SURFACE ELEVATION:

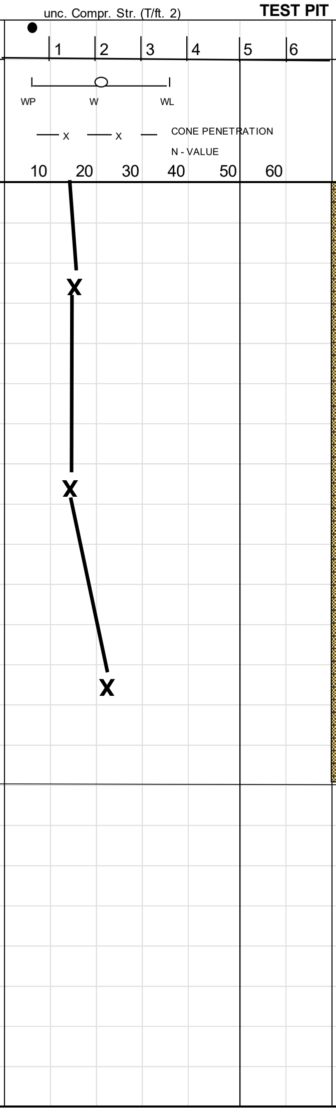
TYPE OF BORING

SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		29									▨	**Medium Dense Cream Brown Calcareous Silty SAND with some Gravel**	
9.1		30											
		31	8	SS	D	100	8	8	8	**16**			
		32											
		33											
		34											
10.7		35											
		36	9	SS	D	100	12	7	7	**14**			
		37											
		38											
		39											
12.1		40											
		41	10	SS	D	100	14	10	12	**22**			
		42											
		43											
		44										**End of borehole at 12.1m (40 ft)**	
13.7		45											
		46											
		47											
		48											
		49											
15		50											
		51											

SOIL SYMBOLS

▦ SHATTERED BEDROCK	▩ FILL	▤ PEAT ORGANIC	▨ CLAY	▥ SILT	▨ SAND	▨ GRAVEL	▨ BOULDER	▨ SEA SHELL	▦ LMSTN	▨ GRANODIORITE	

SAMPLE CONDITION

D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE

SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS

A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS

▼	STABILISED GROUNDWATER
≡	GROUNDWATER LEVEL DURING DRILLING
GW	GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 5** SHEET 1 OF 2

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 31-Jan-2023 SURFACE ELEVATION: ______

TYPE OF BORING

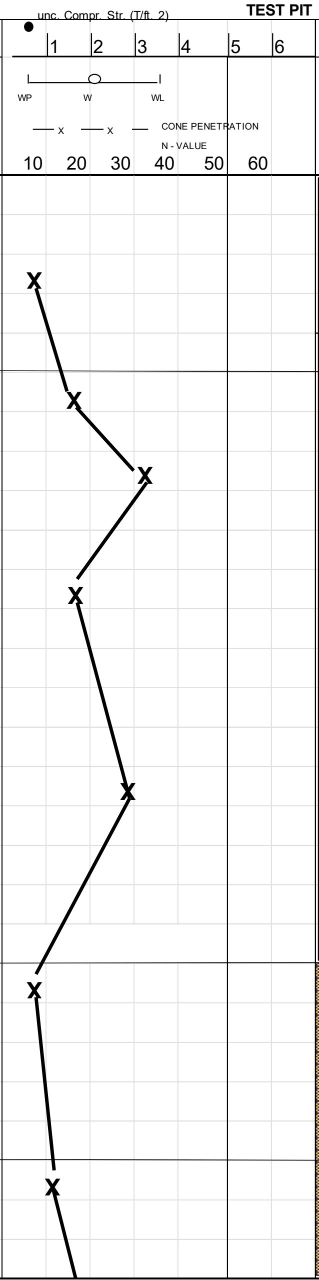
SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER ______ WASH BORING ______

TEST PIT

DIA. OF BORING: ______

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									▨	**Loose Yellowish Brown Silty GRAVEL**	
		2											
		3	1	SS	D	100	3	3	5	**8**			
		4											
1.5		5											
		6	2	SS	D	100	8	9	8	**17**	▨	**Medium Dense to Dense Cream Brown Silty Calcareous GRAVEL with some Sand**	
		7											
		8	3	SS	D	100	8	16	16	**32**			
		9											
3		10											
		11	4	SS	D	100	8	7	10	**17**			
		12											
		13											
		14											
4.5		15											
		16	5	SS	D	100	16	14	15	**29**		**Medium Dense Cream Brown Calcareous GRAVEL and SAND**	
		17											
		18											
		19											
6.0		20											
		21	6	SS	D	100	7	3	4	**7**	▩	**Loose Yellowish Brown Gravelly SAND with some SIlt**	
		22											
		23											
		24											
8.0		25											
		26	7	SS	D	100	7	6	5	**11**	▩	**Medium Dense Yellowish Cream-Brown Silty SAND with some Gravel**	
		27											
		28											



SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE

SAMPLE CONDITION
- D - DISTURBED
- L - LOST
- F - FAIR
- G - GOOD

SAMPLE TYPE
- SS - SPLIT SPOON
- TW - THIN WALL SHELBY
- BS - BAG SAMPLE
- WS - WASH SAMPLE
- RC - ROCK CORE

LABORATORY TEST SYMBOLS
- A - ATTERBERGE LIMITS
- C - CONSOLIDATION
- D - DENSITY
- H - HYDROMETER
- M - MECH. ANALYSIS
- S - SHEAR
- T - TRIAXIAL

OTHER SYMBOLS
- ▼ STABILISED GROUNDWATER
- ☰ GROUNDWATER LEVEL DURING DRILLING
- GW GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE No. 5 SHEET 2 OF 2

PROJECT: Mammee Bay Residential Development

TYPE OF BORING

LOCATION: Mammee Bay, St. Ann

SOLID STEM AUGER ☐ ROTORY DRILLING x

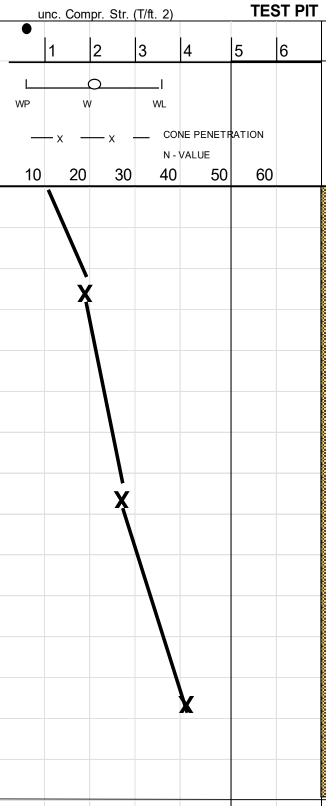
DATE: 31-Jan-2023

SURFACE ELEVATION: ______

HOLLOW STEM AUGER ______ WASH BORING ______

TEST PIT

DIA. OF BORING: ______



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		29										**Medium Dense to Dense Yellowish Cream-Brown Silty SAND**	
9.1		30											
		31	8	SS	D	100	6	8	11	**19**			
		32											
		33											
		34											
10.7		35											
		36	9	SS	D	100	3	12	15	**27**			
		37											
		38											
		39											
12.1		40											
		41	10	SS	D	100	23	14	27	**41**			
		42											
		43											
		44										**End of borehole 5 at 40 ft (12.1m)**	
13.7		45											
		46											
		47											
		48											
		49											
15		50											
		51											

SOIL SYMBOLS

- SHATTERED BEDROCK
- FILL
- PEAT ORGANIC
- CLAY
- SILT
- SAND
- GRAVEL
- BOULDER
- SEA SHELL
- LMSTN
- GRANODIORITE

SAMPLE CONDITION

D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE

SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS

A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS

▼ STABILISED GROUNDWATER
☰ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 6** SHEET 1 OF 1

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 25-Jan-2023 SURFACE ELEVATION:

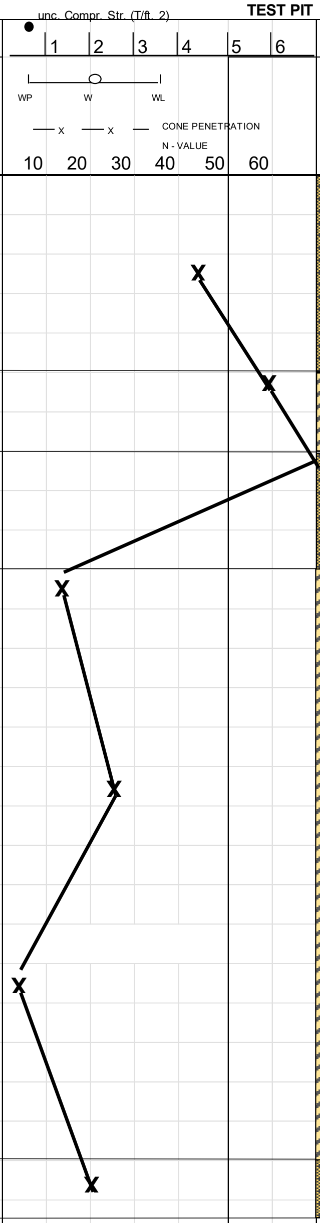
TYPE OF BORING

SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	 2nd 0.15m	 3rd 0.15 m	 N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									▨	**Dense Cream-Brown Calcareous Silty SAND**	
		2											
		3	1	SS	D	100	38	28	16	**44**			
		4											
1.5		5											
		6	2	SS	D	100	17	9	50	**59**	▨	**Hard, Dark Brown Silty CLAY**	
		7											
		8	3	SS	D	100	20	43	30	**73**	▨	**Dense Cream-Brown Calcareous Silty SAND**	
		9											
3		10											
		11	4	SS	D	100	10	10	4	**14**	▨	**Stiff to Very Stiff Silty CLAY and SAND**	
		12											
		13											
		14											
4.5		15											Water Level at 4.5m (15 ft)
		16	5	SS	D	100	17	15	10	**25**			
		17											
		18											
		19											
6.0		20											
		21	6	SS	D	100	11	2	2	**4**			
		22											
		23											
		24											
8.0		25											
		26	7	SS	D	100	7	9	11	20	▨	**Medium Dense Calcareous SAND & GRAVEL**	
		27										**End of Borehole 6 at 7.6m (25 ft)**	
		28											

SOIL SYMBOLS

▦	SHATTERED BEDROCK
▩	FILL
▤	PEAT ORGANIC
▨	CLAY
▥	SILT
▨	SAND
▩	GRAVEL
▢	BOULDER
▢	SEA SHELL
▦	LMSTN
▩	GRANODIORITE

SAMPLE CONDITION

- D - DISTURBED
- L - LOST
- F - FAIR
- G - GOOD

SAMPLE TYPE

- SS - SPLIT SPOON
- TW - THIN WALL SHELBY
- BS - BAG SAMPLE
- WS - WASH SAMPLE
- RC - ROCK CORE

LABORATORY TEST SYMBOLS

- A - ATTERBERGE LIMITS
- C - CONSOLIDATION
- D - DENSITY
- H - HYDROMETER
- M - MECH. ANALYSIS
- S - SHEAR
- T - TRIAXIAL

OTHER SYMBOLS

▼	STABILISED GROUNDWATER
≡	GROUNDWATER LEVEL DURING DRILLING
GW	GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 7** SHEET 1 OF 1

PROJECT: **Mammee Bay Residential Development**

LOCATION: **Mammee Bay, St. Ann**

DATE: 25-Jan-2023 SURFACE ELEVATION: ______

TYPE OF BORING

SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER ______ WASH BORING ______

TEST PIT

DIA. OF BORING: ______

DEPTH (m) Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	unc. Compr. Str. (T/ft. 2) 1 2 3 4 5 6 / WP W WL / CONE PENETRATION N - VALUE 10 20 30 40 50 60	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
	1										**Very Dense Cream Brown Calcareous Sandy GRAVEL or (Weak to moderately weak, cream Limestone)**	
	2											
	3	1	SS	D	10	51			**Refusal**			
	4											
1.5	5											
	6	2	SS	D	10	51			**Refusal**			
	7											
	8	3	SS	D	10	51			**Refusal**			
	9											
3	10											
	11	4	SS	D	100	26	26	30	**56**	X	**Very Dense Cream Brown Silty GRAVEL & SAND**	
	12											
	13											
	14											
4.5	15											
	16	5	SS	D	100	29	31	35	**66**	X	**Very Dense Cream Brown Gravelly SAND and SILT**	
	17											
	18											
	19											
6.0	20											
	21	6	SS	D	10	51			**Refusal**		**Very Dense Cream Brown Calcareous Sandy GRAVEL or (Weak to moderately weak, cream Limestone)**	
	22											
	23											
	24											
8.0	25											
	26	7	SS	D	10	51			**Refusal**			
	27										**End of Borehole 7 at 7.6m (25 ft)**	
	28											

SOIL SYMBOLS: SHATTERED BEDROCK, FILL, PEAT ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE

SAMPLE CONDITION	SAMPLE TYPE	LABORATORY TEST SYMBOLS		OTHER SYMBOLS	DRILLING COMPANY
D - DISTURBED	SS - SPLIT SPOON	A - ATTERBERGE LIMITS	M - MECH. ANALYSIS	▼ STABILISED GROUNDWATER LEVEL	HILL-BETTY (ENGINEERING) LTD.
L - LOST	TW - THIN WALL SHELBY	C - CONSOLIDATION	S - SHEAR	≡ DURING DRILLING	29 BURLINGTON AVENUE
F - FAIR	BS - BAG SAMPLE	D - DENSITY	T - TRIAXIAL	GW GROUNDWATER LEVEL	KINGSTON, JAMAICA
G - GOOD	WS - WASH SAMPLE	H - HYDROMETER			
	RC - ROCK CORE				

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 8** SHEET 1 OF 1

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 24-Jan-2023 **SURFACE ELEVATION:**

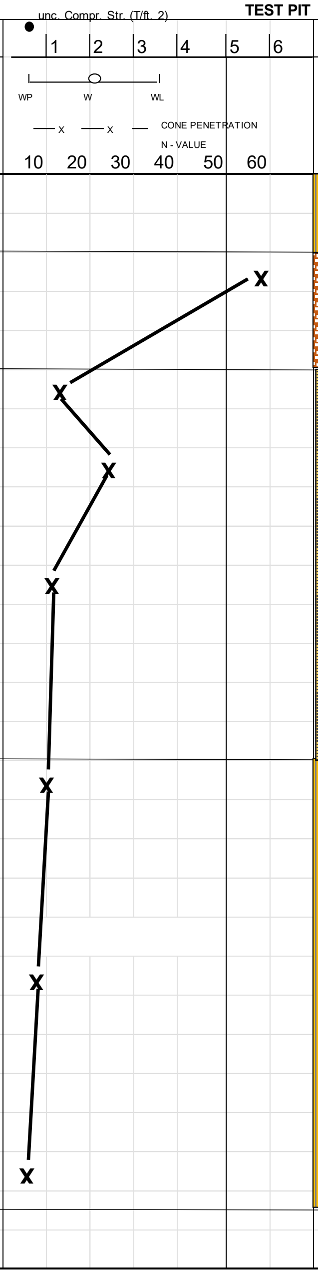
TYPE OF BORING

SOLID STEM AUGER ☐ **ROTORY DRILLING** x

HOLLOW STEM AUGER **WASH BORING**

TEST PIT

DIA. OF BORING:



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	SAMPLE CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15 m	2nd 0.15m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									▥	**Weak Marl (Calcareous Silt)**	
		2									▥		
		3	1	SS	D	100	37	37	21	**58**	▦	**Very Dense Cream-Brown Calcareous GRAVEL & SAND**	
		4									▦		
1.5		5									▦		
		6	2	SS	D	100	9	7	6	**13**	▨	**Compact Cream-Brown Calcareous Silty SAND**	
		7									▨		
		8	3	SS	D	100	10	16	8	**24**	▨		
		9									▨		
3		10									▨		**Water Level at 3m (10 ft)**
		11	4	SS	D	100	13	7	4	**11**	▨		
		12									▨		
		13									▨		
		14									▨		
4.5		15									▨		
		16	5	SS	D	100	4	4	6	**10**	▥	**Firm to Stiff Calcareous Sandy SILT**	
		17									▥		
		18									▥		
		19									▥		
6.0		20									▥		
		21	6	SS	D	100	4	4	4	**8**	▥		
		22									▥		
		23									▥		
		24									▥		
8.0		25									▥		
		26	7	SS	D	100	2	3	2	**5**	▥		
		27										**End of Borehole 8 at 7.6m (25 ft)**	
		28											

SOIL SYMBOLS

- ▦ SHATTERED BEDROCK
- ▩ FILL
- ▤ PEAT ORGANIC
- ▧ CLAY
- ▥ SILT
- ▨ SAND
- ▦ GRAVEL
- ▒ BOULDER
- ▒ SEA SHELL
- ▦ LMSTN
- ▒ GRANODIORITE

SAMPLE CONDITION

- D - DISTURBED
- L - LOST
- F - FAIR
- G - GOOD

SAMPLE TYPE

- SS - SPLIT SPOON
- TW - THIN WALL SHELBY
- BS - BAG SAMPLE
- WS - WASH SAMPLE
- RC - ROCK CORE

LABORATORY TEST SYMBOLS

- A - ATTERBERGE LIMITS
- C - CONSOLIDATION
- D - DENSITY
- H - HYDROMETER
- M - MECH. ANALYSIS
- S - SHEAR
- T - TRIAXIAL

OTHER SYMBOLS

- ▼ STABILISED GROUNDWATER
- ≡ GROUNDWATER LEVEL DURING DRILLING
- GW GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD - FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 9** SHEET 1 OF 1

PROJECT: **Mammee Bay Residential Development**

LOCATION: **Mammee Bay, St. Ann**

DATE: 24-Jan-2023 SURFACE ELEVATION:

TYPE OF BORING

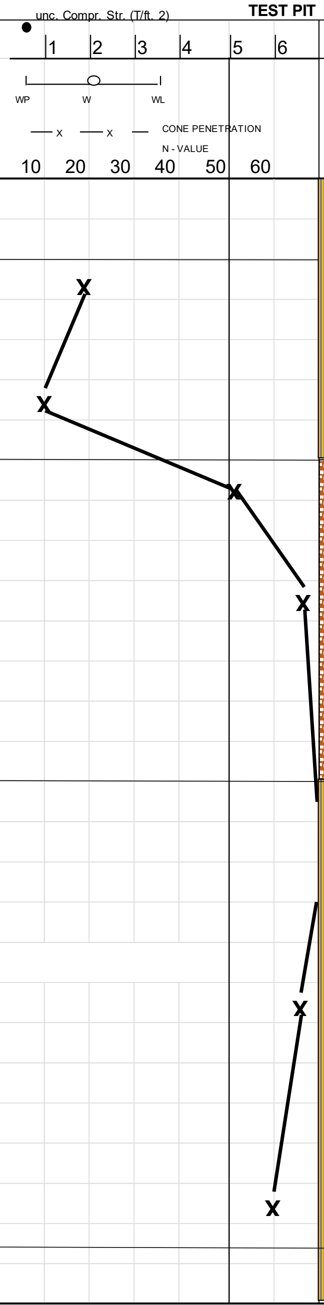
SOLID STEM AUGER ☐ ROTORY DRILLING X

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15 m	3rd 0.15 m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									▥	**Stiff to Very Stiff Cream-Brown Sandy SILT**	
		2											
		3	1	SS	D	100	5	7	12	**19**			
		4											
1.5		5											
		6	2	SS	D	100	7	6	4	**10**			
		7											
		8	3	SS	D	0	51			**Refusal**	▦	**No recovery.**	
		9											
3		10											
		11	4	SS	D	100	32	31	35	**66**		**Very Dense Cream-Brown Calcareous Sandy GRAVEL and SILT**	
		12											
		13											
		14											
4.5		15											
		16	5	SS	D	100	21	35	40	**75**	▥	**Hard Calcareous Sandy SILT**	
		17											
		18											
		19											
6.0		20											
		21	6	SS	D	100	26	30	35	**65**			
		22											
		23											
		24											
8.0		25											
		26	7	SS	D	100	20	29	31	**60**			
		27										**End of Borehole 9 at 7.6m (25 ft)**	
		28											



SOIL SYMBOLS

▦	SHATTERED BEDROCK
▩	FILL
▤	PEAT ORGANIC
▨	CLAY
▥	SILT
▦	SAND
▦	GRAVEL
▦	BOULDER
▦	SEA SHELL
▦	LMSTN
▦	GRANODIORITE

SAMPLE CONDITION
- D - DISTURBED
- L - LOST
- F - FAIR
- G - GOOD

SAMPLE TYPE
- SS - SPLIT SPOON
- TW - THIN WALL SHELBY
- BS - BAG SAMPLE
- WS - WASH SAMPLE
- RC - ROCK CORE

LABORATORY TEST SYMBOLS
- A - ATTERBERGE LIMITS
- C - CONSOLIDATION
- D - DENSITY
- H - HYDROMETER
- M - MECH. ANALYSIS
- S - SHEAR
- T - TRIAXIAL

OTHER SYMBOLS

▼	STABILISED GROUNDWATER LEVEL
≡	GROUNDWATER LEVEL DURING DRILLING
GW	GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD-FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 10** SHEET 1 OF 1

PROJECT: **Mammee Bay Residential Development**

LOCATION: **Mammee Bay, St. Ann**

DATE: 25-Jan-2023 SURFACE ELEVATION: ______

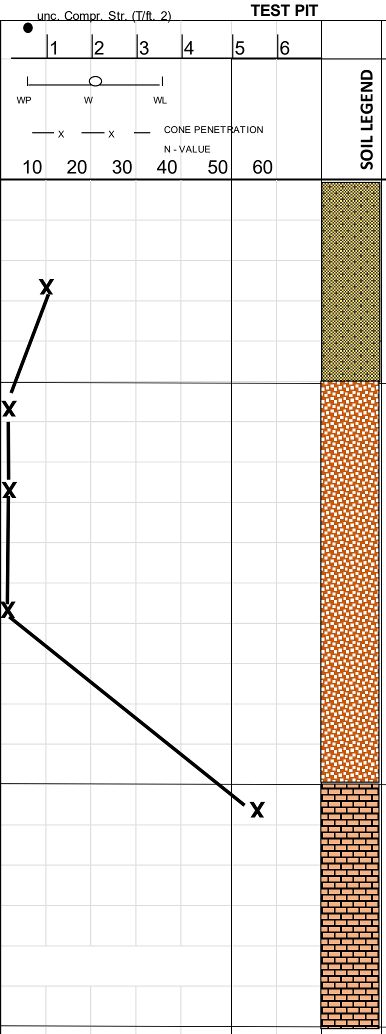
TYPE OF BORING

SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER ______ WASH BORING ______

TEST PIT

DIA. OF BORING: ______



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1										
		2										
		3	1	SS	D	100	6	4	2	**6**	**Loose Cream-Brown Gravelly SAND & CLAY**	
		4										
1.5		5										
		6	2	SS	D	100	1	1	1	**2**		**Water Level at 1.8m (6 ft)**
		7										
		8	3	SS	D	100	3	1	1	**2**	**Very Loose Cream-Brown Calcareous Sandy Clayey GRAVEL**	
		9										
3		10										
		11	4	SS	D	100	1	1	1	**2**		
		12									**Very Loose Cream-Brown Calcareous Sandy GRAVEL & SILT**	
		13										
		14										
4.5		15										
		16	5	SS	D	10	2	51/2"		**Refusal**		
		17										
		18										
		19									**Moderately Strong to strong LIMESTONE**	
6.0		20										
		21	6	SS	D	10	51			**Refusal**		
		22									**Borehole 10 terminated at 6.1m (20 ft)**	
		23										
		24										
8.0		25										
		26										
		27										
		28										

SOIL SYMBOLS

SHATTERED BEDROCK, FILL, PEAT ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE

SAMPLE CONDITION
- D - DISTURBED
- L - LOST
- F - FAIR
- G - GOOD

SAMPLE TYPE
- SS - SPLIT SPOON
- TW - THIN WALL SHELBY
- BS - BAG SAMPLE
- WS - WASH SAMPLE
- RC - ROCK CORE

LABORATORY TEST SYMBOLS
- A - ATTERBERGE LIMITS
- C - CONSOLIDATION
- D - DENSITY
- H - HYDROMETER
- M - MECH. ANALYSIS
- S - SHEAR
- T - TRIAXIAL

OTHER SYMBOLS
- ▼ STABILISED GROUNDWATER
- ≡ GROUNDWATER LEVEL DURING DRILLING
- GW GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

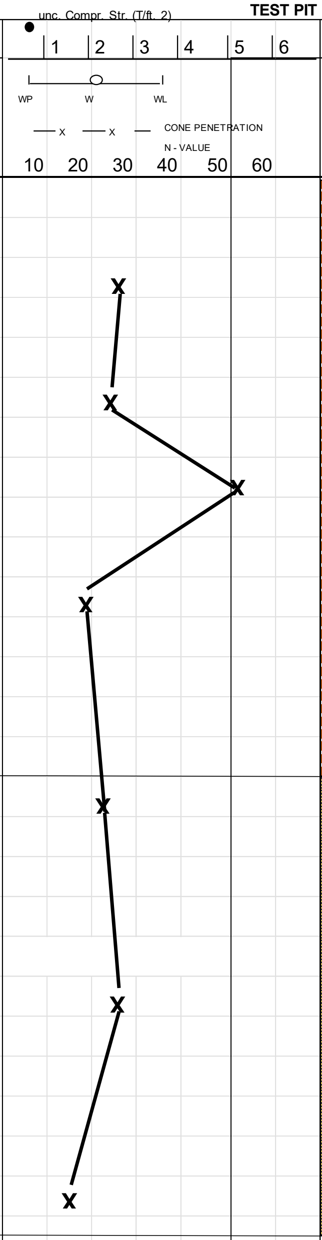
GEO-TECHNICS LTD - FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 11** SHEET 1 OF 1

PROJECT: Mammee Bay Residential Development
LOCATION: Mammee Bay, St. Ann
DATE: 26-Jan-2023 SURFACE ELEVATION:

TYPE OF BORING
SOLID STEM AUGER ☐ ROTORY DRILLING x
HOLLOW STEM AUGER WASH BORING
TEST PIT
DIA. OF BORING:

DEPTH (m)	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
	1									**Medium Dense to Dense Cream Brown Calcareous Sandy GRAVEL**	
	2										
	3	1	SS	D	100	8	11	15	**26**		
	4										
1.5	5										
	6	2	SS	D	100	10	11	14	**25**		
	7										
	8	3	SS	D	100	19	26	51/4"	**Refusal**		
	9										
3	10										
	11	4	SS	D	100	6	7	12	**19**		
	12										
	13										
	14										
4.5	15										
	16	5	SS	D	100	10	15	17	**32**	**Medium Dense to Dense Cream Brown Gravelly SAND with some SIlt**	
	17										
	18										
	19										
6.0	20										
	21	6	SS	D	100	9	9	17	**26**		
	22										
	23										
	24										
8.0	25										
	26	7	SS	D	100	6	7	8	**15**		
	27									**End of Borehole 11 at 7.6m (25 ft)**	
	28										



SOIL SYMBOLS

SHATTERED BEDROCK, FILL, PEAT ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
▽ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY
HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD - FIELD BOREHOLE LOG SHEET

BORE HOLE No. 12 SHEET 1 OF 1

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 26-Jan-2023 **SURFACE ELEVATION:**

TYPE OF BORING

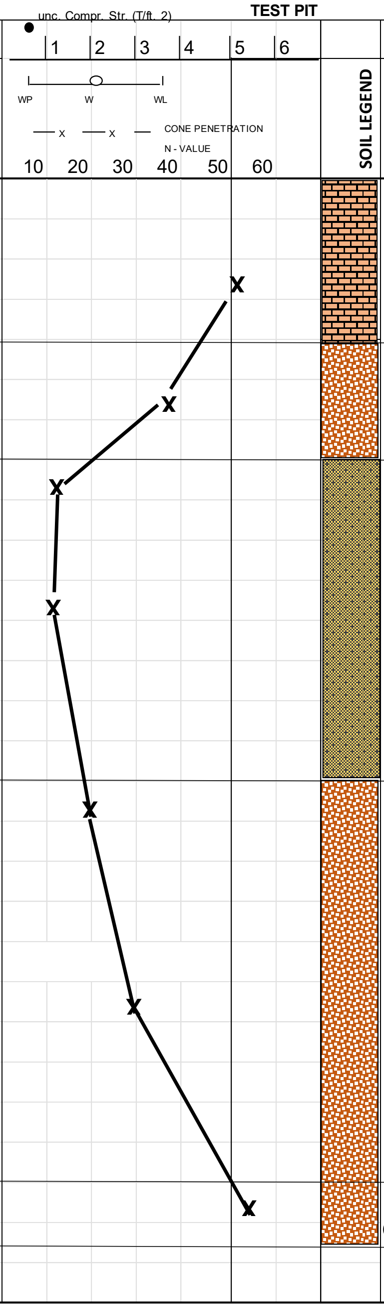
SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:

DEPTH (m) Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15 m	N Value	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
	1									Moderately Weak cream marly Limestone	
	2										
	3	1	SS	D	100	51/3"			Refusal		
	4										
1.5	5									Dense Cream Brown Calcareous Sandy GRAVEL	
	6	2	SS	D	100	22	18	19	37		
	7										
	8	3	SS	D	100	4	5	7	12	Medium Dense Cream Brown Silty SAND with some Gravel	
	9										
3	10										
	11	4	SS	D	100	12	8	3	11		
	12										
	13										
	14										
4.5	15										
	16	5	SS	D	100	11	10	10	20	Medium Dense Cream Brown Calcareous Sandy GRAVEL	
	17										
	18										
	19										
6.0	20										
	21	6	SS	D	100	12	14	15	29		
	22										
	23										
	24										
8.0	25										
	26	7	SS	D	100	37	30	24	54	Very Dense Cream Brown Calcareous Sandy GRAVEL	
	27										
	28									End of Borehole 12 at 7.6m (25 ft)	



SOIL SYMBOLS

SHATTERED BEDROCK, FILL, PEAT ORGANIC, CLAY, SILT, SAND, GRAVEL, BOULDER, SEA SHELL, LMSTN, GRANODIORITE

SAMPLE CONDITION
- D - DISTURBED
- L - LOST
- F - FAIR
- G - GOOD

SAMPLE TYPE
- SS - SPLIT SPOON
- TW - THIN WALL SHELBY
- BS - BAG SAMPLE
- WS - WASH SAMPLE
- RC - ROCK CORE

LABORATORY TEST SYMBOLS
- A - ATTERBERGE LIMITS
- C - CONSOLIDATION
- D - DENSITY
- H - HYDROMETER
- M - MECH. ANALYSIS
- S - SHEAR
- T - TRIAXIAL

OTHER SYMBOLS
- ▼ STABILISED GROUNDWATER LEVEL
- ≡ DURING DRILLING
- GW GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

GEO-TECHNICS LTD - FIELD BOREHOLE LOG SHEET

BORE HOLE **No. 13** SHEET 1 OF 1

PROJECT: Mammee Bay Residential Development

LOCATION: Mammee Bay, St. Ann

DATE: 26-Jan-2023 **SURFACE ELEVATION:**

TYPE OF BORING

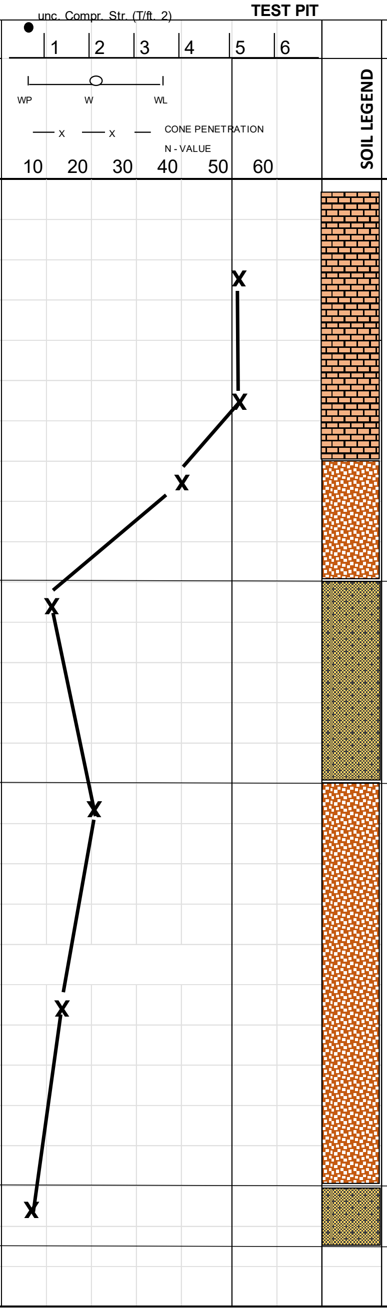
SOLID STEM AUGER ☐ ROTORY DRILLING x

HOLLOW STEM AUGER WASH BORING

TEST PIT

DIA. OF BORING:

DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									**Moderately Weak creamish brown Marly LIMESTONE**	
		2										
		3	1	SS	D	15	51/3"			**Refusal**		
		4										
1.5		5										
		6	2	SS	D	15	51/3"			**Refusal**		
		7									**Dense Cream Brown Calcareous Sandy GRAVEL**	
		8	3	SS	D	100	19	20	20	**40**		
		9										
3		10										
		11	4	SS	D	100	7	6	5	**11**	**Medium Dense Cream Brown Silty SAND with some Gravel**	
		12										
		13										
		14										
4.5		15										
		16	5	SS	D	100	11	10	10	**20**	**Medium Dense Cream Brown Calcareous Sandy GRAVEL**	
		17										
		18										
		19										
6.0		20										
		21	6	SS	D	100	8	6	8	**14**		
		22										
		23										
		24										
8.0		25										
		26	7	SS	D	100	9	5	3	**8**	**Loose Yellowish-Cream Brown Silty SAND**	
		27									**End of Borehole 13 at 7.6m (25 ft)**	
		28										



SOIL SYMBOLS

- SHATTERED BEDROCK
- FILL
- PEAT ORGANIC
- CLAY
- SILT
- SAND
- GRAVEL
- BOULDER
- SEA SHELL
- LMSTN
- GRANODIORITE

SAMPLE CONDITION

- D - DISTURBED
- L - LOST
- F - FAIR
- G - GOOD

SAMPLE TYPE

- SS - SPLIT SPOON
- TW - THIN WALL SHELBY
- BS - BAG SAMPLE
- WS - WASH SAMPLE
- RC - ROCK CORE

LABORATORY TEST SYMBOLS

- A - ATTERBERGE LIMITS
- C - CONSOLIDATION
- D - DENSITY
- H - HYDROMETER
- M - MECH. ANALYSIS
- S - SHEAR
- T - TRIAXIAL

OTHER SYMBOLS

- ▼ STABILISED GROUNDWATER
- ≡ GROUNDWATER LEVEL DURING DRILLING
- GW GROUNDWATER LEVEL

DRILLING COMPANY

HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

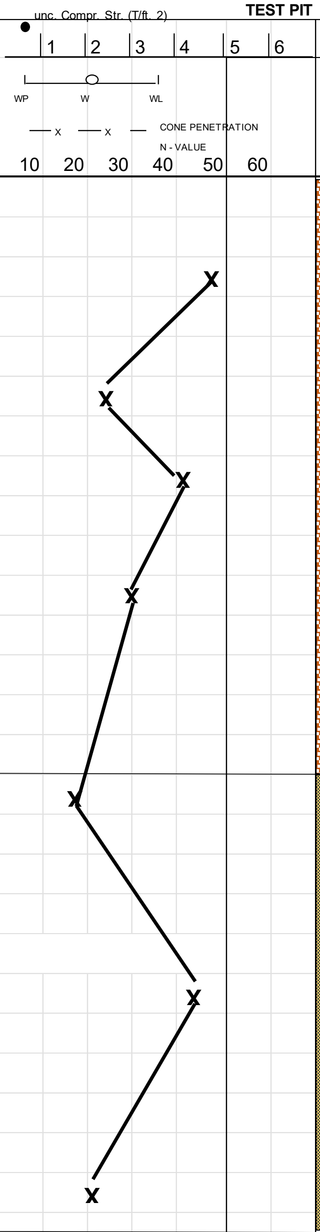
GEO-TECHNICS LTD - FIELD BOREHOLE LOG SHEET

BORE HOLE No. 14 **SHEET** 1 **OF** 1

PROJECT: Mammee Bay Residential Development
LOCATION: Mammee Bay, St. Ann
DATE: 02-Feb-2023 **SURFACE ELEVATION:**

TYPE OF BORING
SOLID STEM AUGER ☐ **ROTORY DRILLING** x
HOLLOW STEM AUGER **WASH BORING**
TEST PIT

DIA. OF BORING:



DEPTH (m)	Meter	Feet	SAMPLE NO.	SAMPLE TYP	CONDITION	% RECOVERY	STANDARD PENETRATION TEST 1st 0.15m	2nd 0.15m	3rd 0.15m	N Value	SOIL LEGEND	DESCRIPTION OF STRATA	GROUNDWATER LEVEL
		1									▨	**Medium Dense to Dense Cream Brown Calcareous Sandy GRAVEL**	
		2											
		3	1	SS	D	100	17	24	23	**47**			
		4											
1.5		5											
		6	2	SS	D	100	16	11	13	**24**			
		7											
		8	3	SS	D	100	12	16	25	**41**			
		9											
3		10											
		11	4	SS	D	100	18	13	17	**30**			
		12											
		13											
		14											
4.5		15											
		16	5	SS	D	100	23	19	8	**27**	▨	**Medium Dense to Dense Cream Brown Calcareous Gravelly SAND with some SIlt**	
		17											
		18											
		19											
6.0		20											
		21	6	SS	D	100	10	21	23	**44**			
		22											
		23											
		24											
8.0		25											
		26	7	SS	D	100	39	11	10	**21**			
		27										**End of Borehole 14 at 7.6m (25 ft)**	
		28											

SOIL SYMBOLS
- ▨ SHATTERED BEDROCK
- ▨ FILL
- ▨ PEAT ORGANIC
- ▨ CLAY
- ▨ SILT
- ▨ SAND
- ▨ GRAVEL
- ▨ BOULDER
- ▨ SEA SHELL
- ▨ LMSTN
- ▨ GRANODIORITE

SAMPLE CONDITION
D - DISTURBED
L - LOST
F - FAIR
G - GOOD

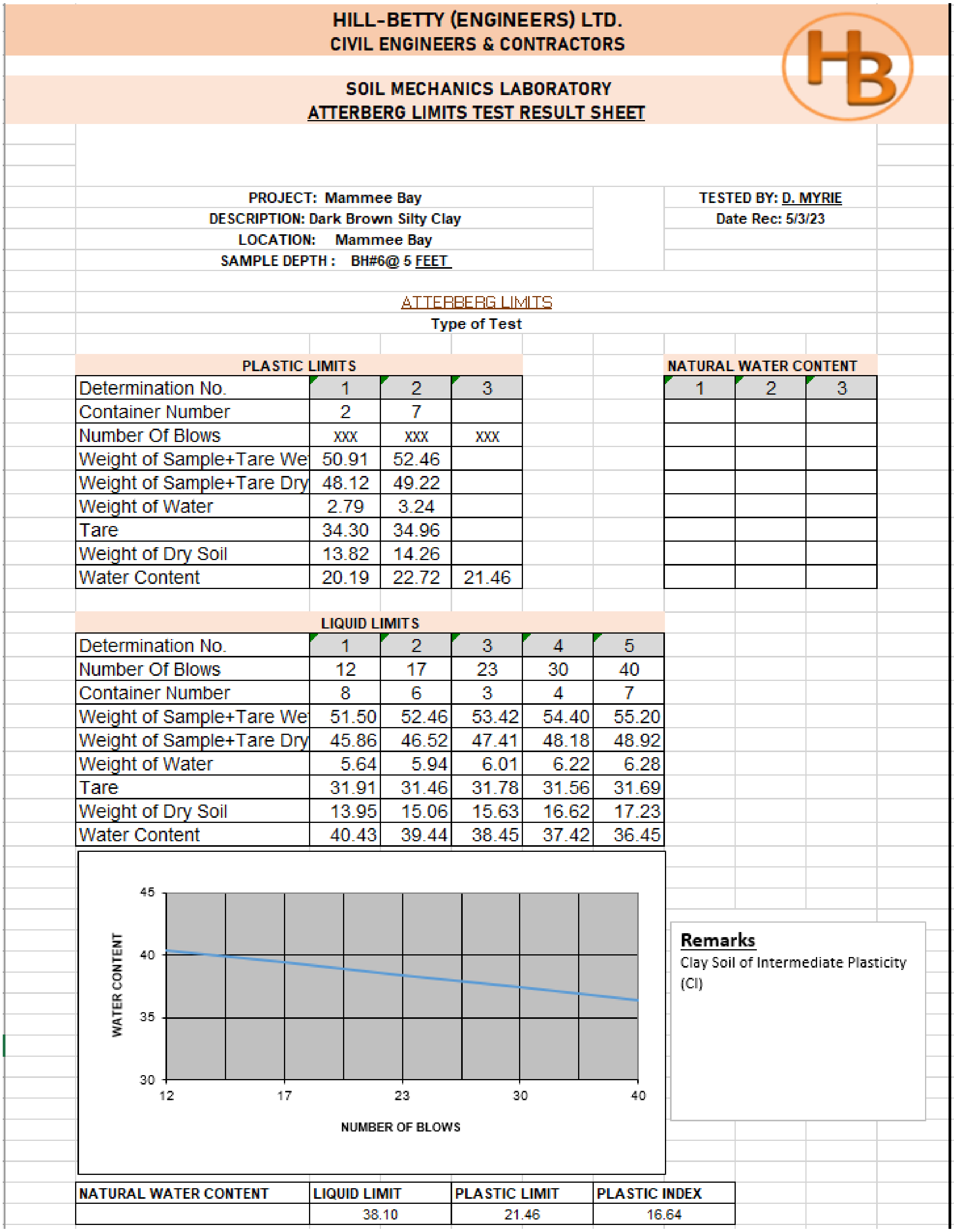
SAMPLE TYPE
SS - SPLIT SPOON
TW - THIN WALL SHELBY
BS - BAG SAMPLE
WS - WASH SAMPLE
RC - ROCK CORE

LABORATORY TEST SYMBOLS
A - ATTERBERGE LIMITS
C - CONSOLIDATION
D - DENSITY
H - HYDROMETER
M - MECH. ANALYSIS
S - SHEAR
T - TRIAXIAL

OTHER SYMBOLS
▼ STABILISED GROUNDWATER
≡ GROUNDWATER LEVEL DURING DRILLING
GW GROUNDWATER LEVEL

DRILLING COMPANY
HILL-BETTY (ENGINEERING) LTD.
29 BURLINGTON AVENUE
KINGSTON, JAMAICA

APPENDIX 2: ATTERBERG LIMITS TEST RESULTS



HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Mammee Bay
DESCRIPTION: Dark Brown Silty Clay
LOCATION: Mammee Bay
SAMPLE DEPTH : BH#6@ 5 FEET

TESTED BY: D. MYRIE
Date Rec: 5/3/23

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

Determination No.	1	2	3
Container Number	2	7	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare We	50.91	52.46	
Weight of Sample+Tare Dry	48.12	49.22	
Weight of Water	2.79	3.24	
Tare	34.30	34.96	
Weight of Dry Soil	13.82	14.26	
Water Content	20.19	22.72	21.46

NATURAL WATER CONTENT

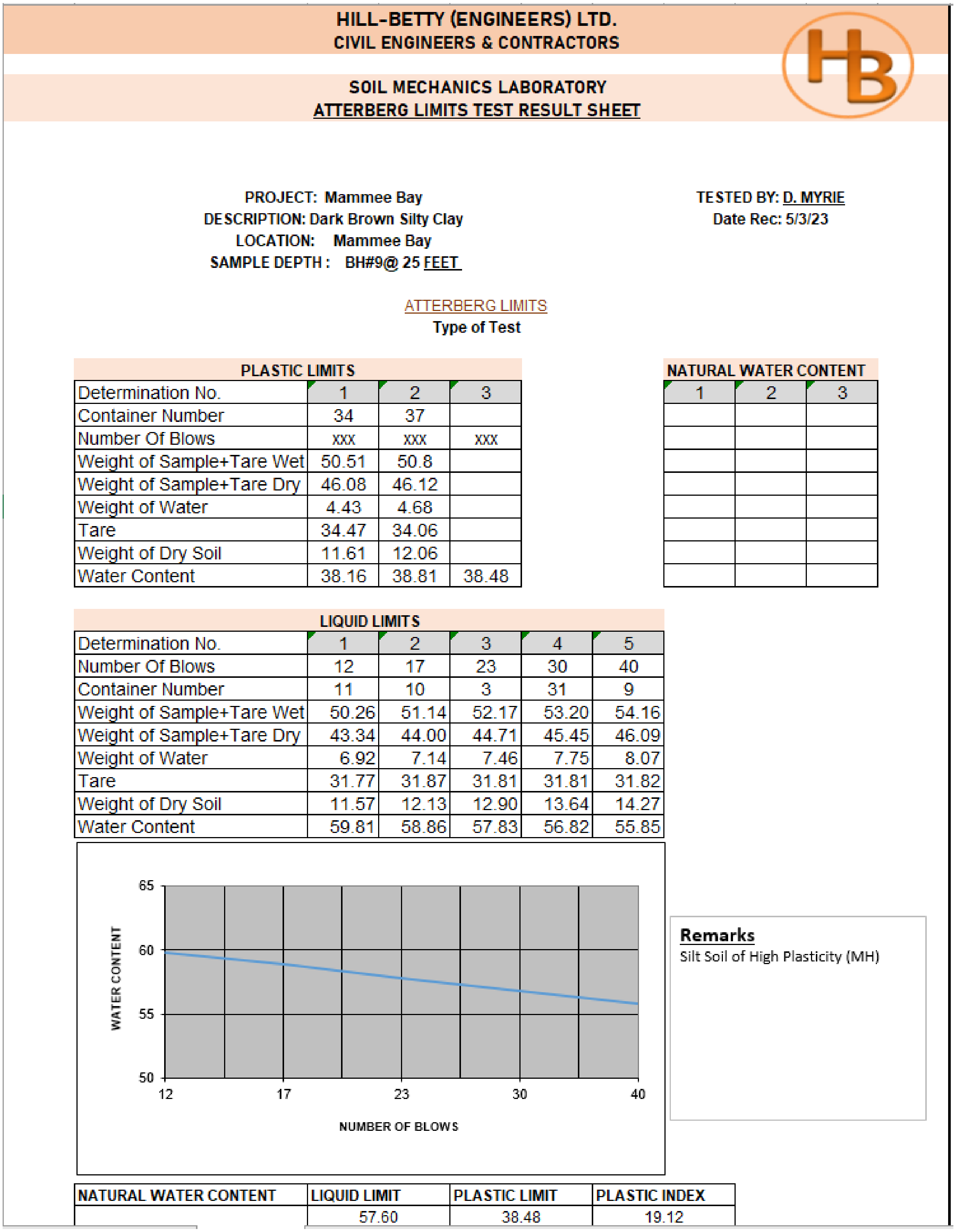
1	2	3

LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	8	6	3	4	7
Weight of Sample+Tare We	51.50	52.46	53.42	54.40	55.20
Weight of Sample+Tare Dry	45.86	46.52	47.41	48.18	48.92
Weight of Water	5.64	5.94	6.01	6.22	6.28
Tare	31.91	31.46	31.78	31.56	31.69
Weight of Dry Soil	13.95	15.06	15.63	16.62	17.23
Water Content	40.43	39.44	38.45	37.42	36.45

Remarks
Clay Soil of Intermediate Plasticity (CI)

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
	38.10	21.46	16.64



HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Mammee Bay
DESCRIPTION: Dark Brown Silty Clay
LOCATION: Mammee Bay
SAMPLE DEPTH : BH#9@ 25 FEET

TESTED BY: D. MYRIE
Date Rec: 5/3/23

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

Determination No.	1	2	3
Container Number	34	37	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare Wet	50.51	50.8	
Weight of Sample+Tare Dry	46.08	46.12	
Weight of Water	4.43	4.68	
Tare	34.47	34.06	
Weight of Dry Soil	11.61	12.06	
Water Content	38.16	38.81	38.48

NATURAL WATER CONTENT

1	2	3

LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	11	10	3	31	9
Weight of Sample+Tare Wet	50.26	51.14	52.17	53.20	54.16
Weight of Sample+Tare Dry	43.34	44.00	44.71	45.45	46.09
Weight of Water	6.92	7.14	7.46	7.75	8.07
Tare	31.77	31.87	31.81	31.81	31.82
Weight of Dry Soil	11.57	12.13	12.90	13.64	14.27
Water Content	59.81	58.86	57.83	56.82	55.85

Remarks
Silt Soil of High Plasticity (MH)

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
	57.60	38.48	19.12

HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Mammee Bay
DESCRIPTION: Dark Brown Silty Clay
LOCATION: Mammee Bay
SAMPLE DEPTH : BH#10@ 15 FEET

TESTED BY: D. MYRIE
Date Rec: 5/3/23

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

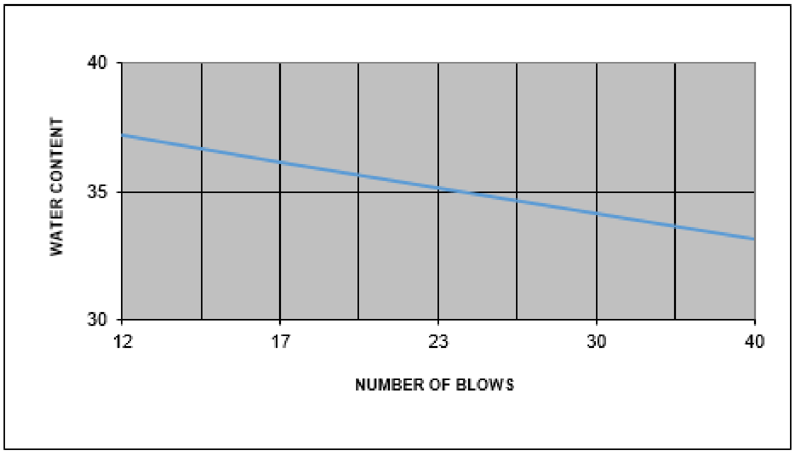
Determination No.	1	2	3
Container Number	48	53	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare Wet	51.80	53	
Weight of Sample+Tare Dry	49.36	50.08	
Weight of Water	2.44	2.92	
Tare	32.42	34.55	
Weight of Dry Soil	14.44	15.53	
Water Content	16.33	18.80	17.57

NATURAL WATER CONTENT

1	2	3

LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	27	54	88	22	33
Weight of Sample+Tare Wet	42.44	43.46	44.40	45.43	45.54
Weight of Sample+Tare Dry	37.58	38.51	39.41	40.22	41.25
Weight of Water	4.86	4.95	4.99	5.21	4.29
Tare	24.50	24.82	25.21	24.97	25.31
Weight of Dry Soil	13.08	13.69	14.20	15.25	15.94
Water Content	37.16	36.10	35.14	34.16	33.18



Remarks
Clay Soil of Intermediate Plasticity (CI)

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
	34.80	17.57	17.23

HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Mammee Bay
DESCRIPTION: Dark Brown Silty Clay
LOCATION: Mammee Bay
SAMPLE DEPTH : BH#11@ 20 FEET

TESTED BY: D. MYRIE
Date Rec: 5/3/23

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

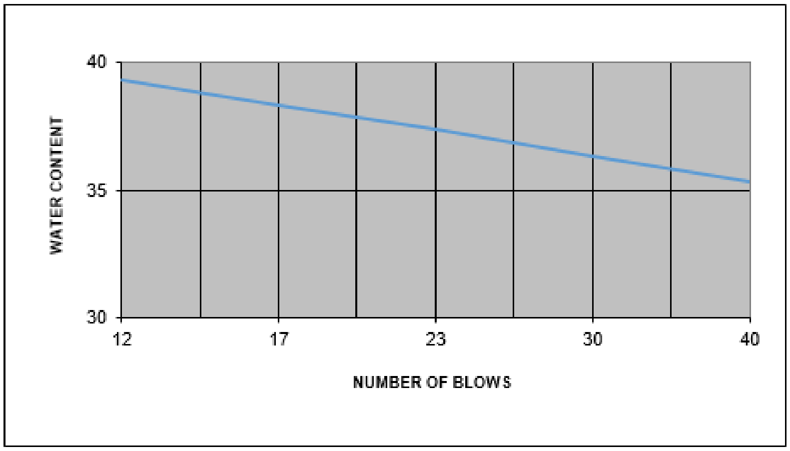
Determination No.	1	2	3
Container Number	17	15	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare Wet	50.86	52.46	
Weight of Sample+Tare Dry	48.12	49.90	
Weight of Water	2.74	2.56	
Tare	34.33	34.75	
Weight of Dry Soil	13.79	15.15	
Water Content	19.87	16.90	18.38

NATURAL WATER CONTENT

1	2	3

LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	64	24	34	53	14
Weight of Sample+Tare Wet	42.36	43.57	44.54	45.34	46.22
Weight of Sample+Tare Dry	37.38	38.52	39.00	39.86	40.78
Weight of Water	4.98	5.05	5.54	5.48	5.44
Tare	24.72	25.35	24.17	24.79	25.38
Weight of Dry Soil	12.66	13.17	14.83	15.07	15.40
Water Content	39.34	38.34	37.36	36.36	35.32



Remarks
Clay Soil of Intermediate Plasticity (CI)

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
	37.10	18.38	18.72

HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Mammee Bay
DESCRIPTION: Dark Brown Silty Clay
LOCATION: Mammee Bay
SAMPLE DEPTH : BH#4@ 40 FEET

TESTED BY: D. MYRIE
Date Rec: 5/3/23

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

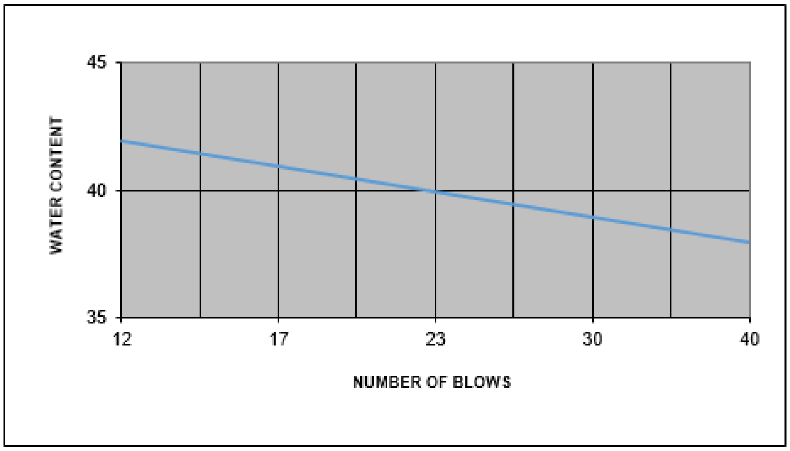
Determination No.	1	2	3
Container Number	4	9	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare Wet	50.85	50.99	
Weight of Sample+Tare Dry	47.03	47.14	
Weight of Water	3.82	3.85	
Tare	34.97	35.04	
Weight of Dry Soil	12.06	12.10	
Water Content	31.67	31.82	31.74

NATURAL WATER CONTENT

1	2	3

LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	10	26	16	15	51
Weight of Sample+Tare Wet	43.32	44.30	45.28	46.26	47.21
Weight of Sample+Tare Dry	37.75	38.87	39.55	40.35	41.24
Weight of Water	5.57	5.43	5.73	5.91	5.97
Tare	24.46	25.43	25.20	25.17	25.50
Weight of Dry Soil	13.29	13.39	14.35	15.18	15.74
Water Content	41.91	40.93	39.93	38.93	37.93



Remarks
Silt Soil of Intermediate Plasticity (MI)

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
	39.70	31.74	7.96

HILL-BETTY (ENGINEERS) LTD.
CIVIL ENGINEERS & CONTRACTORS

SOIL MECHANICS LABORATORY
ATTERBERG LIMITS TEST RESULT SHEET

PROJECT: Mammee Bay
DESCRIPTION: Dark Brown Silty Clay
LOCATION: Mammee Bay
SAMPLE DEPTH : BH#5@ 30 FEET

TESTED BY: D. MYRIE
Date Rec: 5/3/23

ATTERBERG LIMITS
Type of Test

PLASTIC LIMITS

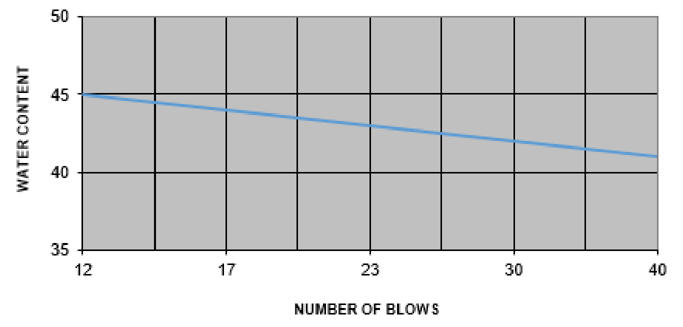
Determination No.	1	2	3
Container Number	3	33	
Number Of Blows	xxx	xxx	xxx
Weight of Sample+Tare Wet	50.18	50.33	
Weight of Sample+Tare Dry	46.18	46.29	
Weight of Water	4.00	4.04	
Tare	34.82	34.88	
Weight of Dry Soil	11.36	11.41	
Water Content	35.21	35.41	35.31

NATURAL WATER CONTENT

1	2	3

LIQUID LIMITS

Determination No.	1	2	3	4	5
Number Of Blows	12	17	23	30	40
Container Number	95	83	22	61	30
Weight of Sample+Tare Wet	43.46	44.38	45.44	46.34	47.36
Weight of Sample+Tare Dry	37.91	38.52	39.47	40.22	41.13
Weight of Water	5.55	5.86	5.97	6.12	6.23
Tare	25.58	25.21	25.60	25.66	25.95
Weight of Dry Soil	12.33	13.31	13.87	14.56	15.18
Water Content	45.01	44.03	43.04	42.03	41.04

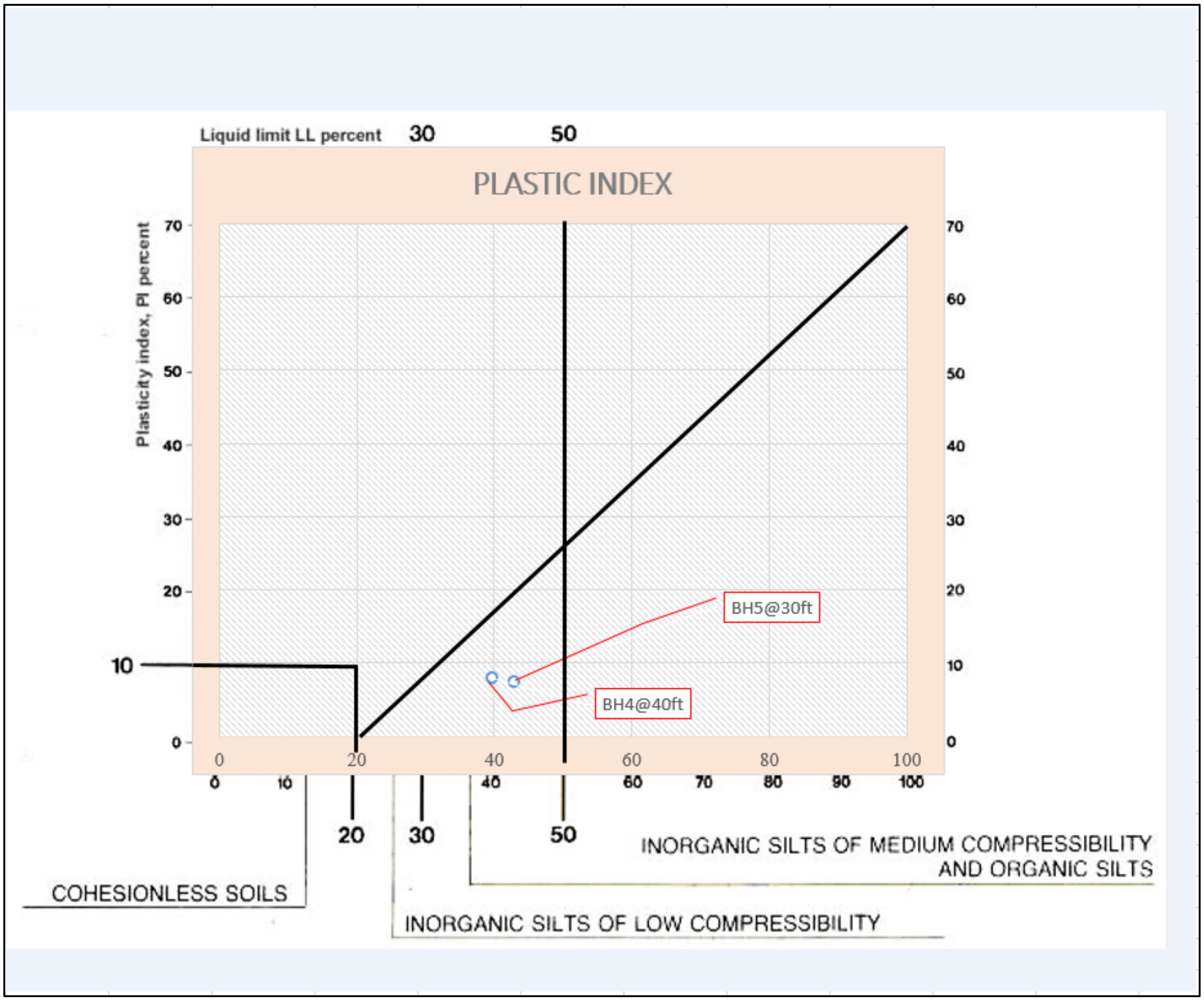


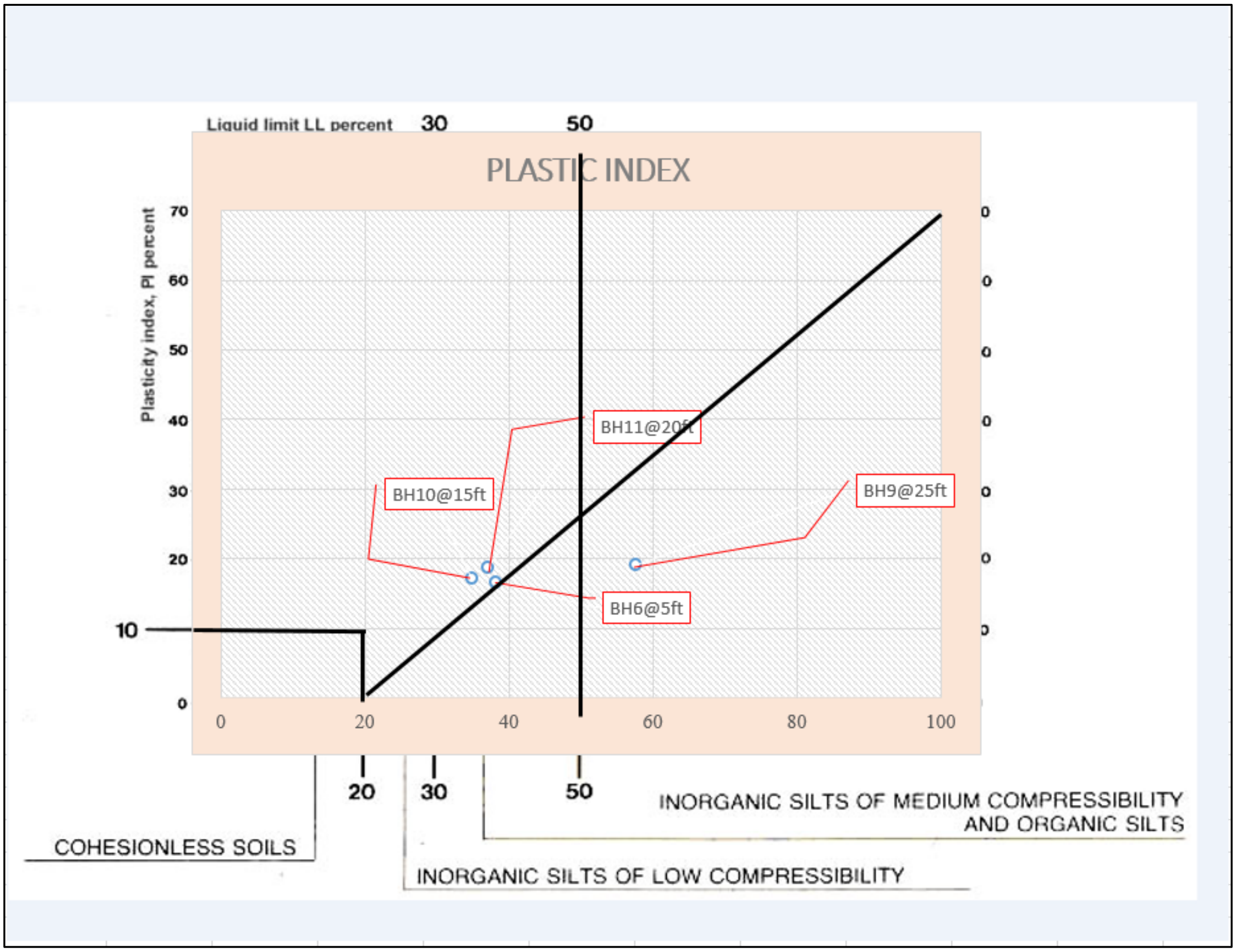
Remarks

Silt Soil of Intermediate Plasticity (MI)

NATURAL WATER CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTIC INDEX
	42.80	35.31	7.49

APPENDIX 3: CASAGRANDE PLASTICITY CHART




Liquid limit LL percent
30
50
PLASTIC INDEX
Plasticity index, PI percent
70
60
50
40
30
20
10
0
0
20
40
60
80
100
BH11@20ft
BH10@15ft
BH9@25ft
BH6@5ft
20
30
50
COHESIONLESS SOILS
INORGANIC SILTS OF MEDIUM COMPRESSIBILITY AND ORGANIC SILTS
INORGANIC SILTS OF LOW COMPRESSIBILITY

APPENDIX 4: SIEVE ANALYSIS RESULTS

LABORATORY TEST REPORT

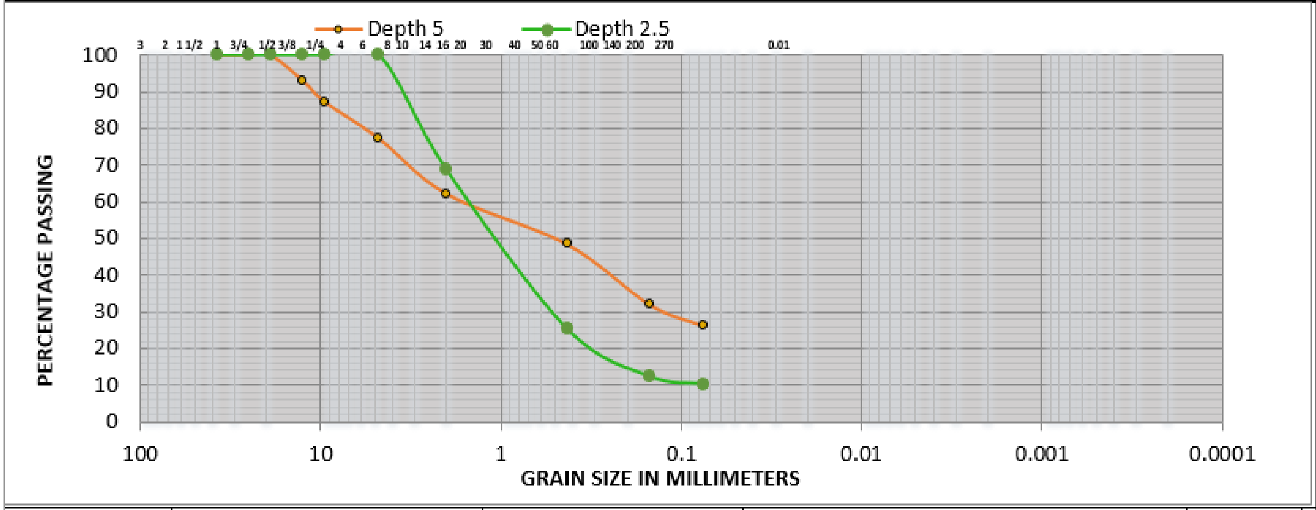
CLIENT NAME:	**PROJECT NAME:**		**REPORT DATE:**
	Mammee Bay		March 30, 2023
CLIENT ADDRESS:	**SAMPLE SOURCE:**		**DATE TESTED:**
	Rotary Drilling/ Subsurface		March 30, 2023
CLIENT REP:.	**SAMPLE TYPE .:**		**REPORT No.:**
	Split Spoon Sample		

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :1						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 5	100	100	100	93.0	87.3	77.3	62.2	48.5	32.1	26.3
PERCENTAGE PASSING 2.5	100	100	100	100.0	100.0	100.0	68.6	25.3	12.4	10.3
SPECIFICATION										

MATERIAL TYPE **BH1@2.5FT: Gravelly SAND with some Silt,** **BH1@5Ft: Silty GRAVEL & SAND**

5



Gravel		**Sand**			**Clay & Silt**
Coarse	Fine	Coarse	Medium	Fine	

LABORATORY TEST REPORT

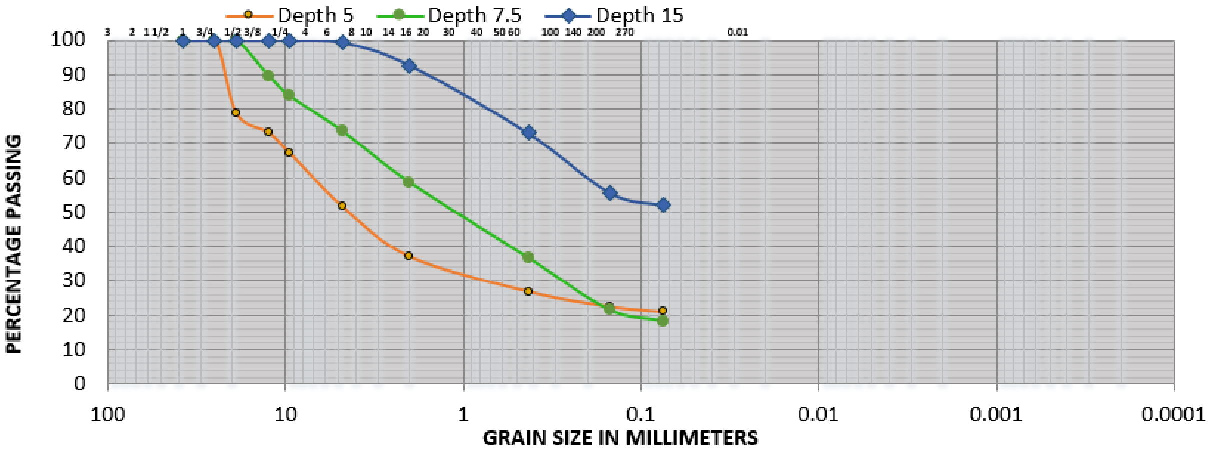
CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
	Mammee Bay	March 30, 2023
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
	Rotary Drilling/ Subsurface	March 30, 2023
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :3					**DEPTH:**					
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 5	100	100	78.8	73.2	67.3	51.5	37.1	27.0	22.6	21.0
PERCENTAGE PASSING 7.5	100	100	100	89.7	83.8	73.4	58.6	36.7	21.6	18.3
PERCENTAGE PASSING 15	100	100	100	100.0	100.0	99.3	92.7	73.0	55.7	52.0
SPECIFICATION										

MATERIAL TYPE BH3@5Ft: Silty GRAVEL with some Sand, BH3@7.5: SAND & GRAVEL with some Silt, BH3@15: SILT & SAND

5



	Gravel			**Sand**			**Clay & Silt**	
	Coarse		Fine	Coarse	Medium	Fine		

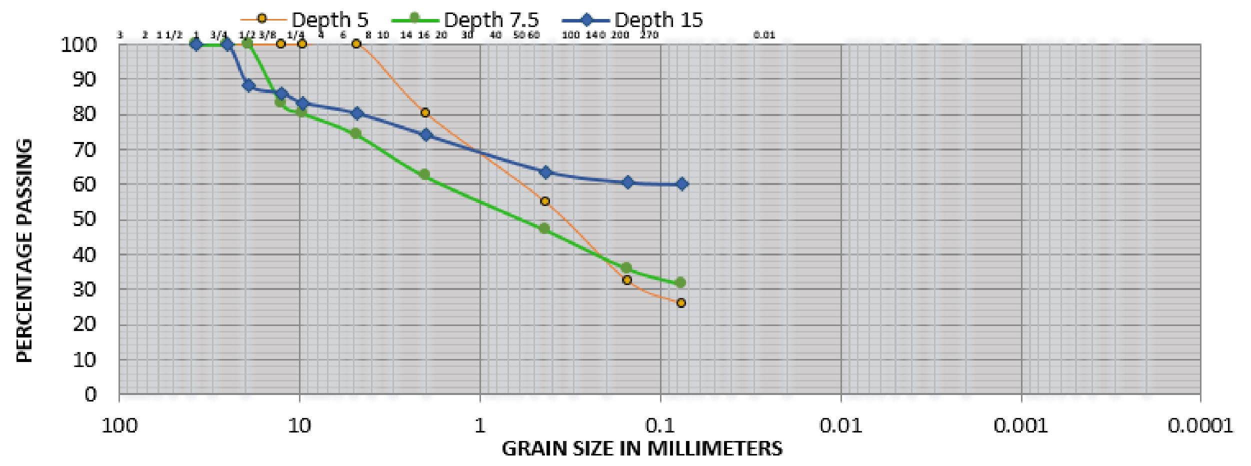
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
	Mammee Bay	March 30, 2023
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
	Rotary Drilling/ Subsurface	March 30, 2023
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :4						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 2.5	100	100	100	100.0	100.0	100.0	80.4	54.9	32.3	25.8
PERCENTAGE PASSING 7.5	100	100	100	83.1	80.3	74.1	62.3	46.9	35.8	31.4
PERCENTAGE PASSING 15	100	100	88.3	86.0	83.2	80.2	74.1	63.6	60.5	59.9
SPECIFICATION										
MATERIAL TYPE	BH4@5FT: Gravelly Silty SAND, BH4@7.5FT: Sandy Silty GRAVEL, BH4@15FT: Gravelly SILT with some Sand									

5



	Gravel			**Sand**			**Clay & Silt**
	Coarse		Fine	Coarse	Medium	Fine	

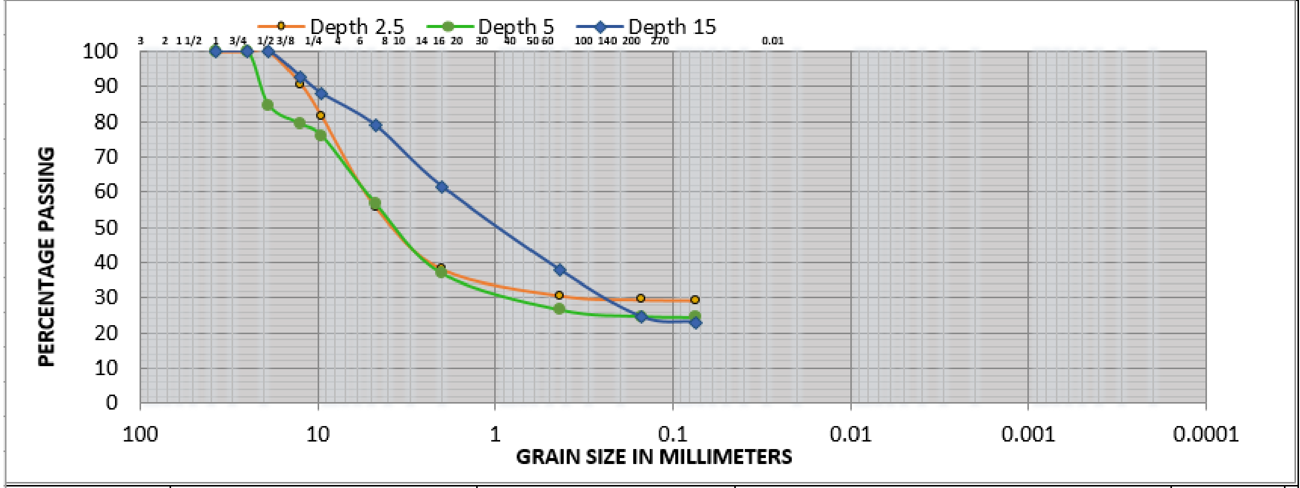
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
	Mammee Bay	March 30, 2023
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
	Rotary Drilling/ Subsurface	March 30, 2023
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :5					**DEPTH:**					
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 2.5	100	100	100	90.7	81.4	55.9	38.1	30.6	29.5	29.3
PERCENTAGE PASSING 5	100	100	84.6	79.2	75.9	56.7	36.8	26.5	24.7	24.4
PERCENTAGE PASSING 20	100	100	100	92.6	87.8	78.8	61.4	37.6	24.4	22.9
SPECIFICATION										
MATERIAL TYPE	BH5@2.5:Silty GRAVEL ,			BH5@5FT: Silty GRAVEL with some Sand,				BH5@15FT: Silty GRAVEL & SAND		

5



	Gravel		**Sand**			**Clay & Silt**	
	Coarse	Fine	Coarse	Medium	Fine		

LABORATORY TEST REPORT

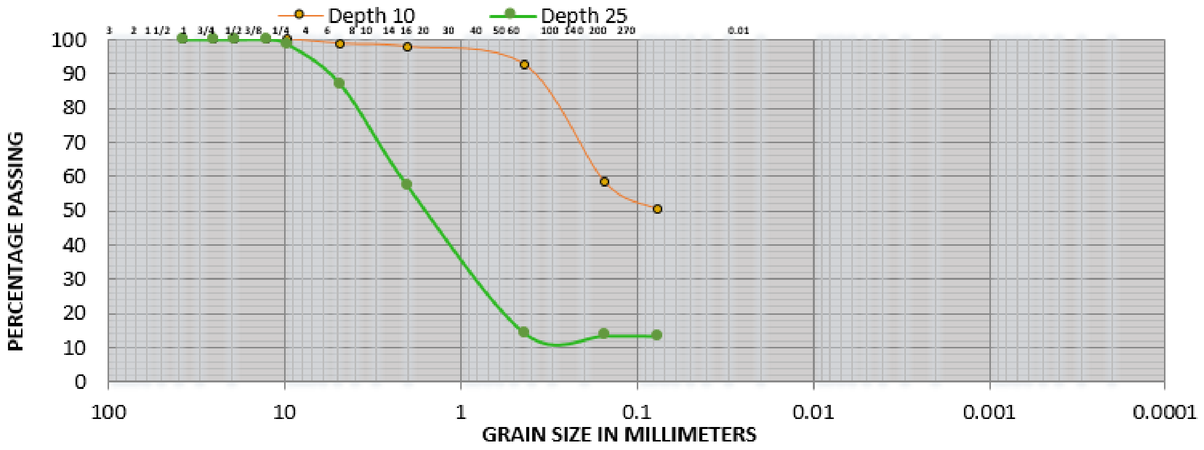
CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
China Harbour Engineering	Mammee Bay	March 05, 2021
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
St. Lucia Avenue	Rotary Drilling/ Subsurface	March 04, 2021
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
Herona Thompson (ESL)	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :6					**DEPTH:**					
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 10	100	100	100	100.0	100.0	98.7	97.8	92.5	58.3	50.4
PERCENTAGE PASSING 25	100	100	100	100.0	98.6	86.7	57.3	14.2	13.6	13.5
SPECIFICATION										

MATERIAL TYPE **BH6@10FT-Brown CLAY and SAND, BH6@25- Brown SAND & GRAVEL with some Clay**

5



	Gravel		**Sand**			**Clay & Silt**	
	Coarse	Fine	Coarse	Medium	Fine		

LABORATORY TEST REPORT

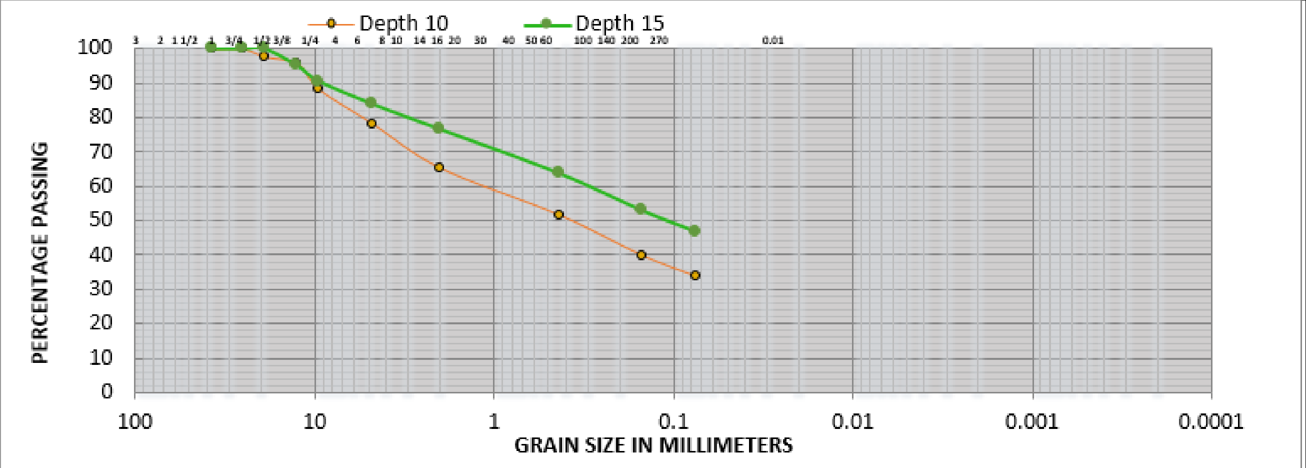
CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
China Harbour Engineering	Mammee Bay	March 05, 2021
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
St Lucia	Rotary Drilling/ Subsurface	March 04, 2021
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
Herona Thompson (ESL)	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :7						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 10	100	100	97.8	95.8	88.3	78.2	65.3	51.5	39.8	33.7
PERCENTAGE PASSING 15	100	100	100	95.1	90.6	83.9	76.6	63.7	53.0	46.8
SPECIFICATION										

MATERIAL TYPE **BH7@10FT- Sandy Silty GRAVEL, BH7@15FT-Gravelly SAND and SILT**

5



	Gravel		**Sand**			**Clay & Silt**
	Coarse	Fine	Coarse	Medium	Fine	

LABORATORY TEST REPORT

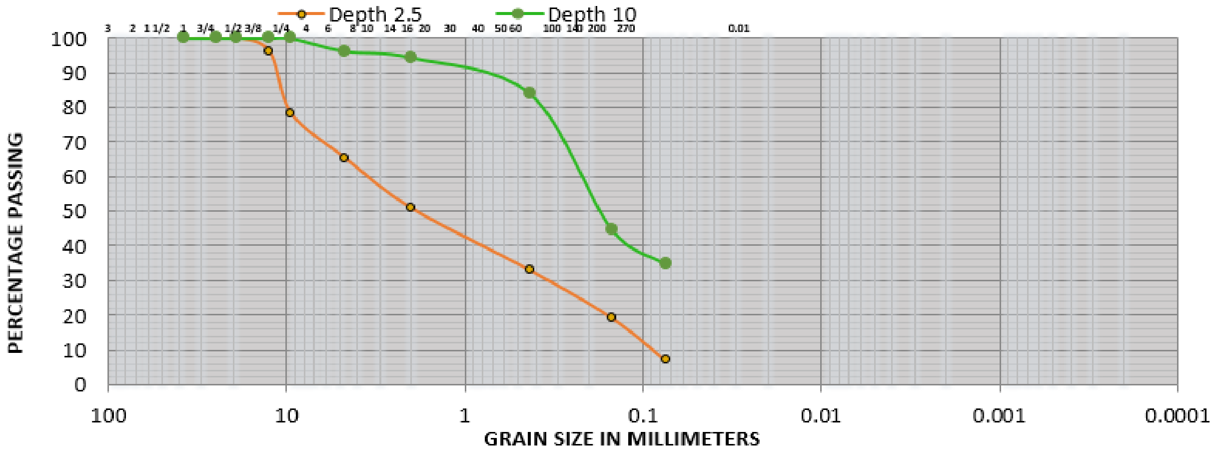
CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
China Harbour Engineering	Mammee Bay	March 05, 2021
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
St. Lucia Avenue	Rotary Drilling/ Subsurface	March 04, 2021
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
Herona Thompson (ESL)	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

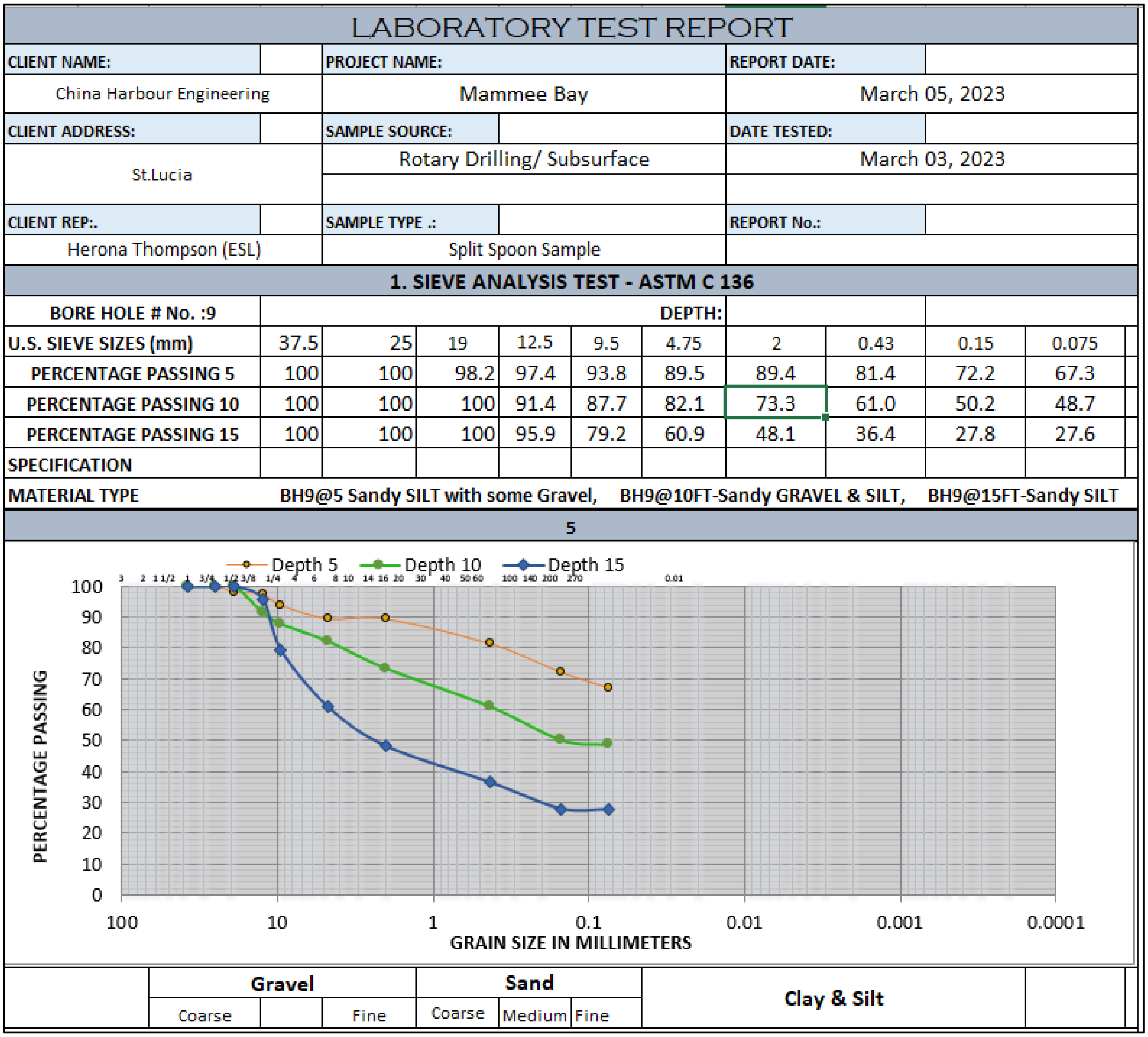
BORE HOLE # No. :8					**DEPTH:**					
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 2.5	100	100	100	96.0	78.3	65.5	50.9	32.9	19.2	7.0
PERCENTAGE PASSING 10	100	100	100	100.0	100.0	96.3	94.4	83.9	44.7	34.7
SPECIFICATION										

MATERIAL TYPE **BH8@2.5FT- Brown GRAVEL & SAND BH8@10FT-Brown Silty Sand**

5



	Gravel			**Sand**			**Clay & Silt**
	Coarse		Fine	Coarse	Medium	Fine	



LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
China Harbour Engineering	Mammee Bay	March 05, 2023
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
St.Lucia	Rotary Drilling/ Subsurface	March 03, 2023
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
Herona Thompson (ESL)	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :9 **DEPTH:**

U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 5	100	100	98.2	97.4	93.8	89.5	89.4	81.4	72.2	67.3
PERCENTAGE PASSING 10	100	100	100	91.4	87.7	82.1	73.3	61.0	50.2	48.7
PERCENTAGE PASSING 15	100	100	100	95.9	79.2	60.9	48.1	36.4	27.8	27.6
SPECIFICATION										

MATERIAL TYPE **BH9@5 Sandy SILT with some Gravel, BH9@10FT-Sandy GRAVEL & SILT, BH9@15FT-Sandy SILT**

5

	Gravel			**Sand**			**Clay & Silt**
	Coarse		Fine	Coarse	Medium	Fine	

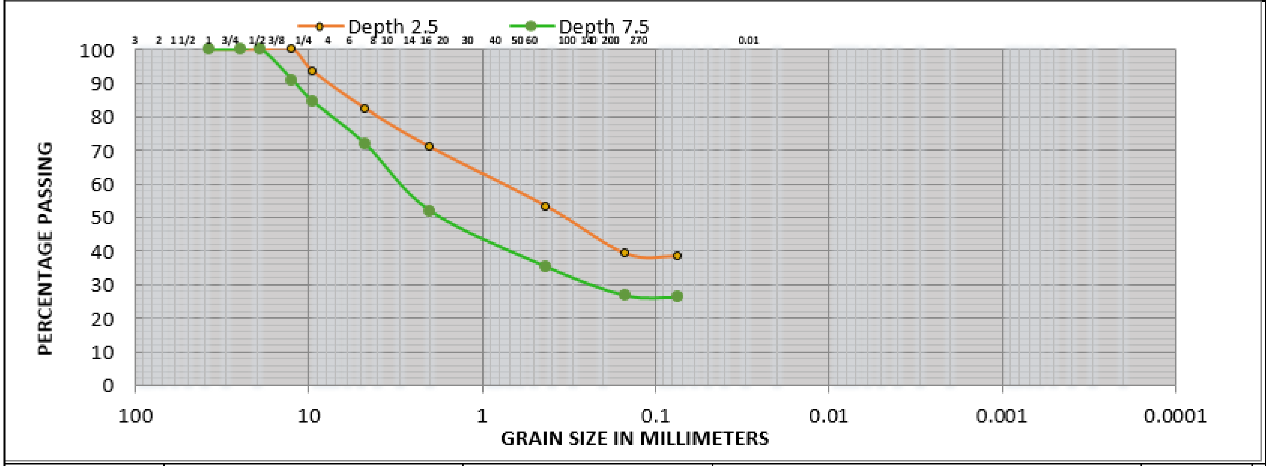
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
China Harbour Engineering	Mammee Bay	March 05, 2021
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
St. Lucia Avenue	Rotary Drilling/ Subsurface	March 04, 2021
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
Herona Thompson (ESL)	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :10						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 2.5	100	100	100	100.0	93.4	82.4	71.0	53.4	39.3	38.4
PERCENTAGE PASSING 7.5	100	100	100	90.8	84.4	72.0	52.0	35.4	26.8	26.2
SPECIFICATION										
MATERIAL TYPE	**BH10@2.5 Brown Gravelly SAND & CLAY BH10@7.5FT- Sandy Clayey GRAVEL**									

5



	Gravel		**Sand**			**Clay & Silt**	
	Coarse	Fine	Coarse	Medium	Fine		

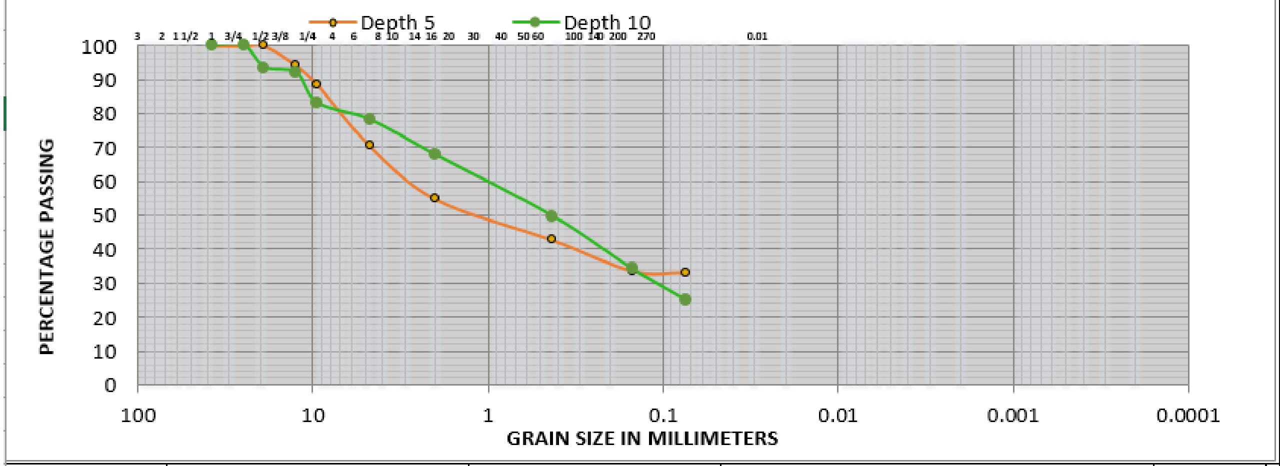
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
China Harbour Engineering	Mammee Bay	March 05, 2021
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
St. Lucia Avenue	Rotary Drilling/ Subsurface	March 04, 2021
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
Herona Thompson (ESL)	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :11					**DEPTH:**					
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 5	100	100	100	94.2	88.6	70.5	54.8	42.8	33.7	33.3
PERCENTAGE PASSING 10	100	100	93.6	92.0	83.1	78.2	67.8	49.8	34.2	25.2
SPECIFICATION										
MATERIAL TYPE	**Brown Silty Sand**									

5



	Gravel		**Sand**			**Clay & Silt**	
	Coarse	Fine	Coarse	Medium	Fine		

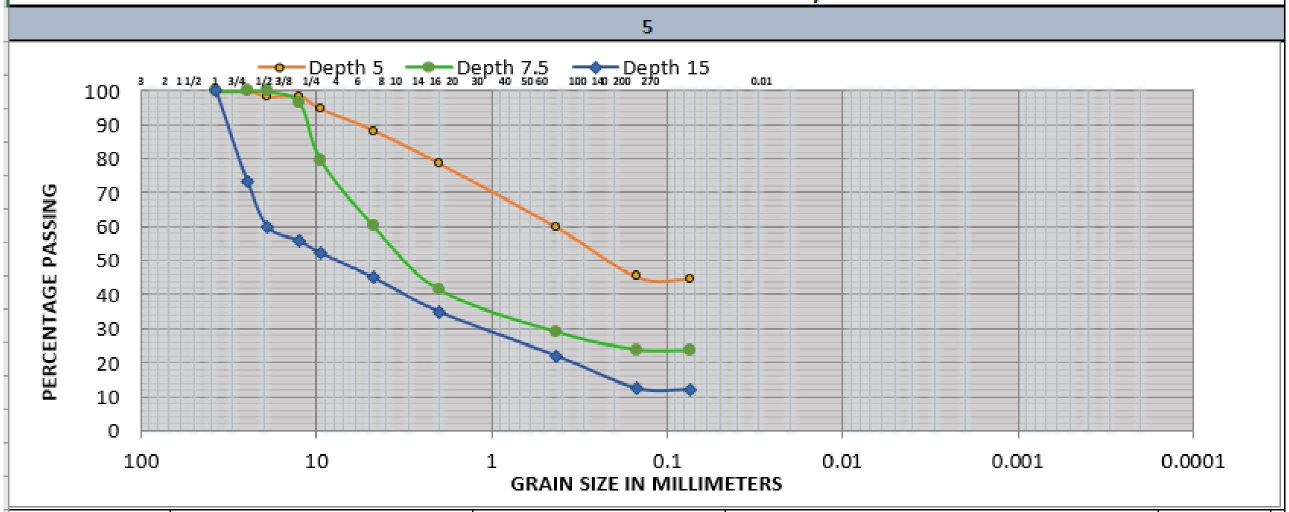
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
China Harbour Engineering	Mammee Bay	March 05, 2023
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
St.Lucia	Rotary Drilling/ Subsurface	March 03, 2023
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
Herona Thompson (ESL)	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :12						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 5	100	100	98.2	98.4	94.6	88.3	78.6	59.9	45.4	44.6
PERCENTAGE PASSING 7.5	100	100	100	96.5	79.7	60.2	41.4	29.0	23.8	23.6
PERCENTAGE PASSING 15	100	73.5	59.9	55.8	52.2	45.0	34.9	21.9	12.4	12.0
SPECIFICATION										
MATERIAL TYPE	**Brown Silty Sand**									

5



	Gravel		**Sand**			**Clay & Silt**
	Coarse	Fine	Coarse	Medium	Fine	

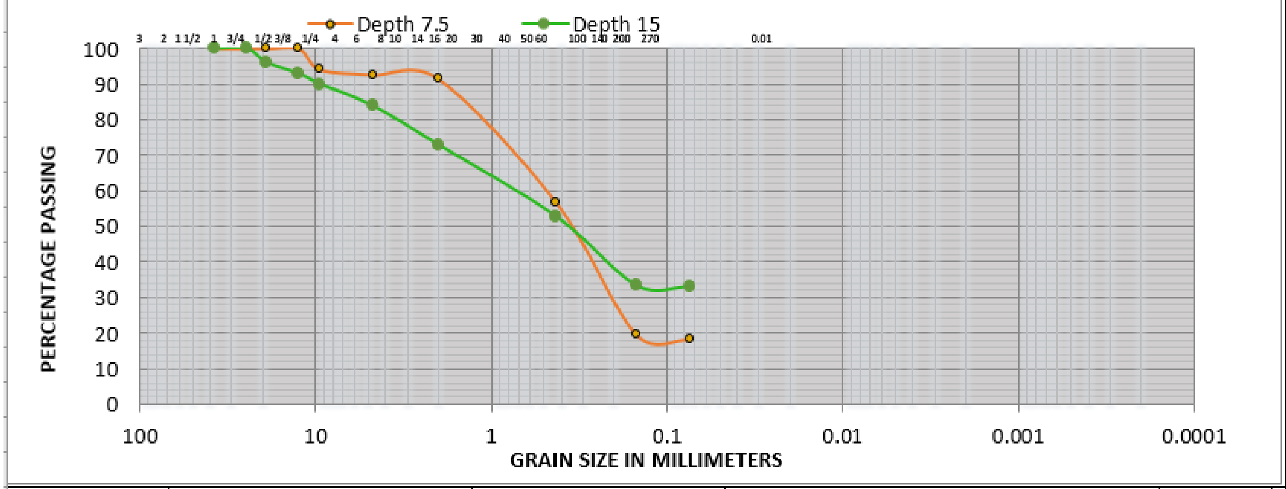
LABORATORY TEST REPORT

CLIENT NAME:	**PROJECT NAME:**	**REPORT DATE:**
China Harbour Engineering	Mammee Bay	March 05, 2021
CLIENT ADDRESS:	**SAMPLE SOURCE:**	**DATE TESTED:**
St. Lucia Avenue	Rotary Drilling/ Subsurface	March 04, 2021
CLIENT REP:.	**SAMPLE TYPE .:**	**REPORT No.:**
Herona Thompson (ESL)	Split Spoon Sample	

1. SIEVE ANALYSIS TEST - ASTM C 136

BORE HOLE # No. :13						**DEPTH:**				
U.S. SIEVE SIZES (mm)	37.5	25	19	12.5	9.5	4.75	2	0.43	0.15	0.075
PERCENTAGE PASSING 7.5	100	100	100	100.0	94.2	92.7	91.5	56.9	19.6	18.1
PERCENTAGE PASSING 15	100	100	96	92.9	90.0	83.9	72.9	52.9	33.5	33.1
SPECIFICATION										
MATERIAL TYPE	**Brown Silty Sand**									

5



	Gravel			**Sand**			**Clay & Silt**
	Coarse		Fine	Coarse	Medium	Fine	

APPENDIX 5: TEST PIT LOGS

Test Pit 1- Comprising upper 8" of Grey Brown Silty SAND underlain by yellowish brown weathered calcareous Silty SAND.

Test Pit 2. Comprising thin upper layer of Brown Silty Sand (0.3m Topsoil) underlain by compact Limestone marlstone and Limestone Boulders.

(Test pit abandoned due to compact marlstone encountered at 2 ft).

Test Pit 3: Upper 12” of dark grey topsoil underlain by yellowish grey-brown weathered limestone Gravelly Silty SAND.

Test Pit 4: Reddish Brown soil to 24’’. This surficial soil horizon is underlain by large limestone boulders. Of note, the underlying limestone rock mass is not visible in the photograph as the rock mass is draped by the reddish-brown topsoil.

(Test pit was abandoned due to difficulty of excavation in limestone bedrock).

Test Pit 5: Upper 8-16” of Grey Brown Silty SAND underlain by Yellowish-Grey Brown calcareous Silty SAND.

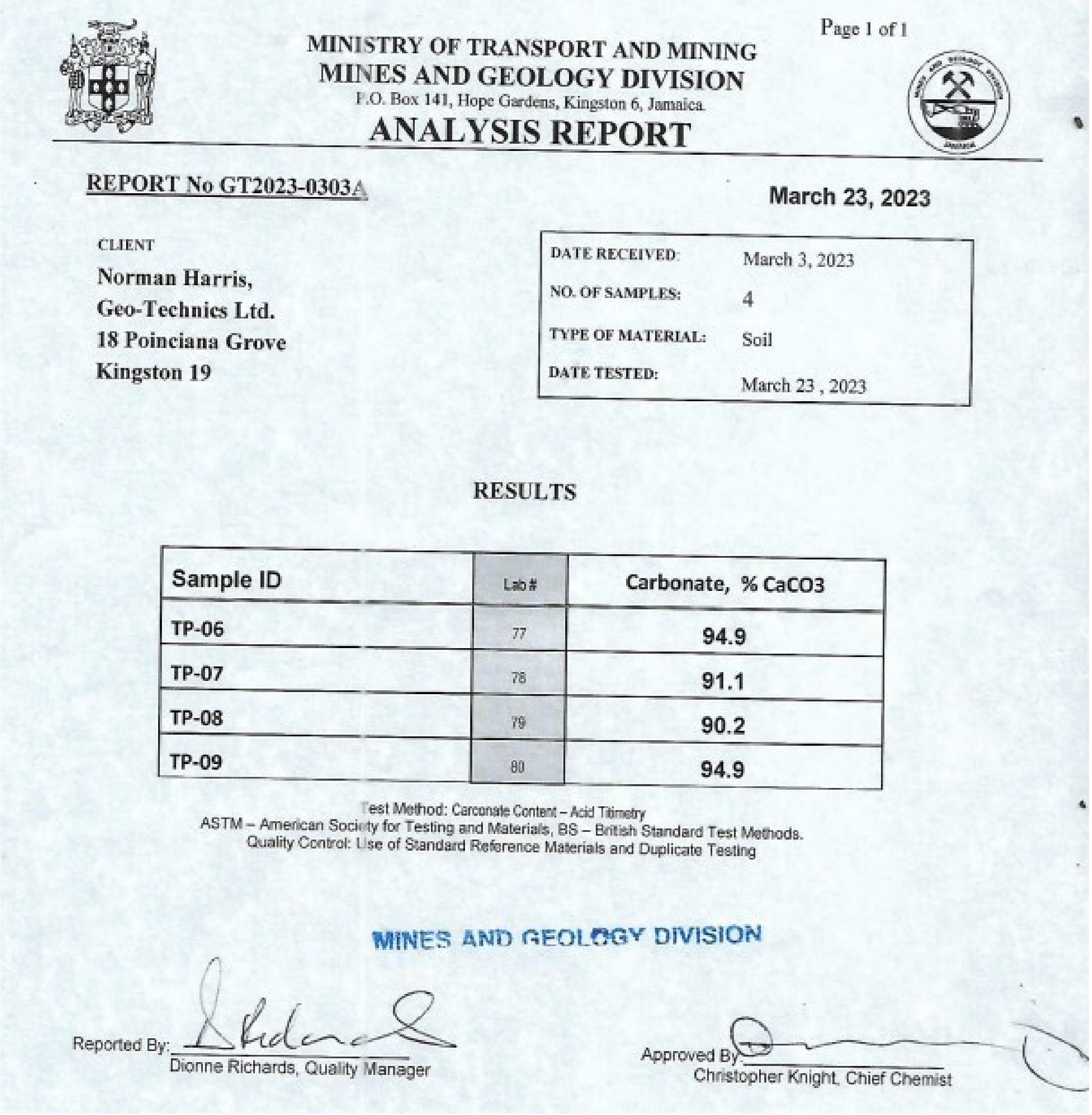
Test Pit 6: Upper 12" of dark grey topsoil underlain by yellowish Brown Calcareous Silty SAND to 5.5 ft.

Test Pit 7: Upper 8" of dark grey topsoil underlain by Yellowish Cream-Brown Calcareous Silty SAND. Test pit excavated to 9 ft.

Test Pit 8: Upper 14" of dark grey topsoil underlain by Yellowish Brown Calcareous Silty SAND.

Test Pit 9: Comprising of an upper layer of Grey Brown Topsoil, underlain by yellowish Brown Silty SAND and Limestone boulders.

APPENDIX 6 : CARBONATE TEST RESULTS



Page 1 of 1

MINISTRY OF TRANSPORT AND MINING
MINES AND GEOLOGY DIVISION
P.O. Box 141, Hope Gardens, Kingston 6, Jamaica.

ANALYSIS REPORT

REPORT No GT2023-0303A

March 23, 2023

CLIENT

Norman Harris,
Geo-Technics Ltd.
18 Poinciana Grove
Kingston 19

DATE RECEIVED:	March 3, 2023
NO. OF SAMPLES:	4
TYPE OF MATERIAL:	Soil
DATE TESTED:	March 23 , 2023

RESULTS

Sample ID	Lab #	Carbonate, % $CaCO3$
TP-06	77	94.9
TP-07	78	91.1
TP-08	79	90.2
TP-09	80	94.9

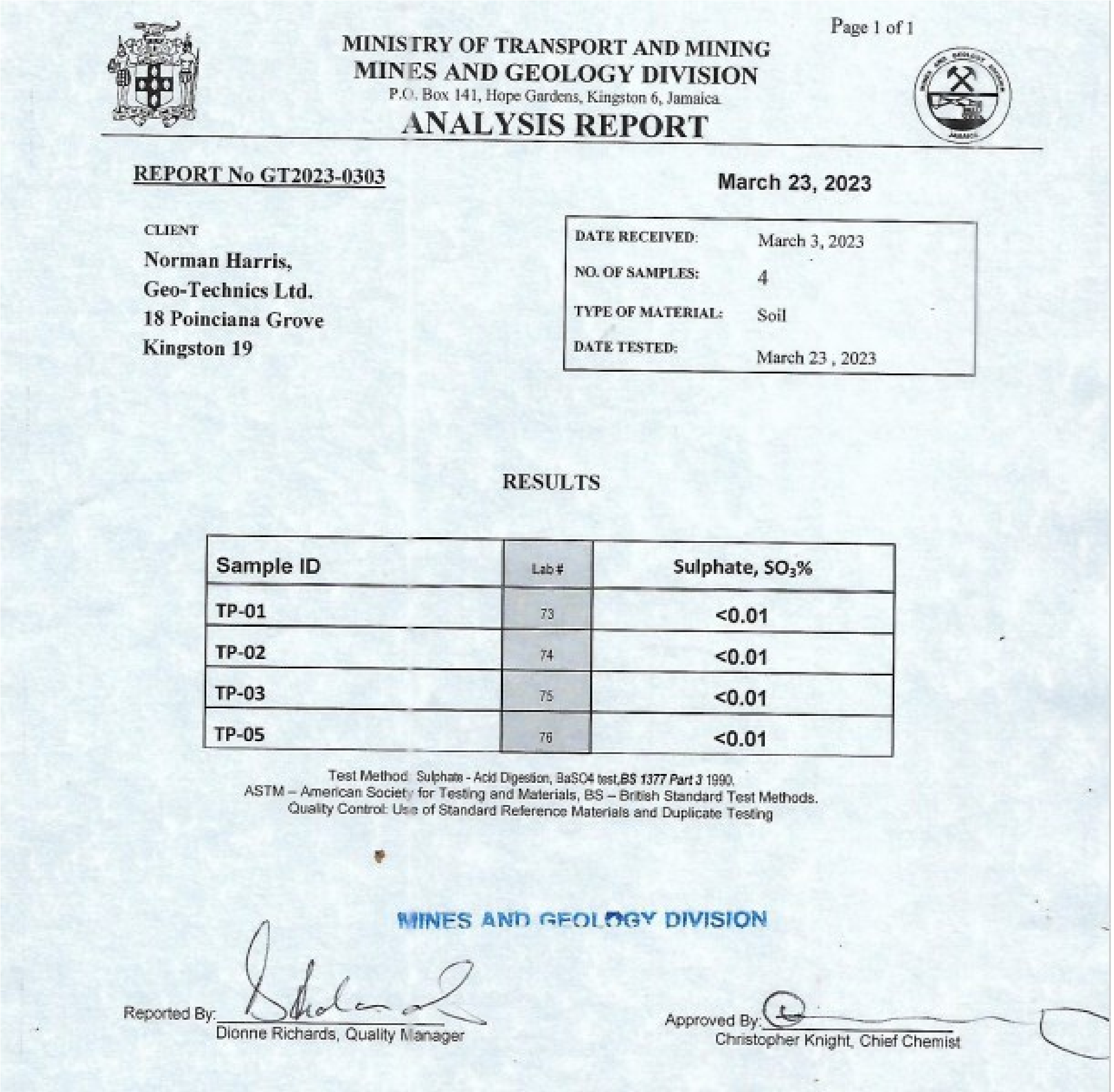
Test Method: Carconate Content – Acid Titimetry
ASTM – American Society for Testing and Materials, BS – British Standard Test Methods.
Quality Control: Use of Standard Reference Materials and Duplicate Testing

MINES AND GEOLOGY DIVISION

Reported By: ____________________
Dionne Richards, Quality Manager

Approved By: ____________________
Christopher Knight, Chief Chemist

APPENDIX 7: SULPHATE TEST RESULTS



Page 1 of 1

MINISTRY OF TRANSPORT AND MINING
MINES AND GEOLOGY DIVISION
P.O. Box 141, Hope Gardens, Kingston 6, Jamaica.

ANALYSIS REPORT

REPORT No GT2023-0303

March 23, 2023

CLIENT
Norman Harris,
Geo-Technics Ltd.
18 Poinciana Grove
Kingston 19

DATE RECEIVED:	March 3, 2023
NO. OF SAMPLES:	4
TYPE OF MATERIAL:	Soil
DATE TESTED:	March 23 , 2023

RESULTS

Sample ID	Lab #	Sulphate, SO_3%
TP-01	73	<0.01
TP-02	74	<0.01
TP-03	75	<0.01
TP-05	76	<0.01

Test Method: Sulphate - Acid Digestion, BaSO4 test,*BS 1377 Part 3* 1990.
ASTM – American Society for Testing and Materials, BS – British Standard Test Methods.
Quality Control: Use of Standard Reference Materials and Duplicate Testing

MINES AND GEOLOGY DIVISION

Reported By: ______________
Dionne Richards, Quality Manager

Approved By: ______________
Christopher Knight, Chief Chemist

APPENDIX 8: CLASSIFICATION OF SULPHATES IN SOIL BASED ON SULPHATE CONTENT (SOURCE: TOMLINSON 1991)

CLASSIFICATION of SULPHATE SOIL CONDITIONS	**RECOMMENDATIONS AND PRECAUTIONS BASED ON TYPE OF MATERIAL**			
SO_3 in Soil (total %)	**Precast concrete products (piles, cylinders, blockwork)**	**Massive concrete in foundations (including pile caps)**	**Thin concrete sections in basements, culverts, pipes and manholes**	**Concrete in cast-in-place piles**
Less than 0.2	No special precautions	*If foundations wholly above the water table$^{2)}$ no special precautions necessary. *If foundations are in contact with a fluctuating water table, use normal Portland cement (cement content not less than 310 kg/m$^{(3)}$, Max. W/C 0.55)	*If structures wholly above the water table$^{(2)}$ use normal Portland cement (cement content not less than 310 kg/m$^{(3)}$, Max. W/C 0.55). *If structures are subjected to external water pressure use normal Portland cement (cement content not less than 350 kg/m$^{(3)}$, Max. W/C 0.55). Alternatively, apply asphalt or other membrane as tanking.	*If piles wholly above the water table use normal Portland cement (cement content not less than 330 kg/m$^{(3)}$, Max. W/C 0.55). *If piles are in contact with a fluctuating water table use normal Portland cement (cement content not less than 340 kg/m$^{(3)}$, Max. W/C 0.55).
0.2 – 0.5	*If structures wholly above the water table$^{(2)}$ use normal Portland cement (cement content not less than 310 kg/m$^{(3)}$, Max. W/C 0.50). *If structures are in contact with a fluctuating water table use normal Portland cement (cement content not less than 330 kg/m$^{(3)}$, Max. W/C 0.50), or sulphate-resisting cement (cement content not less than 290 kg/m$^{(3)}$, Max. W/C 0.50).	*If foundations wholly above the water table$^{(2)}$ use normal Portland cement (cement content not less than cement 330 kg/m$^{(3)}$, Max. W/C 0.50). *If foundations are in contact with a fluctuating water table use normal Portland cement (cement content not less than cement 350 kg/m$^{(3)}$, Max. W/C 0.50), or sulphate-resisting cement (cement content not less than 310 kg/m$^{(3)}$, Max. W/C 0.50).	* If structures wholly above the water table$^{(2)}$ use normal Portland cement (cement content not less than 370 kg/m$^{(3)}$, Max. W/C 0.50). *If structures are subjected to external water pressure use normal Portland cement (cement content not less than 370 kg/m$^{(3)}$, Max. W/C 0.55), or sulphate-resisting cement (cement content not less than 370 kg/m$^{(3)}$, Max. W/C 0.50). **Alternatively, apply asphalt or other membrane as tanking**.	*If piles wholly above the water table use normal Portland cement (cement content not less than 370 kg/m$^{(3)}$, Max. W/C 0.55). *If piles are in contact with a fluctuating water table use normal Portland cement (cement content not less than 370 kg/m$^{(3)}$, Max. W/C 0.55). or sulphate-resisting cement (cement content not less than 370 kg/m$^{(3)}$, Max. W/C 0.50).

CLASSIFICATION of SULPHATE SOIL CONDITIONS	**RECOMMENDATIONS AND PRECAUTIONS BASED ON TYPE OF MATERIAL**			
SO_3 in Soil (total %)	**Precast concrete products (piles, cylinders, blockwork)**	**Massive concrete in foundations (including pile caps)**	**Thin concrete sections in basements, culverts, pipes and manholes**	**Concrete in cast-in-place piles**
0.5 to 1.0	*If structures wholly above the water table(2) use normal Portland cement (cement content not less than 330 kg/m(3), Max. W/C 0.50), or sulphate-resisting cement (cement content not less than 290 kg/m(3), Max. W/C 0.50). * If structures are in contact with a fluctuating water table use normal Portland cement (cement content not less than 330 kg/m(3), Max. W/C 0.50),	*If foundations wholly above the water table(2) use normal Portland cement (cement content not less than cement 350 kg/m(3), Max. W/C 0.50), or sulphate-resisting cement (cement content not less than 340 kg/m(3), Max. W/C 0.50. * If foundations are in contact with a fluctuating water table use sulphate-resisting cement (cement content not less than 350 kg/m(3), Max. W/C 0.50),	* If structures wholly above the water table(2) use normal Portland cement (cement content not less than 370 kg/m(3), Max. W/C 0.55), or sulphate-resisting cement (cement content not less than 370 kg/m(3), Max. W/C 0.50. * If structures are subjected to external water pressure use sulphate-resisting cement (cement content not less than 370 kg/m(3), Max. W/C 0.50). Alternatively, apply asphalt or other membrane as tanking.	* If piles wholly above the water table use normal Portland cement (cement content not less than 370 kg/m(3), Max. W/C 0.55), or sulphate-resisting cement (cement content not less than 370 kg/m(3), Max. W/C 0.50. * If piles are in contact with a fluctuating water table use normal Portland cement (cement content not less than 370 kg/m(3), Max. W/C 0.55) for end bearing piles only.

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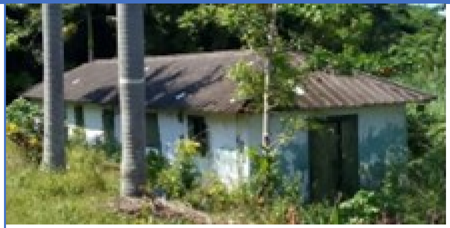
I. Heritage Mitigation and Recommendations

Repair and repurposing are recommended as mitigation measures for existing structures. The walls of the Mammee Bay mill house (waterwheel) should be stabilized and capped. Monuments should be erected in the vicinity of the Redware and Taíno sites in memory of these early peoples. A watching brief should be in place to allow for salvage archaeology.

Table 1 Heritage Sites and Mitigation

#	Visual/Picture	Heritage Sites	Location GPS Coordinates	Description	Mitigation
1		Roaring River Estate Great House	18o 24' 32" N; 77o 09' 16" W	Building in use	Repair and continue usage. Prepare storyboard on the Mammee Bay site to include narratives of the great house and the Redware culture sites; Establish a boundary around the Great house site. and protect by designating it a National Heritage site under the JNHT Act.
2		Roaring River Estate Ancillary Building 1 - Building north west of great house	18o 24' 33" N; 77o 09' 17" W		Repair and use
3		Roaring River Estate Ancillary Buildings Cluster due south of great house	18o 24' 31" N; 77o 09' 16" W	Buildings in use	Repair and continue usage
4	na	Estate Ancillary Building 2 - Structure due west of great house	18o 24' 32"N; 77o 09' 14" W		Repair and use

#	Visual/Picture	Heritage Sites	Location GPS Coordinates	Description	Mitigation
5	na	Roaring River Taíno Site	18o 24' 31"N; 77o 09' 16 W	Overgrown area south of Roaring River Great house overlooking sea	Erect monument in the general vicinity of site in remembrance of these people
6		Mammee Bay Estate Aqueduct Ruins	18o 25' 15" N; 77o 09' 11" W	Only remnants of this aqueduct remain	Include narrative of the Aqueduct in the storyboard located at the mill house
7		Mammee Bay Estate Water Wheel	18o 25' 24" N; 77o 09' 30"W	Area around the structure being landscaped	Managers should repair and stabilize walls of the mill house; make access areas secure for visitor movement;
8	na	Mammee Bay Estate Great House Ruins	18o 25' 22" N; 77o 09' 29" W	Within an overgrown area of the property. Only walls standing - no roof	No mitigation recommended, but include narrative on great house in storyboard.
9	Watching brief to be in place generally during the construction of roadways, tanks, houses other structures. (See methodology)				

Table 2: Mitigation Measures for Potential Impacts on the various resource heritage assets

Resource Heritage Assets	**Potential Impact**	**Duration**		**Magnitude**		**Form**		**Mitigation**
		Long	**Short**	**Major**	**Minor**	**Reversible**	**Irreversible**	
Roaring River Estate Great House	Negative Impact: Damage by activities resulting from heavy equipment working in construction Positive Impact: Improved access to the great house	**X**		**X**			**X**	Restore the building and continue usage. Prepare storyboard on the Mammee Bay site to include narratives of the great house and the Redware culture sites; demark an area in or near the great house to place this and other storyboards telling of the history of the properties. Watching brief should be in place when construction work is being carried out I this area
Roaring River Estate Ancillary Building 1 - Building north west of great house	Negative Impact: Damage by activities resulting from heavy equipment working in construction Positive Impact: Improved access	**X**		**X**			**X**	Repair and continue usage
Roaring River Estate Ancillary Buildings Cluster due south of great house	Negative Impact: Damage by activities resulting from heavy equipment working in construction Positive Impact: Improved access	**X**		**X**			**X**	Repair and continue usage

Resource Heritage Assets	Potential Impact	Duration		Magnitude		Form		Mitigation
		Long	Short	Major	Minor	Reversible	Irreversible	
Estate Ancillary Building 2 - Structure due west of great house	Negative Impact: Positive Impact: Improved access	X		X			X	Repair and continue usage
Roaring River Taíno Site	Negative Impact: Construction activity by way of heavy earth moving equipment may destroy the site. Positive Impact: With an effective watching brief, the site will be located.	X		X			X	The site in question is the Taino site located behind the Great House on the southern side of the road forming the boundary between the CHEC property and that of the UDC. An expedient lithic artefact was obtained from the site. This item was used by the Taínos for the purpose of inhaling the hallucinogen, cohoba. Salvage archaeological work was conducted north of the site to determine its northern boundary. The area of this site ought to be preserved and made into a park area with a monument erected and established as a site of memory to the ancestors. However, this task will not be the responsibility of CHEC as is falls outside of their boundary.
Mammee Bay Estate Aqueduct Ruins	Negative Impact: Damage threatened by construction activities use of heavy equipment especially during clearance of land	X		X			X	Watching brief Include narrative of the Aqueduct in the storyboard located at the great house. The aqueduct should be come a part of the design of the development and possibly be used as an attraction the base of which would be established a running or walking track for resident of the newly build compound

Resource Heritage Assets	**Potential Impact**	**Duration**		**Magnitude**		**Form**		**Mitigation**
		Long	**Short**	**Major**	**Minor**	**Reversible**	**Irreversible**	
	Positive Impact							
Mammee Bay Estate Water Wheel	Negative Impact: Construction activities by way of dust and debris . Positive Impact: may improve access to the Waterwheel Attraction	**:**	**X**		**X**	**X**		Watching brief Managers should repair and stabilize walls of the mill house; make access areas secure for visitor movement; To the extent that this Developer has access to this Water wheel attraction the Developer should take action to improve and effect the necessary repairs.
Mammee Bay Estate Great House Ruins	Negative Impact: The north/south highway has already demolished this cultural asset Positive Impact: None from a heritage perspective	NA	NA	NA	NA	NA	NA	A narrative on this great house in storyboard form should be placed in the recommended location of storyboards in or on the grounds of the present great house.
Graves	Negative Impact: Construction equipment may overturn grave stones and damage graves. Positive Impact: Graves should remain in place.	**X**		**X**			**X**	Graves are historic and should remain in place where they are presently located..

J. Salvage Archaeology Report

MAMMEE RIVER HOUSING DEVELOPMENT PROJECT SALVAGE ARCHAEOLOGY

Dr. Ivor Conolley for Environmental Solutions Ltd.
September 5, 2023

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Introduction

Objectives

To conduct archaeological investigations to determine the presence of a prehistoric site, its extent and locating artefacts, especially skeleton remains; and in the process to determine the extent of the southern border of the site on the west and east sides and to answer questions regarding the extent of the site and middens and burials.

Background

The excavation was requested by the Jamaica National Heritage Trust (JNHT) as a requisite for the completion of an Archaeological Impact Assessment forming a part of the wider Environmental Impact Assessment conducted for the Mammee River Housing Development Project.

Methodology

As recommended by the JNHT, Bucket Test Pits (BTP) are to be utilized to maximize speed up the archaeological investigations. The intention was for the bucket on the tractor/back hoe to scoop up material from the designated test points. The bucket utilized has a width of 1.47 metres and a fork depth of 31 cm. The tractor was equipped with a back hoe only. Tape and compass were used to measure in the points.

The back hoe is expected to clear the vegetation from the area under investigation. The back hoe operator was given appropriate instructions to expedite the necessary work of clearing the site and excavating the material. The site was cleared to expose the soil but not removing the topsoil initially. Subsequently, the operator was instructed to skim the surface of the designated BTP and proceed with as many passes over it as is necessary to achieve the intended purpose. The operator skimmed the surface of the unit scooping material at the approximate depth of his fork of 31 cm and place the excavated material next to the unit for inspection by the archaeologist. The archaeologist inspected both the material excavated and material in the unit itself that was loosened by the back hoe but remained in the unit.

The first back hoe pass over the designated spot was recorded as Context 1 and the second as Context 2, and so forth.

The areas to be excavated were determined by the JNHT and were located in two parts of the property. One was located east of the Roaring River Great House and the other to the west of it. Screening of material was used as necessary. Four units were placed in each area at intervals between 10 metres to 20 metres apart.

Stratigraphy were identified and the depth below surface (DBS) type of soil, and colour of soil/cultural material were recorded using Munsell soil colour charts.

Survey Location

Two areas were surveyed in, namely, Area 1 and Area 2.

Area 1: *The Wild-Cane Piece*

The permanent datum point for Area 1 was located at the fork in the dirt road east of the Great House. This permanent datum point was identified as the inner part of the letter (just above the descender or tail) of **Y** in the fork in the road near the southeastern part of the development site. GPS Location: 18 degrees 24' 23" N; 77 degrees 09' 01" W.

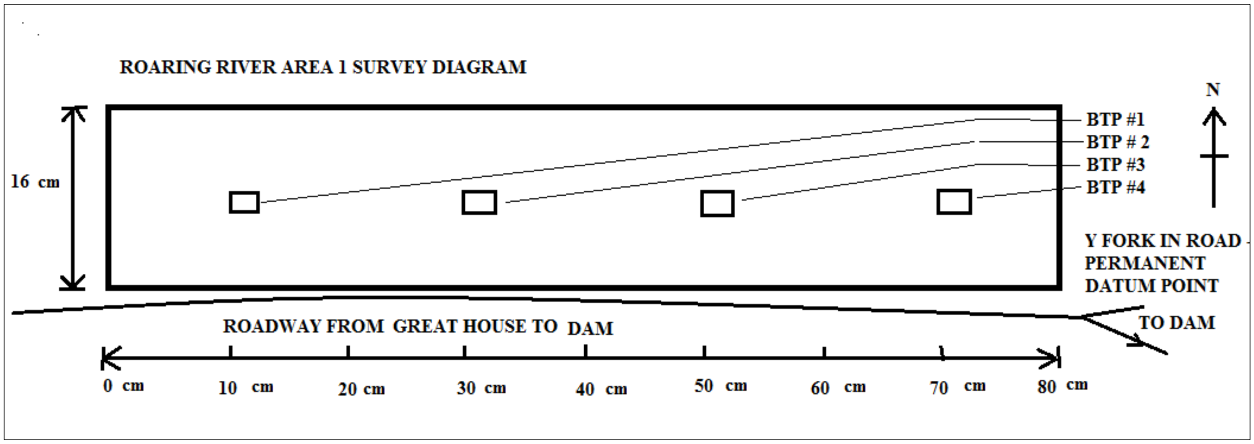


Figure 1: Survey map of Roaring River Salvage Archaeology Area 1

On this Area 1, a linear pattern of four bucket test pits was established 20 metres apart starting from the west of the area 10 metres from the edge of the cleared area, where a distance of 80 metres by 16 metres was measured in. The length of the area exposed for excavation was 16 metres by 80 metres. 80 metres ran along the length of the roadway.

Area 2: *Near the River*

The permanent datum point for Site 2 was the junction of the main dirt road to the Great House and a feeder road running parallel to the river west of the Great House. GPS location: 18 degrees 24' 35" N; 77 degrees 09' 21" W.

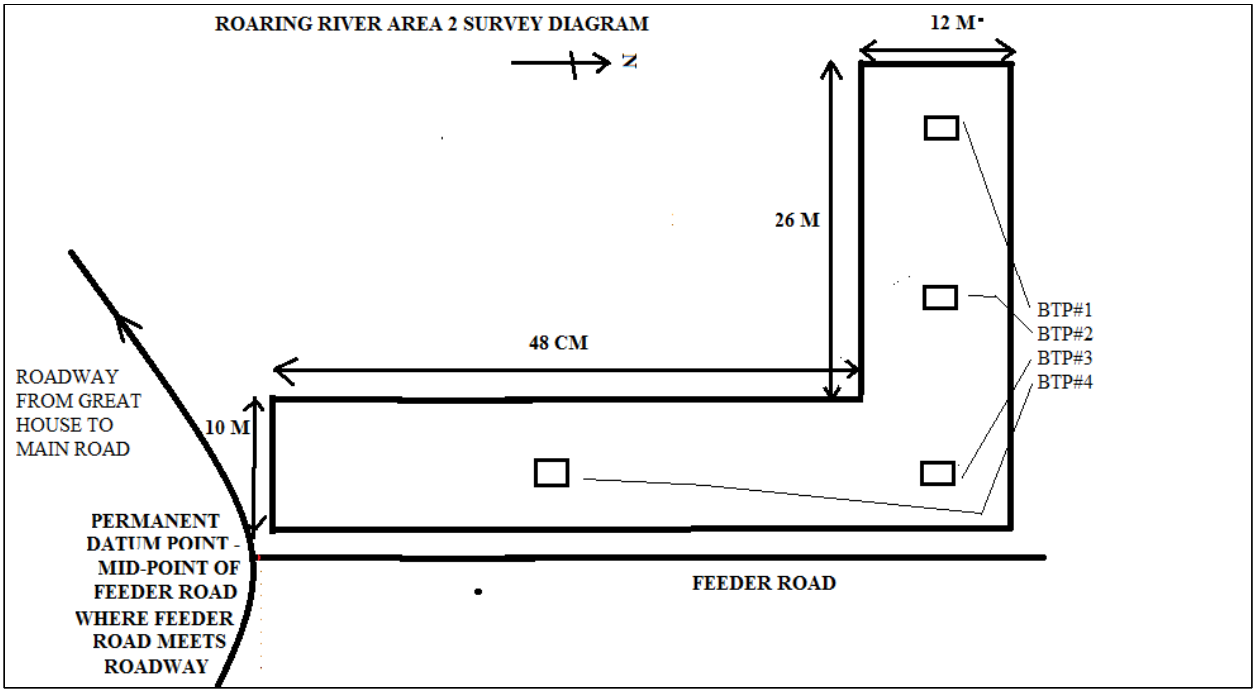


Figure 2: Survey map of Roaring River Salvage Archaeology Area 2

Four bucket test pits were established in the formation of an L. Two of these units followed and ran parallel to the feeder road and the other two were at right angles to the feeder road running in a westerly direction. The distances between BTP Unit 1, BTP Unit 2 and BTP Unit 3 were 15 metres. The distance between BTP Unit 3 and BTP Unit 4 was 30 metres.

Findings

Area 1

Table 1: SURFACE SCATTER

AREA 1 SURFACE SCATTER	Number
WHITEWARE	2
GREEN WINE BOTTLE GLASS	1
METAL BARRREL STRAP	1
METAL	1

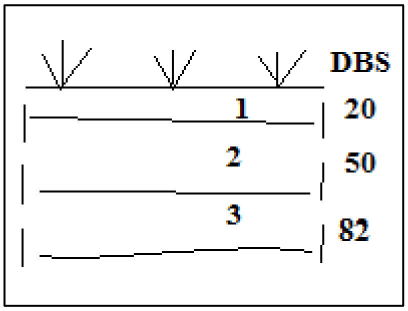


Figure 3: BTP AREA 1 UNIT 1

Context 1
DBS 20 cm
7.5YR2.5/1 REDDISH BLACK
Clay soil No pebbles and cobbles

Context 2
DBS 50 cm
7.5YR4/1 DARK REDDISH GREY
Clay soil No pebbles and cobbles

Context 3
DBS 82 cm
7.5YR8/1 WHITE - MARL BEDROCK
Marl substrate not disturbed

Table 2: AREA 1 UNIT 1

AREA 1 UNIT 1	Number
WHITEWARE	5
GREEN WINE BOTTLE GLASS	5
WINE BOTTLE GLASS WITH PETINA	1
IRON POT SHERDS	4
METAL TOOL POSSIBLY CHISEL	1
PEARLWARE	1
SHELL EDGE	1

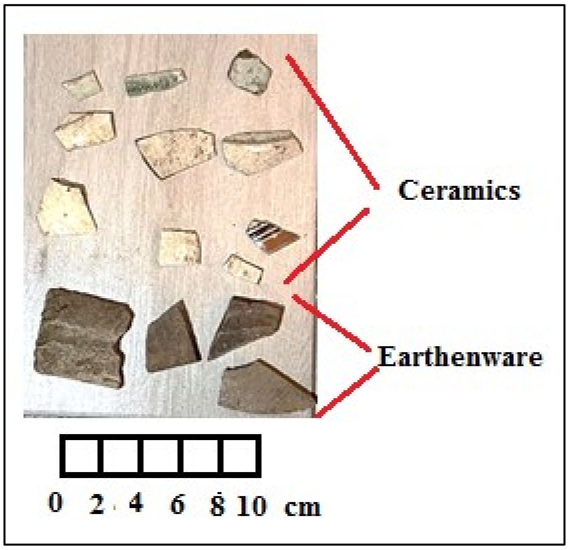


Figure 4: Artefacts from Area 1 Unit 1.

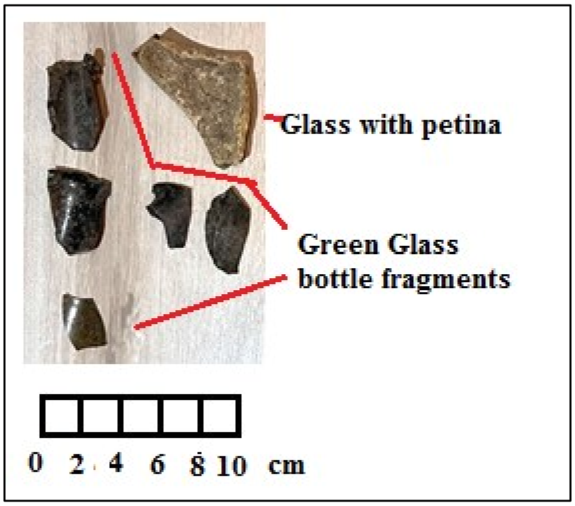


Figure 5: Artefacts from Area 1 Unit 1.

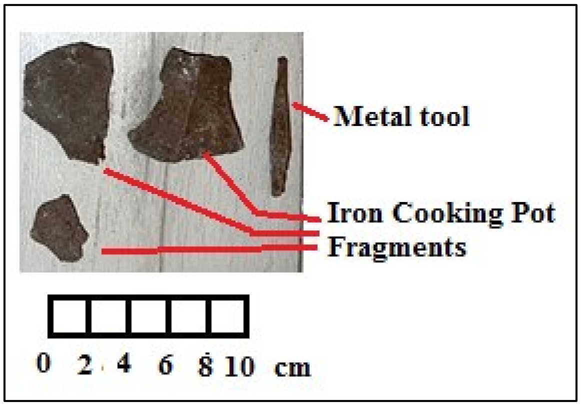


Figure 6: Artefacts from Area 1 Unit 1.

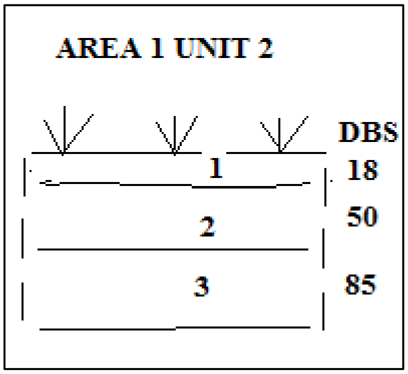


Figure 7: BTP AREA 1 UNIT 2

Context 1
DBS 18 CM
7.5YR2.5/1 REDDISH BLACK
Clay soil No pebbles and cobbles

Context 2
DBS 50 CM
7.5YR4/1 DARK REDDISH GREY
Clay soil No pebbles and cobbles

Context 3
DBS 85 CM
7.5YR8/1 WHITE
MARL BEDROCK

Table 3: BTP AREA 1 UNIT 2

AREA 1 UNIT 2	Number
GREEN WINE BOTTLE GLASS	1
SHELL EDGE	1
PEARL WARE	1
EARTHENWARE	1
METAL TOOL FOR CUTTING	1
ANIMAL TOOTH1	

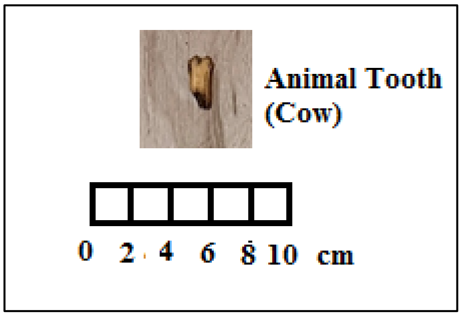


Figure 8: Artefacts from BTP AREA 1 UNIT 2

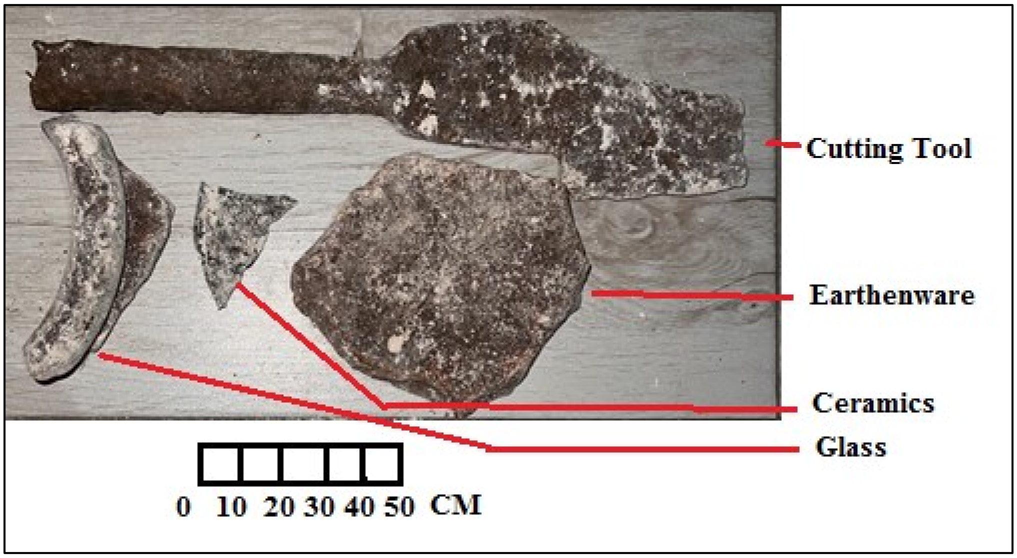


Figure 9: Artefacts from BTP Area 1 Unit 2.

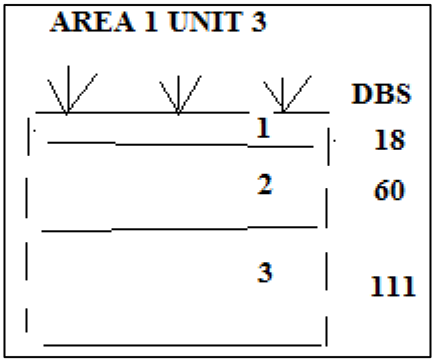


Figure 10: BTP AREA 1 UNIT 3

Context 1
DBS 18 cm
7.5YR2.5/1 REDDISH BLACK
Clay soil No pebbles and cobbles

Context 2
DBS 60
7.5YR4/1 DARK REDDISH GREY
Clay soil No pebbles and cobbles

Context 3
DBS 111 cm
7.5YR8/1 WHITE –
MARL BEDROCK

Table 4: BTP AREA 1 UNIT 3

AREA 1 UNIT 3	Number
GREEN WINE BOTTLE GLASS	1
BARREL STRAP	1
CERAMICS	1

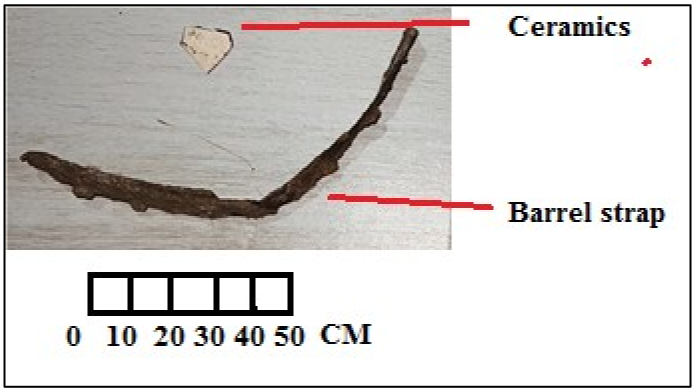


Figure 11: Artefacts from BTP Area 1 Unit 3.

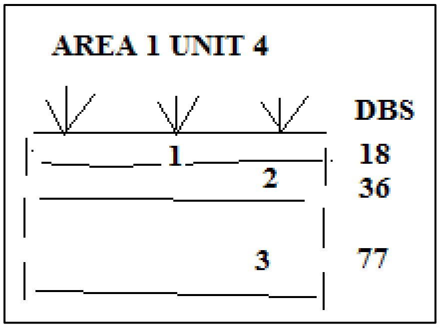


Figure 12: BTP AREA 1 UNIT 4 STRATIGRAPHY

Context 1
DBS 18 CM
7.5YR2.5/1 REDDISH BLACK
Clay soil No pebbles and cobbles

Context 2
DBS 36 CM
7.5YR4/1 DARK REDDISH GREY

Context 3
DBS 77 CM
7.5YR8/1 WHITE –
MARL BEDROCK

Table 5: BTP AREA 1 UNIT 4 ARTEFACTS

AREA 1 UNIT 4	Number
BARREL STRAP	1

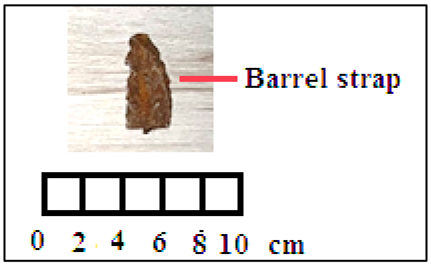


Figure 13: BTP AREA 1 UNIT 4 ARTEFACT

Figure 14: Roaring River Salvage Archaeology Clearing Land 4 Area 1

Figure 15: Roaring River Salvage Archaeology Area 1 BTP 1

Figure 16: Roaring River Salvage Archaeology Area 1 BTP Stratigraphy

Figure 17: Roaring River Salvage Archaeology Area 1 Assessing

Area 2

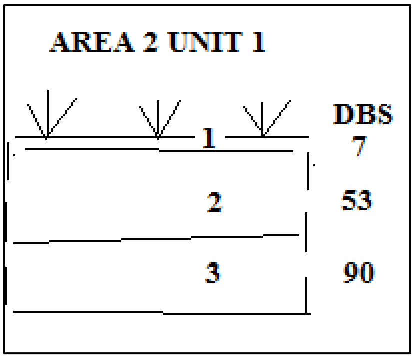


Figure 18: BTP AREA 2 UNIT 1 STRATIGRAPHY

Context 1
DBS 7 CM
7.5YR2.5/1 REDDISH BLACK
Clay soil No pebbles and cobbles

Context 2
DBS 53
7.5YR4/1 DARK REDDISH GREY
Clay soil No pebbles and cobbles

Context 3
DBS 90 CM
7.5YR8/1 WHITE –
MARL BEDROCK

Table 6: BTP AREA 2 UNIT 1 ARTEFACTS

AREA 2 UNIT 1
NO FINDS

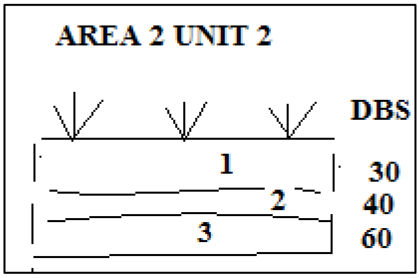


Figure 19: BTP AREA 2 UNIT 2 STRATIGRAPHY

Context 1

DBS 30 CM
7.5YR2.5/1 REDDISH BLACK
Clay soil No pebbles and cobbles

Context 2
DBS 40 CM
7.5YR4/1 DARK REDDISH GREY
Clay soil No pebbles and cobbles

CONTEXT 3
DBS 60 CM
7.5YR8/1 WHITE –
MARL BEDROCK

Table 7: AREA 2 UNIT 1 ARTEFACTS

AREA 2 UNIT 2
NO FINDS

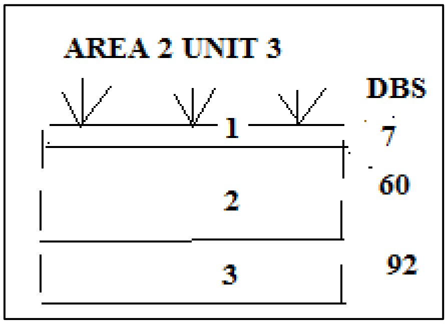


Figure 20: BTP AREA 2 UNIT 3 STRATIGRAPHY

Context 1
DBS 7 cm
7.5YR2.5/1 REDDISH BLACK
Clay soil No pebbles and cobbles

Context 2
DBS 60 CM
7.5YR4/1 DARK REDDISH GREY
Clay soil no pebbles

Context 3
DBS 92 CM
7.5YR8/1 WHITE –
MARL BEDROCK

Table 8: AREA 2 UNIT 3 ARTEFACTS

AREA 2 UNIT 3	NUMBER
BARREL STRAP	1

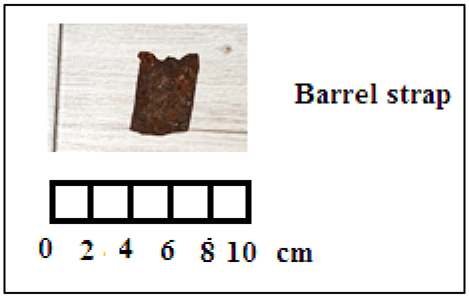


Figure 21: BTP AREA 2 UNIT 4 ARTEFACTS

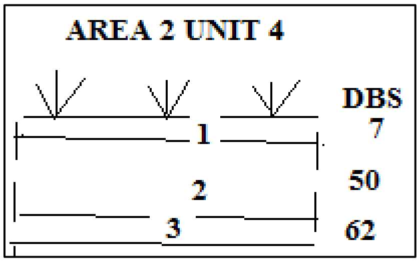


Figure 22: BTP AREA 2 UNIT 4 STRATIGRAPHY

CONTEXT 1
DBS 7 CM
7.5YR2.5/1 REDDISH BLACK
Clay soil No pebbles and cobbles

CONTEXT 2
DBS 50 CM
7.5YR4/1 DARK REDDISH GREY
Clay soil No pebbles and cobbles

CONTEXT 3
DBS 62 CM
7.5YR8/1 WHITE –
MARL BEDROCK

Table 9: AREA 2 UNIT 4 ARTEFACTS

AREA 2 UNIT 4
NO FINDS

ALL UNITS BACK FILLED

Figure 23: Roaring River Salvage Archaeology Area 2. Clearing Next to the River

Figure 24: Roaring River Salvage Archaeology Area 2 Back Hoe Excavating

Figure 25: Roaring River Salvage Archaeology Area 2 Back Hoe Excavating

Figure 26: Roaring River Salvage Archaeology Area 2 Investigating The Context Just Raked By The Back Hoe

Figure 27: Roaring River Salvage Archaeology Area 2 Stratigraphy

Figure 28: Roaring River Salvage Archaeology Area 2 Searching the Sediment for Artefacts

General Findings Summary

Area 1 revealed the presence of the historic site through British colonial artefacts of various types including ceramics, glass and metal. Animal bones were evident as surface scatter on the site and were ostensibly modern. A large tooth was also obtained from the site. This tooth appeared to be from a mandible forming part of the surface scatter. There was no evidence of prehistoric presence in this part of the site.

Area 2 was almost completely sterile. There was one barrel strap obtained and there were no prehistoric artefacts present on the surface nor within the units dug.

Where the units were dug, the marl substrate was solid and undisturbed. We nonetheless dug through into the substrate to verify the expectation that the rock was solid for another 31 cm (the length of the fork on the back hoe).

Conclusion

It is evident from these findings that the pre-Columbian site does not extend onto the areas investigated and that pre-Columbian burials did not occur in this area. The back hoe was used in all units excavated to try to penetrate the solid marl substrate to unearth skeleton remains should they be present. In all instances we observed solid bedrock. This provides answers to the questions asked regarding the extent of the site and the matter of burials.

Acknowledgements

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K. Nocturnal Survey

Rapid Fauna assessment with emphasis on nocturnal animals 2023

Damion Whyte

Table of Contents

List of Figures

List of Tables

Method

Site Selection

The vegetation in the study area was categorised as open fields according to the Forestry Department 1998 Land Use Cover. The vegetation was further categorized into Woodland and Grassland (Figure 29).

Figure 29:The area categorised as Grassland in the project area.

Figure 30: The Area categorised as Woodland on the property.

Figure 31: River (possibly Roaring River) located in the area categorised as Woodland.

Figure 32:The vegetation removed in the project area for the road.

The sample points for the nocturnal fauna assessments were placed within the 2 main forest categories. The study was carried out primarily along the trails distributed throughout the study area (**Error! Reference source not found.**). The study was conducted over 2 weeks: fieldwork (September 22 and October 6, 2023) and nocturnal studies using acoustic detectors (September – October 6, 2023).

Figure 33:The location of the AudioMoths used for the acoustic survey on the property.

Fauna Assessment

The team explored and described the fauna using techniques applicable to the following taxonomic groups: Birds, Herpetofauna, and Bats. The fauna within each sample site was identified to the lowest practical taxonomic level; some were readily identified. In other cases, identification was made with local knowledge, available literature (keys) and applications such as iNaturalist (iNaturalist, 2020). No specimens were removed from the area.

The following were gathered from the fauna assessments: the number of species observed, the number of individuals of the same species observed, and a DAFOR (D=dominant, A=abundant, F=frequent, O=occasional and R=rare) ranking of the abundance of species (Table 10).

Table 10:The DAFOR scale and the 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 during the assessment
Dominant	≥ 20
Abundant	15 – 19
Frequent	10 – 14
Occasional	5- 9
Rare	< 4

Bat study

The bat assessments were carried out by deploying stationary detectors at selected points. Nine AudioMoth® acoustic recorders were deployed in selected sites within the project area. The AudioMoth acoustic detectors were placed at least 250 m from each other and were configured to record from 18:00 to 06:00 for 14 consecutive nights. The sample rate was up to 384 kHz, and the gain was set at medium. The sleep duration was 30 seconds, and the recording duration was 10 seconds. The devices were deployed at least 1.5 m above the ground.

Table 11: The AudioMoths devices deployed in the project area.

Device	Vegetation Type	Micro Habitat where the device was placed
NR1	Woodland	Fig tree along the road
HM1	Woodland	Large tree along the banks of Little River
D1	Woodland	On a large tree near a Guango Tree with Tank Bromeliads
D3	Grassland	Open grassland at the fringe of the Woodland
D4	Woodland	River near the main road
D6	Grassland	Large tree with tank bromeliads
D8	Woodland	Large fig tree in the woodland
D10	Woodland	Almond tree with fruits at the banks of Little River

Figure 34: An AudioMoth device deployed in the field on the property.

The Kaleidoscope Pro software from Wildlife Acoustics was used to Auto ID the bat call. The software generally clusters and visualises recordings, automatically identifies bats, and analyses sound. The program's auto-ID feature was used to carry out the analysis of the acoustic data. The expert further vetted the acoustic files (auto ID calls, unknown calls, and noise) as the program will misidentify some calls.

A bat survey was also carried out where the area was searched for bats roosting in trees and within rock holes/ caves encountered within the project area.

Avifauna Survey

The avifauna survey was carried out using the line transect method, as several roads and footpaths were distributed throughout the project area. The method entailed walking slowly along a trail and noting all the birds (seen or heard) in the area (Bibby, Jones, and Marsden 2000).

The nocturnal avian survey was conducted by deploying Audio devices (AudioMoth) throughout the project using the methods above in the bat section (Figure 34). The devices were active from 18:00 to 06:30 for 2 weeks. The audio files were processed using the Kaleidoscope Pro software from Wildlife Acoustics and the process audio file ID by experts.

All surveys were carried out using a binocular. A phone was also used to assist with photo and sound identification. Reference material used in species identification (pictures and calls) includes Merlin App (Cornell University 2021), Ebird (Fink, et al. 2018), and Bird of the West Indies (Raffaele, et al., 1998).

Herpetofauna Survey

The herpetofauna assessment was conducted at the microhabitat within each zone, including trees, stone piles, and other debris vegetation types. Pictures were taken of each specimen observed in the area. Some specimens were captured temporarily for closer analysis and released at the same location. The resource material used includes Amphibians and Reptiles of the Caribbean Islands keys (Caribherp, 2021)and Amphibians and reptiles of the West Indies (Schwartz & Henderson 1991). Ponds were also searched during the day, mainly for crocodiles and turtles.

Nocturnal Surveys - Audio devices (AudioMoth) were deployed in the field to conduct the nocturnal herp survey (**Error! Reference source not found.**). The devices were active from 17:30 to 06:30. The audio files were processed using the Kaleidoscope Pro software from Wildlife Acoustics, the process audio file ID by experts, and acoustic material from Caribherp 2021.

Figure 35: Several Tank bromeliads were observed growing on the large trees on the property.

Figure 36:Termite nests with old Jamaica Parakeet nest cavities were searched for the presence of the Jamaican Boa and other snakes.

Result and discussion

Avifauna

A total of 39 bird species (Residents (N=20), Introduced (N=2), Migrants (N=5), and Endemic (N=12)) were identified across the study area. Most of the species observed were terrestrial (Table 12). Twelve of the 31 species of endemic birds reported in Jamaica were identified during the study, and the majority are not forest-dependent except for the Rufous-throated Fly Catcher and the Yellow Shouldered Grassquit.

Table 12: The number of bird species detected in the study using the line transect and acoustic methods.

Common Name	Scientific Name	Range	IUCN	Grassland	Forest
American Kestrel	*Falco sparverius*	*Resident*	LC	R	R
American Redstart	*Setophaga ruticilla*	*Migrant*	LC		R
Antillean Palm-Swift	*Tachornis phoenicobia*	*Resident*	LC	O	
Bananaquit	*Coereba flaveola*	*Resident*	LC		O
*Barn Owl	*Tyto alba*	*Resident*	LC	R	R
Black-and-white Warbler	*Mniotilta varia*	*Migrant*	LC		R
Black-faced Grassquit	*Melanospiza bicolor*	*Resident*	LC	O	R
Caribbean Dove	*Leptotila jamaicensis*	*Resident*	LC		R
Cattle Egret	*Bubulcus ibis*	*Resident*	LC	O	
Common Ground Dove	*Columbina passerina*	*Resident*	LC	R	R
Gray Kingbird	*Tyrannus dominicensis*	*Migrant*	LC	O	R
Greater Antillean Bullfinch	*Melopyrrha violacea*	*Resident*	LC		R
Greater Antillean Grackle	*Quiscalus niger*	*Resident*	LC	R	
Green-rumped Parrotlet	*Forpus passerinus*	*Introduced*	LC	R	F
Jamaican Crow	*Corvus jamaicensis*	*Endemic*	NT	R	
Jamaican Euphonia	*Euphonia jamaica*	*Endemic*	LC		R
Jamaican Mango	*Anthracothorax mango*	*Endemic*	LC		R
Jamaican Oriole	*Icterus leucopteryx*	*Resident*	LC		R
Jamaican Tody	*Todus todus*	*Endemic*	LC		R
Jamaican Vireo	*Vireo modestus*	*Endemic*	LC		R
Jamaican Woodpecker	*Melanerpes radiolatus*	*Endemic*	LC		R
Loggerhead Kingbird	*Tyrannus caudifasciatus*	*Resident*	LC	O	
Northern Mockingbird	*Mimus polyglottos*	*Resident*	LC	O	R

Common Name	Scientific Name	Range	IUCN	Grassland	Forest
Northern Waterthrush	*Parkesia noveboracensis*	*Migrant*	LC		R
Jamaican Parakeet	*Eupsittula nana*	*Endemic*	NT	O	O
Prairie Warbler	*Setophaga discolor*	*Migrant*	LC		R
Rufous-tailed Flycatcher	*Myiarchus validus*	*Endemic*	LC		R
Sand Flycatcher	*Myiarchus barbirostris*	*Endemic*	LC	R	R
Smooth-billed Ani	*Crotophaga ani*	*Resident*	LC	O	O
Red-billed Streamertail	*Trochilus polytmus*	*Endemic*	LC	R	R
Tricolored Munia	*Lonchura malacca*	*Introduced*	LC	F	
Turkey Vulture	Cathartes aura	*Resident*	LC	O	O
Vervain Hummingbird	*Mellisuga minima*	*Resident*	LC	R	R
White-chinned Thrush	*Turdus aurantius*	*Endemic*	LC		O
White-crowned Pigeon	*Patagioenas leucocephala*	*Resident*	NT	O	O
White-winged Dove	*Zenaida asiatica*	*Resident*	LC	R	O
Yellow-faced Grassquit	*Tiaris olivaceus*	*Resident*	LC	F	O
Yellow-shouldered Grassquit	*Loxipasser anoxanthus*	*Endemic*	LC		R
Zenaida Dove	*Zenaida aurita*	*Resident*	LC	O	R

*Species observed from the acoustic survey: LC = Least Concern; NT = Near Threatened

The bird species distribution and abundance were greater in the forest (N=33) compared to the Grassland (N=23) (Figure 37). The forest (11) had the most significant number of endemic species, compared to (4) in the Grassland.

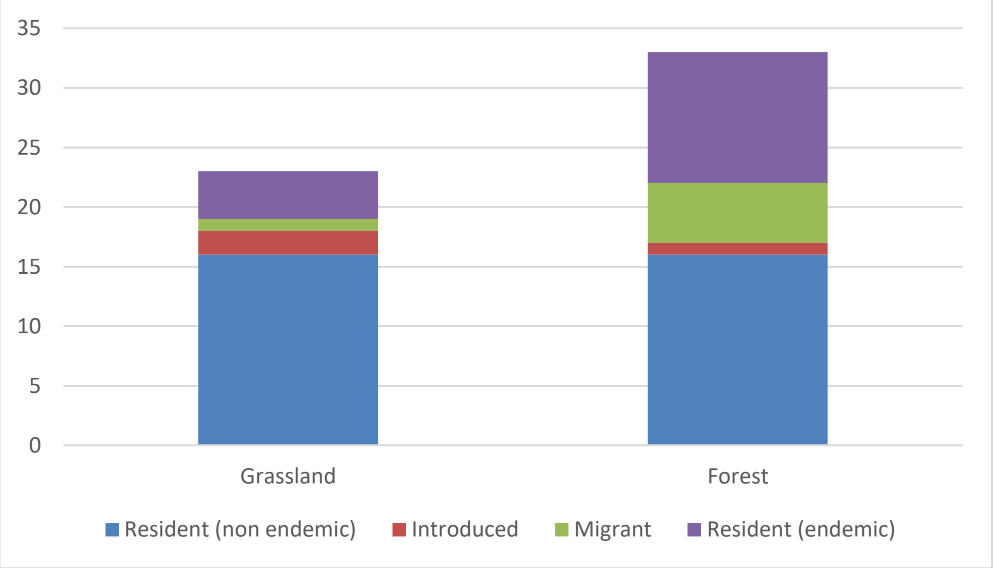

Figure 37: The bird species distribution, as per vegetation type

Migrant species – The study was carried out during the winter migration survey. Five migrant species (4 migrant Warbler and a Northern Waterthrush) were observed in the study. The species diversity in the study area is expected to rise in the coming months as more migrants are expected to visit the area.

Introduced species- Twenty-nine introduced species have been reported in Jamaica, and 2 species were reported in this study: Green Rumper Parrotlet and Tricolored Munia. The majority were found in the Grassland.

Nocturnal species - the birds encountered at night by observation/ sound and using the AudioMoths was the Barn Owl. The Northern Potoo (Nyctibius jamaicensis) and Jamaican Owl (*Pseudoscops grammicus*) have been detected in the surrounding area, but have not been observed in the study area.

Species of special conservation status

There are 16 species of birds in Jamaica listed as globally threatened by the IUCN Red List (Lepage 2022). Three species from the study are on the IUCN red list and are listed as Near Threatened by the IUCN: the Jamaican Parakeet (*Eupsittula nana*), Jamaican Crow (*Corvus jamaicensis*) and White-crowned Pigeon (*Patagioenas leucocephala*).

Bat Assessment

Ten species of bats were identified using the Kaleidoscope Pro Acoustic software (**Error! Reference source not found.**). The species, trophic guild, include Frugivore (n=1), Piscivore (n=1) and Insectivore (n=8). For the study, presence /absence was used to represent the bat species detected in the study area. The acoustic data was not used to generate relative abundance, although the number of calls varied from the sample site.

The Jamaican Fruit Bat, *Artibeus jamaicensis*, was detected at a site at the Fig tree and the Almond tree on the property. However, their calls are faint and difficult to pick up in the field. Of the 8 insectivorous bats detected, 4 are known to forage in forested areas. While the other 4 species are known to forage in open areas.

The fish-eating bat was detected on two sections of the property. It was detected at a pool at Little River and at a stream on the property assumed to be Roaring River.

A special search of the vegetation was carried out for tree roosting species, such as the Jamaican fig eating Bat (*Ariteus flavescens*). No bat was observed roosting in the trees in the study area. In addition, no caves or rock holes where bats used were observed in the study area.

The data analysis was generated from 278 GB of data files. There were 94,185 files generated from the software. Nine species were identified by the auto-ID file in Kaleidoscope Pro software and further verified by experts. There were 2 unidentified bat calls.

Species of Special Conservation

There were no endemic bats or bats with special protection or deemed endangered identified in the study area.

Table 13: The bat species recorded and identified in the study.

Scientific Name	Common Name	IUCN	Range	Diet	Roost	Grass-land	Woodland
Artibeus jamaicensis	Jamaican Fruit Bat	LC	Native	Frugivore	Cave, man-made structure, foliage		1
Eumops glaucinus	Wagner's Bonneted Bat	LC	Native	Insectivore	Cave, man-made structures	1	1
Molossus milleri	Pallas' Mastiff Bat	LC	Native	Insectivore	Cave, man-made structures	1	1
Moormops blainvillei	Antillean Ghost-faced Bat	LC	Native	Insectivore	Obligate cave	1	1
Noctilio leporinus	Fishing Bat	LC	Native	Piscivore	Cave, crevice, Tree hollow		1
Nyctinomops macrotus	Big Free-tailed Bat	LC	Native	Insectivore	Cave, crevices	1	1

Scientific Name	Common Name	IUCN	Range	Diet	Roost	Grass-land	Woodland
Pteronotus macleayii	MacLeay's Mustached Bat	LC	Native	Insectivore	Obligate cave	1	1
Pteronotus parnellii	Parnell's Mustached Bat	LC	Native	Insectivore	Obligate cave	1	1
Pteronotus quadridens	Sooty Mustached Bat	LC	Native	Insectivore	Obligate cave	1	1
Tadarida brasiliensis	Free-tailed Bat	LC	Native	Insectivore	Cave, man-made structures	1	1

The calls were generated from information from Genoways et al. 2005, Koenig 2015, IUCN Red List 2019 and Wikipedia 2019

Impact of the development on the bat

The proposed development will not be expected to impact the bats foraging activity on the property. The proposed development will unlikely result in the loss of any major roosting areas for the bats on the property. There were no caves or manmade structures, and bats were observed roosting on the property.

Herpetology

Five amphibians were observed in the study area; 2 species are endemic, and 3 are listed as invasive species. The two endemics include the Laughing frog *Osteopilus ocellatus* and the Jamaican Forest Frog (*Eleutherodactylus gossei*). The Jamaican Laughing Frog was identified from the tank bromeliad removed from the forest. They were also heard calling in the bromeliad in the tree after a little drizzle in the day. The Jamaican Forest Frog (*Eleutherodactylus gossei*) was heard calling in the day in the forest when the place was overcast and after a light drizzle. It was also identified from the acoustic recordings from the nocturnal assessments. The most abundant species was the introduced Lesser Antillean Frog *Eleutherodactylus johnstonei*. It was observed and detected throughout the project area.

Several bromeliads were seen on the large trees on the property. It is possible that other bromeliad specialist frogs could be in the project area; however, they were not detected in the acoustic study.

Figure 38: The Bromeliads (from one of the Large Guango trees that was chopped down) searched for frogs

Figure 39: The Jamaican Laughing Frog Tadpoles and eggs were found in a few bromeliads sampled on the ground in the project area.

Regarding the reptiles, 7 species (6 endemic and 1 native) were observed in the study (Table 14). The native Jamaican Croaking Lizard (*Aristelliger praesi*gnis) have been observed and detected in the acoustic study in the project area. No gallwasp was observed in the study area; however, *Celestus crusculus* has been collected in the general Roaring River area outside the project's scope (Whyte PersObs). The endemic Jamaican Boa *Chilabothrus subflavus* have been recorded in the Belmont Area, which is in close proximity to the project area (Whyte PersObs), but was not observed in the study area.

Species of special conservation status

Amphibians

Regarding species of special conservation status, the three species identified in the study are listed as Least Concern by the IUCN. Two endemic amphibian species were identified in the study: the Jamaican laughing frog (*Osteopilus ocellatus*), listed as Near-threatened, and the Vulnerable Jamaican Forest Frog (*Eleutherodactylus gossei*)

Figure 40: The Jamaica Forest Frog (*Eleutherodactylus gossei*)

Reptiles

Of the 7 species of Reptiles identified in the study, none of the reptiles were of any special conservation status. However, the team should be on the lookout for the endemic Jamaican Boa (*Chilabothrus subflavus*), which could be in the project area.

Table 14: The Herps observed and reported in the study area

Class	**Family**	**Scientific Name**	**Common Name**	**Range**	**IUCN**	**Grass-land**	**Forest**
Amphibia	Bufonidae	*Rhinella marina*	Cane toad	Introduced	LC	R	A
Amphibia	Eleutherodactylidae	*Eleutherodactylus gossei*	Jamaican Forest Frog	Endemic	VU	A	F
Amphibia	Eleutherodactylidae	*Eleutherodactylus johnstonei*	Lesser Antillean Frog	Introduced	LC		O
Amphibia	Eleutherodactylidae	*Eleutherodactylus planirostris*	Cuban Flat-headed Frog	Introduced	LC	O	R
Amphibia	Hylidae	*Osteopilus ocellatus*	Jamaican laughing frog	Endemic	NT	O	
Reptilia	Anguidae	*Celestus crusculus*	Jamaican Brown Galliwasp	Endemic	LC		R
Reptilia	Boidae	*Chilabothrus subflavus*	Jamaican Boa	Endemic	VU		
Reptilia	Dactyloidae	*Anolis garmani*	Jamaican Giant Anole	Endemic	LC	R	F
Reptilia	Dactyloidae	*Anolis grahami*	Jamaican Turquoise Anole	Endemic	LC		O
Reptilia	Dactyloidae	*Anolis lineatopus*	Jamaican Brown Anole	Endemic	LC		R
Reptilia	Dactyloidae	*Anolis opalinus*	Jamaican Opal-bellied Anole	Endemic	LC		R
Reptilia	Sphaerodactylidae	*Aristelliger praesignis*	Jamaican Croaking Gecko	Native	LC		R

Potential impacts of the proposed development on biodiversity within the project area

- There is the possibility of injury or death of animals during land clearing, preparation and construction activities.
- The displacement of fauna during land preparation and construction activities is imminent. Most of the fauna species recorded are adapted to disturbance and, in most cases, would be temporarily displaced and will more than likely relocate to adjacent blocks of land outside of the development footprint and could even return after the initial phases of the project.
- Noise generated by land clearance and construction activities can impact animals, particularly birds. The noise impacts can contribute to the displacement of fauna within the project boundary and adjacent land parcels.
- The proposed development will impact the bats foraging activity on the property.
- The proposed development will unlikely result in the loss of any major roosting areas for the bats on the property, as none was found during the assessment. There were no caves or manmade structures, and bats were not observed roosting on the property.
- These represent cumulative impacts given that the highway and Ocho Rios main road border the entire western and northern section of the property, respectively.

Recommendations

- Large trees (>25cm DBH), particularly those with many bromeliads/orchids/epiphytic cacti, should be preserved and incorporated into the development. These have been identified and tagged for those located within accessible areas. Several of these are endemic and the bromeliads are the home of several amphibians, some of which could be in the project area although not detected in the study.
- 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 NEPA so that 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.

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L. Tree Flagging Survey Report

TREE FLAGGING SURVEY REPORT

MAMMEE RIVER DEVELOPMENT

October 2023

Prepared By:
Environmental Solutions Limited

Prepared For:
China Harbour Engineering Company

1 Introduction

This Environmental Tree Survey Report was prepared by Environmental Solutions Ltd. (ESL) on behalf of China Harbour Engineering Company (CHEC) for the proposed housing development in Mammee River, St. Ann. The tree survey was conducted as a supporting study to the ecological assessment for the Environmental Impact Assessment and to guide the Landscape Management Plan that is to be developed.

2 Methodology

The tree survey was conducted on October 14, 15 and 20, 2023. The approach involved identifying, geo-referencing, coding, measuring and flagging all trees (within reasonable reach) with trunk diameter equal to or greater than 25cm (1m) at Breast Height. These trees included those located within areas to be cleared for the development of the residential (apartment, detached and townhouse) units, commercial units, park, clubhouse, sewage treatment plant and sections of the reserve that where navigable. Trees with conservation designated (i.e., endemic, threatened, rare etc.) were also tagged, regardless of their Diameter at Breast Height (DBH). Just over 200 trees were tagged and coded for preservation and incorporation into green areas as is best as possible. According to the Mammee River Development Masterplan (Figure 1), the development will occur in six (6) phases progressing from the northernmost sections of the property boundary to the southernmost sections.

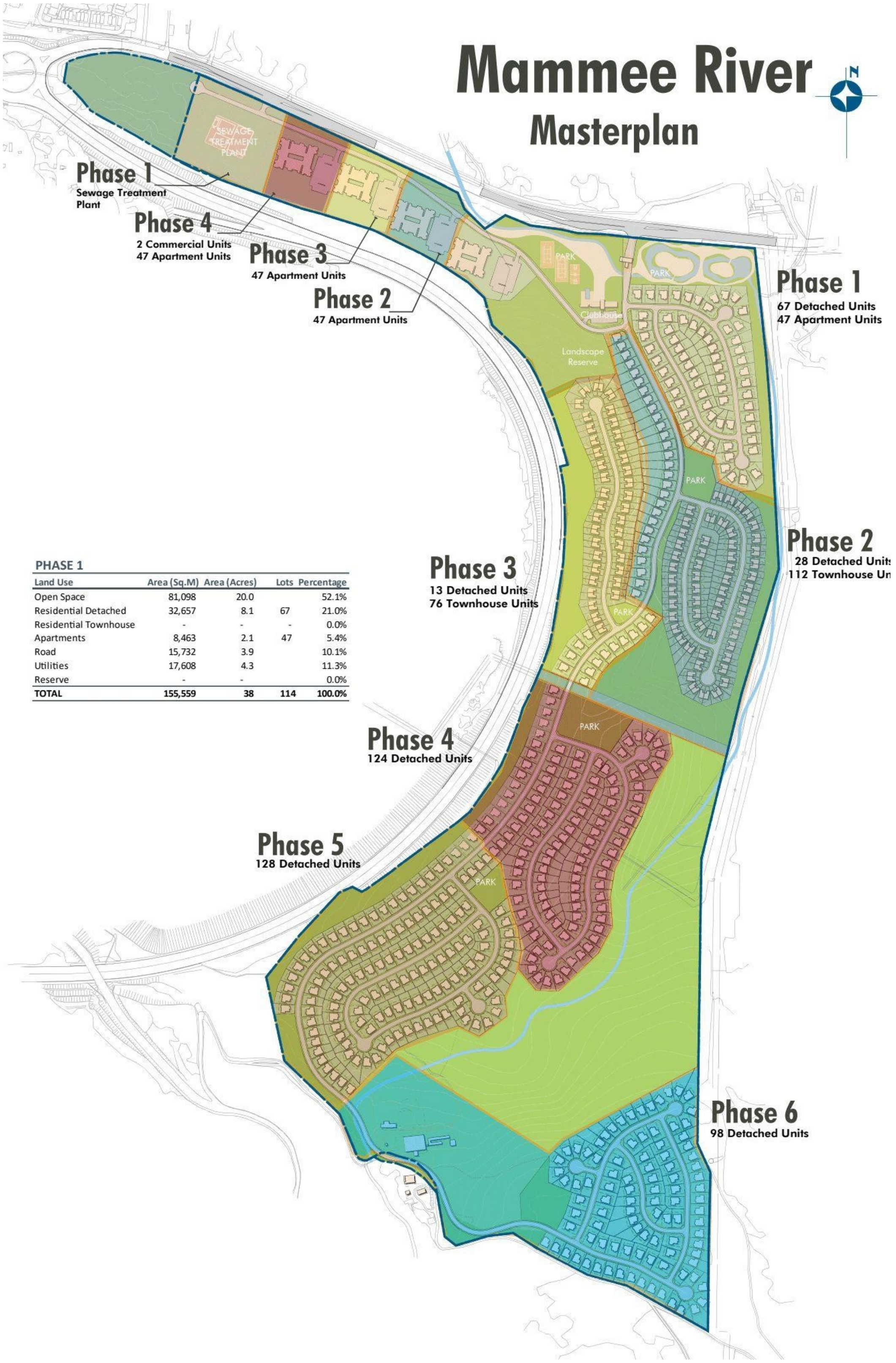
The health status of each tree was also determined, and the DBH and approximate tree height recorded. A map showing all geo-referenced trees was created (Figure 8) along with a supporting attribute table providing information on each tree, including its conservation status (Table 1).

3 Limitations

1. Full-scale land clearing for Phase 1, Phase 3, and Phase 4 along he northwesternmost tip of the property began before the tree survey could begin (Figure 2). Only remaining trees were primarily Trumpet trees (*Cecropia peltata*), Poincianna trees (*Delonix regia*), Crab Eye trees (*Adenanthera pavonina*), Fig (*Ficus maxima*), *Cassia fistula*, Pudding Pipe Tree (*Piper amalago*), West Indian Almond trees (*Terminalia catappa*) that seem to form a buffer/barrier between the site and both the Ocho Rios Main Road and the North-South Highway. The tree barrier was structured into two canopy layers, the lower ranging between 15-20ft and the taller trees ranging between 40-45ft in height. Several trees that were cleared had DBH greater than 25cm.
2. Other large patches of the site near the westward and southern boundary were also already cleared.
3. The DBH of majority of trees growing along the western site boundary were very small. It is likely that the trees here are just recolonizing the area after extensive roadwork associated with the construction of the highway.
4. Some areas were highly dense and inaccessible without the relevant machinery, as such the trees in these areas were not able to be tagged.
5. In the southwestern and southeastern section of the site there were large ditches/precipice and along the eastern site boundary, there was a deep valley, all of which were impossible to access.

4 Recommendations

1. It is recommended that all endemic trees (these have been specially labelled) remain undisturbed on site as these are considered to be important native species.
2. Trees of the stipulated diameter should be incorporated into the landscaping design of the development.
3. Trees of similar size and species located in inaccessible areas should not be removed during clearing, where possible.
4. It is understood that the location of some of these trees may conflict with the location of roads and buildings. However, where possible, they should be preserved and incorporated in the landscaping of lots, parks and sidewalks. Of particular mention are the very large Guango, Almond and Fig trees which can be used for shade and as a barrier from strong winds. Several of these very large Fig and Guango trees are home to a number of endemic epiphytes including the cacti, *Hylocereus triangularis* and the Bromeliad, *Hohenbergia* sp. (bottom of Figure 5)
5. Red Birch trees are wind-tolerant trees and are considered to be hurricane-resistant. They should be kept to provide wind protection for homes, and can also be used as one of the many tree species forming the tree line along the highway and other major roadways.
6. A number of the trees are good for providing lumber/timber for indoor and outdoor carpentry. Those which are removed can be reused for such purposes.
7. The river that cuts across the northern sections of the property seems to periodically overflow its banks. As such, it has resulted in a consistent cool, moist environment that encourages the growth of several species of ferns (like *Thelypteris* sp. and *Nephrolepis* sp.) and an abundance of Anchovy trees (*Grias cauliflora*) which is endemic to Jamaica. The natural environment within and surrounding the river including the riparian vegetation should be integrated into the development as a reserve and kept in its natural state as best possible (Figure 6).
8. The Landscape Site Plan proposes the use of the Royal Palm, Italian Cypress Tree, Red Birch, Yellow Poui, and the African Tulip Tree and other tropical fruit trees like mango, apple and breadfruit. The Royal Palm and Red Birch already exist on site and so tagged trees can be retained and incorporated into the landscaping. The Pink Poui and the Endemic Poui already exist across the site and could be used for their ornamental value alongside the Poinciana and any other existing flowering plants on the site.
9. *Of most importance is that the African Tulip trees are an introduced species which is considered to be an invasive species that are known to quickly outcompete native trees in woodland/secondary forests in Jamaica. Therefore, new trees from this species should not be planted at the site*.
10. It is highly recommended that a nursery be established on the site in an area that will not be immediately cleared or not cleared at all. There is an abundance of seedlings for various trees and ferns that can be strategically relocated across the site and integrated into the landscaping plan (Figure 4).



PHASE 1

Land Use	Area (Sq.M)	Area (Acres)	Lots	Percentage
Open Space	81,098	20.0		52.1%
Residential Detached	32,657	8.1	67	21.0%
Residential Townhouse	-	-	-	0.0%
Apartments	8,463	2.1	47	5.4%
Road	15,732	3.9		10.1%
Utilities	17,608	4.3		11.3%
Reserve	-	-		0.0%
TOTAL	**155,559**	**38**	**114**	**100.0%**

Figure 1: Masterplan for the proposed Mammee River development

Figure 2: Sections of the site that were cleared prior to conducting the survey

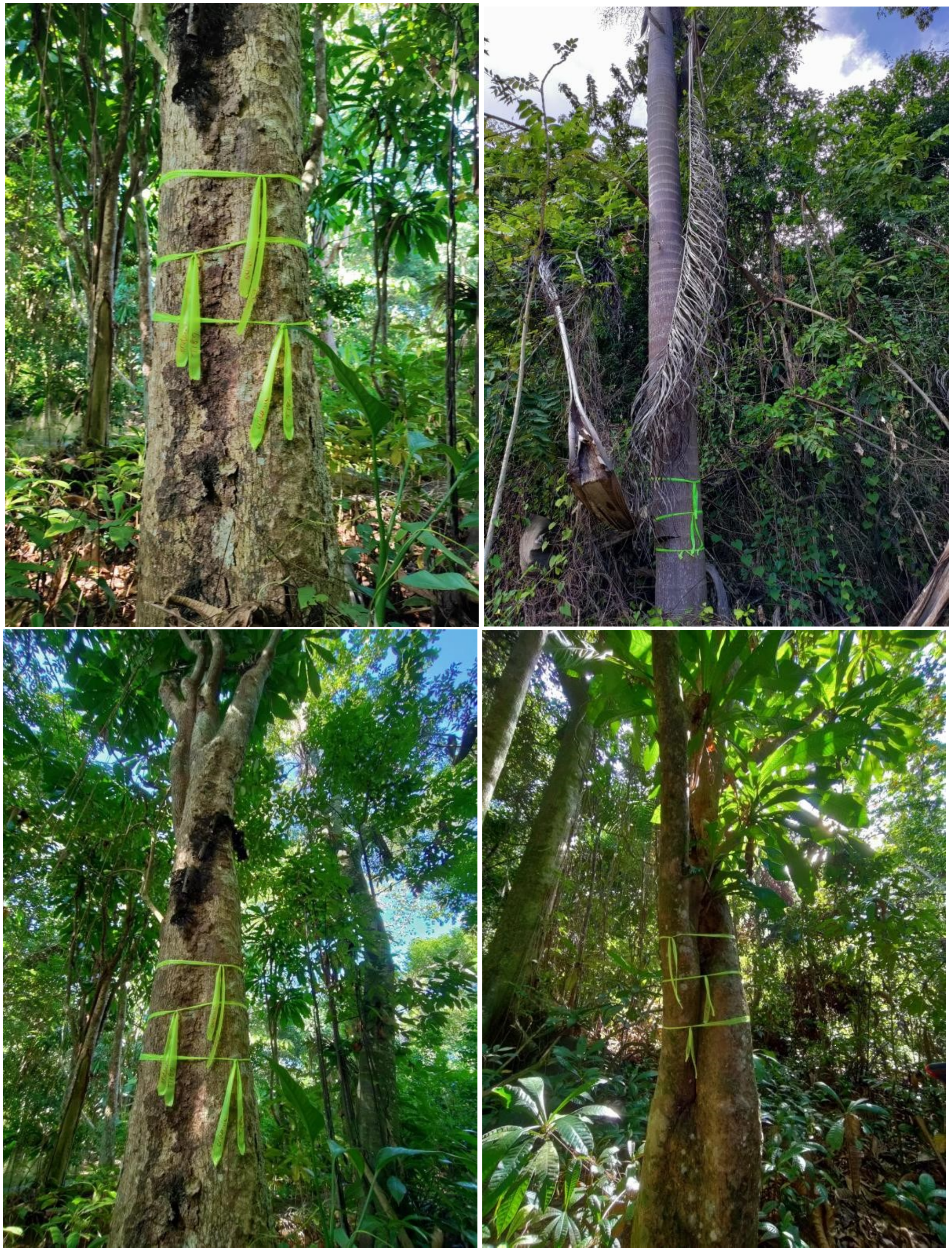


Figure 3: Examples of trees tagged on site. Sweetwood tree (top left), Royal Palm (top right), and Anchovy (bottom left and right)

Figure 4: Examples of tree seedlings and ferns observed on site. Area can be used as a nursery from which existing ornamental plants and trees can be obtained.

Figure 5: Examples of some endemics identified during surveys.

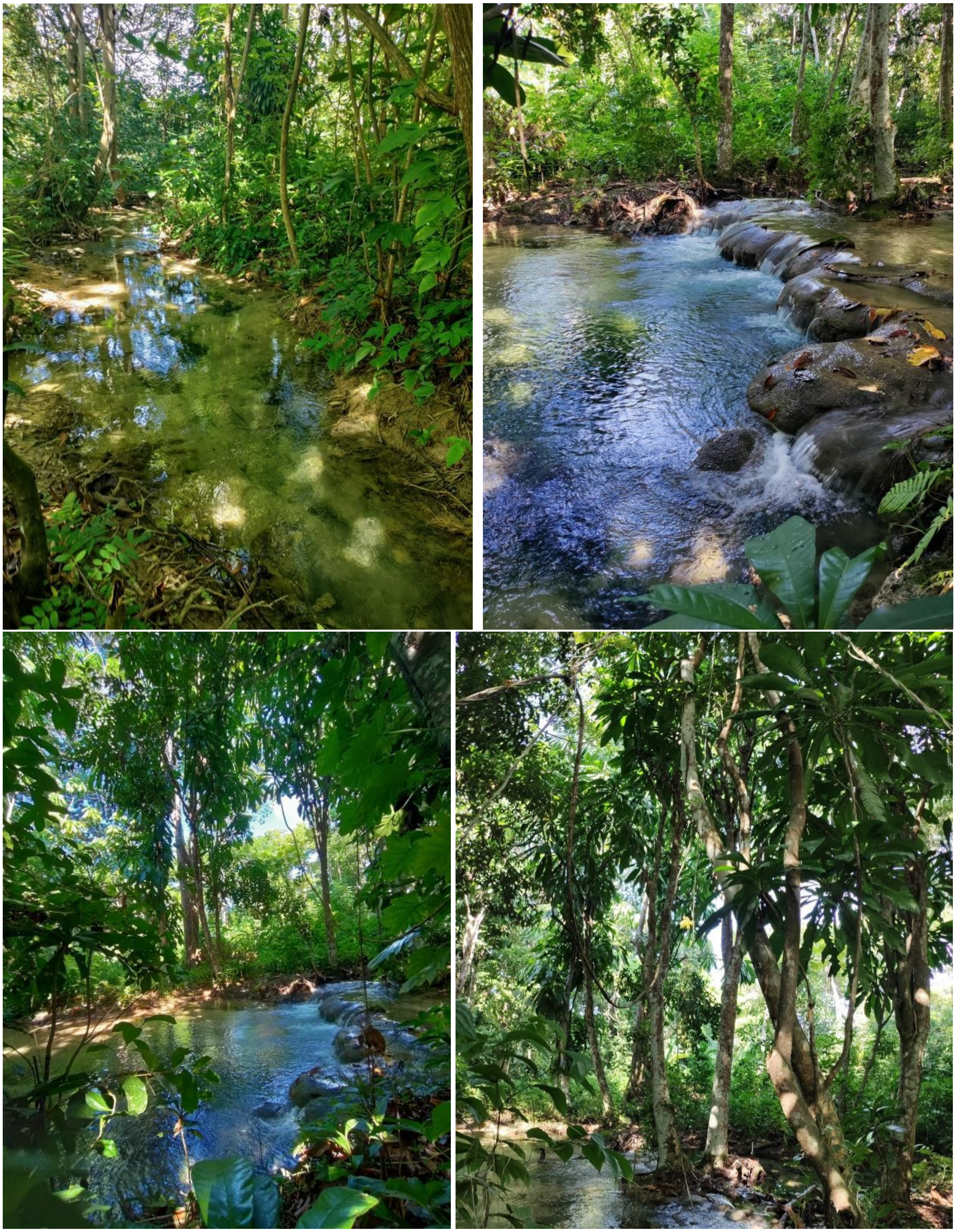


Figure 6: Areas along the Roaring River that runs through the site. Recommended to have this area remain undisturbed. Several trees with large DBH are also located here.

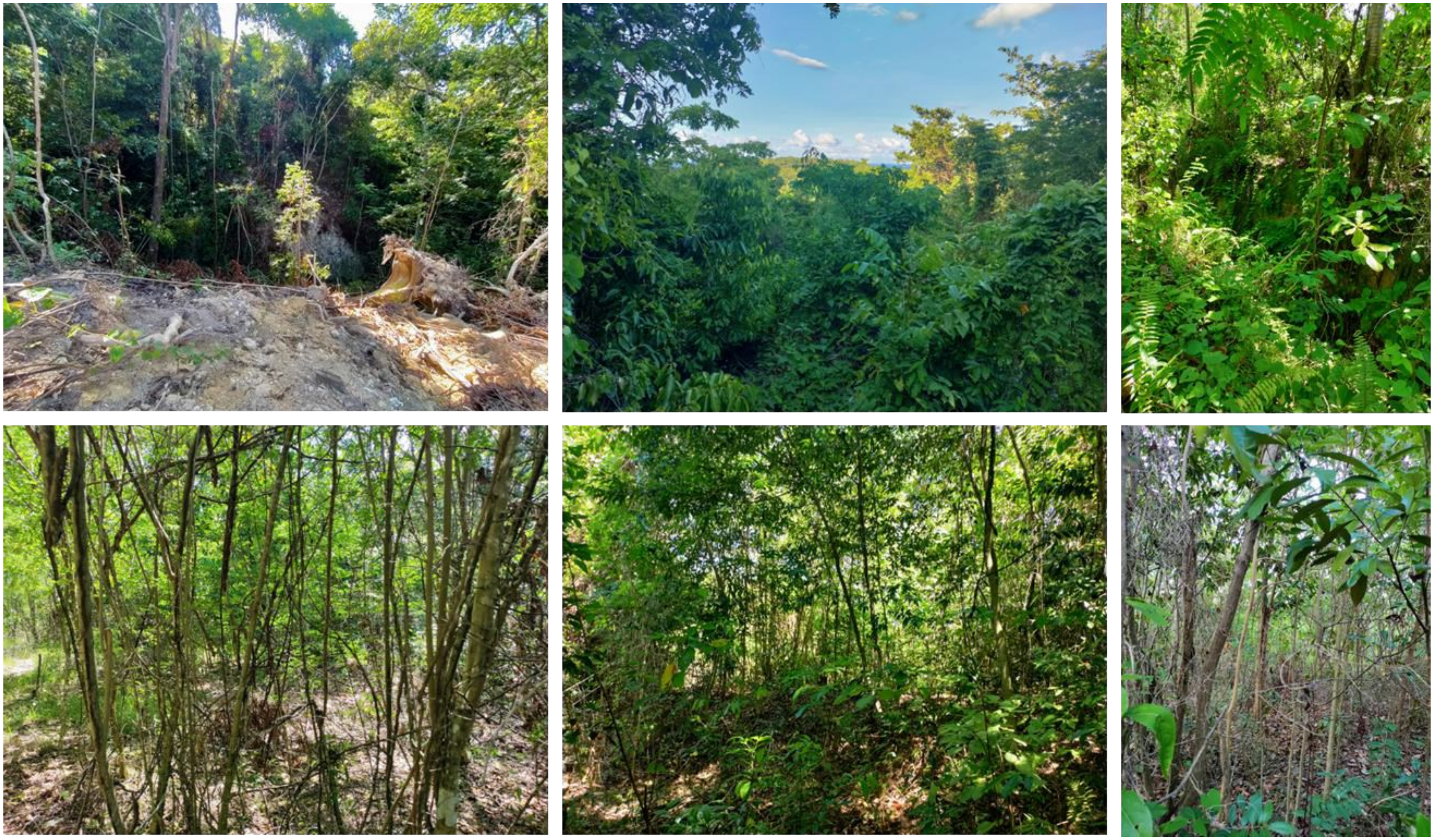


Figure 7: Examples of inaccessible areas across the site including ditches, trenches, and precipices which left sections of the site isolated or impossible to traverse (top row), and sections of the site with expanses of very thin trees (bottom row).

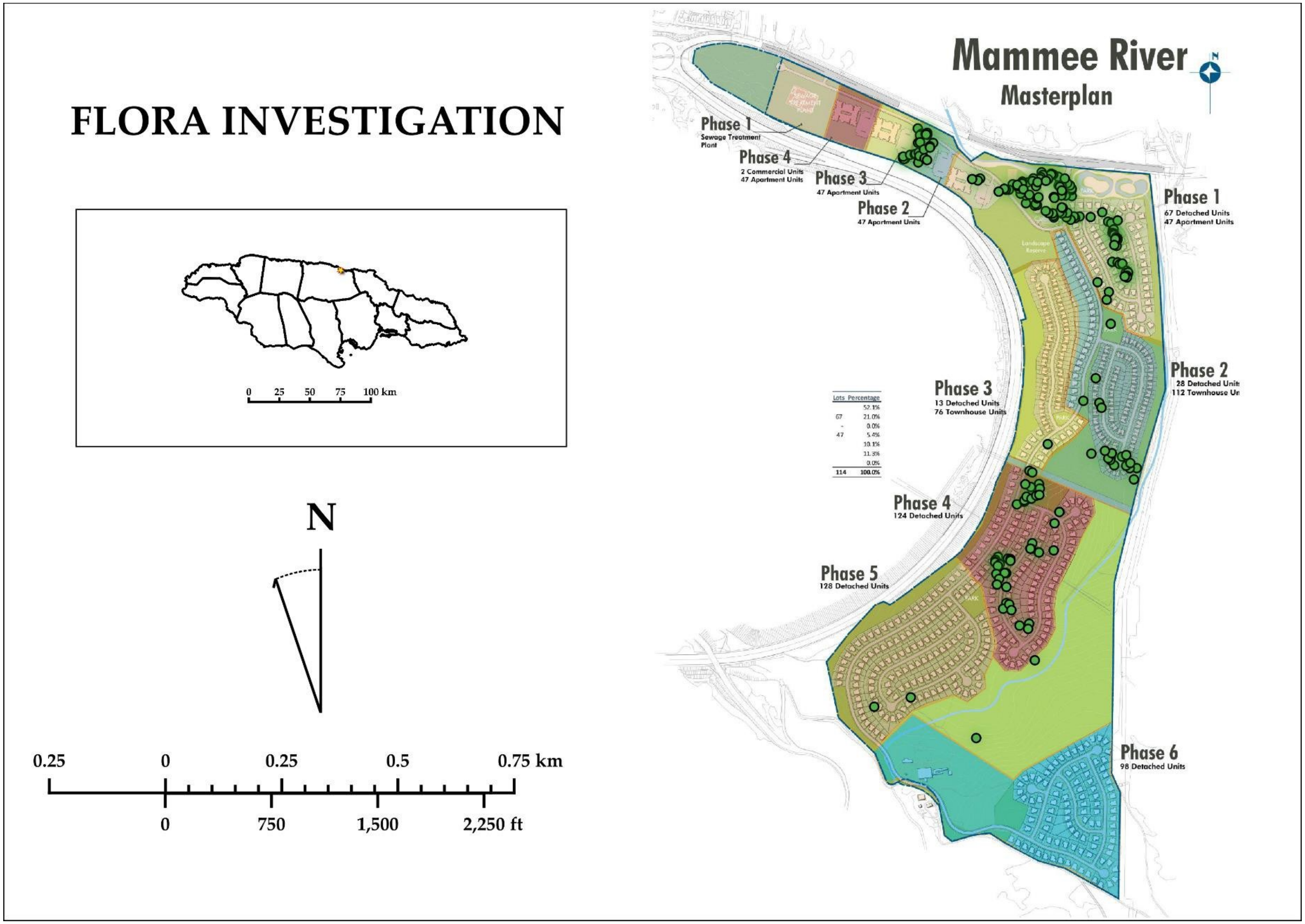


Figure 8: Map showing the location of tagged trees across the proposed Mammee River Development. Several sections were unable to surveyed as they are either already cleared, devoid of trees, inaccessible or lacked large enough trees.

Whilst there were a vast number of species identified across the site, only a few species had trees with diameters that met the size requirements. These are listed in Table 1 below.

Table 1: List of trees identified and tagged during the survey along with their characteristics

Tree Code	Latitude	Longitude	Species Name	Common Name	Tree Height	DBH	Conservation Status
T1	18.42108833	-77.155025	*Delonix regia*	Poinciana	55	33.0	Introduced
T2	18.42109167	-77.15506833	*Delonix regia*	Poinciana	50	25.0	Introduced
T3	18.42107833	-77.15505	*Delonix regia*	Poinciana	45	43.0	Introduced
T4	18.42112667	-77.155065	*Delonix regia*	Poinciana	45	115.5	Introduced
T5	18.42116	-77.15492333	*Delonix regia*	Poinciana	50	71.0	Introduced
T6	18.42117167	-77.15483	*Delonix regia*	Poinciana	45	36.0	Introduced
T7	18.42117833	-77.15481167	*Delonix regia*	Poinciana	55	43.0	Introduced
T8	18.421205	-77.15475	*Delonix regia*	Poinciana	40	38.0	Introduced
T9	18.42167	-77.15476833	*Delonix regia*	Poinciana	30	51.5	Introduced
T10	18.42156833	-77.15469	*Delonix regia*	Poinciana	55	25.0	Introduced
T11	18.42156333	-77.15464833	*Delonix regia*	Poinciana	40	29.0	Introduced
T12	18.42154	-77.15472333	*Delonix regia*	Poinciana	25	26.0	Introduced
T13	18.42156167	-77.15461167	*Cecropia peltata*	Trumpet Tree	45	33.0	Common
T14	18.421585	-77.15457667	*Terminalia latifolia*	Broadleaf	30	24.5	Endemic
T15	18.42154667	-77.154575	*Delonix regia*	Poinciana	30	38.5	Introduced
T16	18.42155333	-77.15459833	*Delonix regia*	Poinciana	25	30.0	Introduced
T17	18.42139167	-77.15476167	*Delonix regia*	Poinciana	45	25.0	Introduced
T18	18.42140333	-77.15472167	*Delonix regia*	Poinciana	50	70.0	Introduced
T19	18.42139	-77.154455	*Terminalia latifolia*	Broadleaf	20	37.0	Endemic
T20	18.42101333	-77.15475833	*Delonix regia*	Poinciana	50	48.5	Introduced
T21	18.42113833	-77.154735	*Delonix regia*	Poinciana	45	31.0	Introduced
T22	18.42126333	-77.15464333	*Delonix regia*	Poinciana	45	46.0	Introduced
T23	18.42132667	-77.15452333	*Delonix regia*	Poinciana	30	46.5	Introduced

Tree Code	Latitude	Longitude	Species Name	Common Name	Tree Height	DBH	Conservation Status
T24	18.42130167	-77.15452	*Cecropia peltata*	Trumpet Tree	25	27.5	Common
T25	18.421095	-77.15463	*Delonix regia*	Poinciana	45	39.0	Introduced
T26	18.42106	-77.15457833	*Delonix regia*	Poinciana	50	26.0	Introduced
T27	18.42069333	-77.15352167	*Artocarpus altilis*	Breadfruit	30	53.0	Introduced
T28	18.42070333	-77.15349833	*Delonix regia*	Poinciana	35	29.0	Introduced
T29	18.420665	-77.153545	*Cecropia peltata*	Trumpet Tree	40	37.0	Common
T30	18.42069167	-77.15366167	*Cecropia peltata*	Trumpet Tree	45	45.0	Common
T31	18.41997	-77.15147333	*Cecropia peltata*	Trumpet Tree	55	36.5	Common
T32	18.41993833	-77.151565	*Cecropia peltata*	Trumpet Tree	40	28.5	Common
T33	18.41997167	-77.15158833	*Cecropia peltata*	Trumpet Tree	30	42.3	Common
T34	18.41990667	-77.151655	*Cecropia peltata*	Trumpet Tree	40	25.6	Common
T35	18.419955	-77.15174167	*Cecropia peltata*	Trumpet Tree	40	35.9	Common
T36	18.42004167	-77.15172167	*Cecropia peltata*	Trumpet Tree	45	44.3	Common
T37	18.42002833	-77.15183167	*Samanea saman*	Guango	40	50.5	Naturalized
T38	18.420055	-77.15188	*Cedrela odorata*	West Indian Cedar	30	30.8	Introduced; Common
T39	18.420135	-77.15181333	*Cecropia peltata*	Trumpet Tree	40	75.0	Common
T40	18.41995167	-77.15199833	*Terminalia catappa*	West Indian Almond	25	52.1	Naturalized
T41	18.419985	-77.15200667	*Samanea saman*	Guango	30	31.0	Naturalized
T42	18.42003	-77.15202167	*Terminalia catappa*	West Indian Almond	50	56.8	Naturalized
T43	18.42003667	-77.15210667	*Cecropia peltata*	Trumpet Tree	45	31.1	Common
T44	18.42007667	-77.15216333	*Terminalia catappa*	West Indian Almond	45	41.5	Naturalized
T45	18.42018	-77.15238667	*Roystonea princeps*	Morass Royal; Royal Palm	45	51.5	Endemic
T46	18.42019	-77.15233833	*Simarouba glauca*	Bitter Damson	45	59.4	Common
T47	18.420215	-77.152365	*Guazuma ulmifolia*	Bastard Cedar	25	102.5	Common
T48	18.42022667	-77.152565	*Andira inermis*	Cabbage Bark Tree	35	34.0	Common

Tree Code	Latitude	Longitude	Species Name	Common Name	Tree Height	DBH	Conservation Status
T49	18.420375	-77.15256667	*Cecropia peltata*	Trumpet Tree	55	26.1	Common
T50	18.42041167	-77.152675	*Cecropia peltata*	Trumpet Tree	50	75.0	Common
T51	18.42050667	-77.152705	*Cecropia peltata*	Trumpet Tree	40	50.4	Common
T52	18.42059167	-77.152835	*Tabebuia platyantha*	N/A	55	49.4	Endemic
T53	18.42048667	-77.15291333	*Terminalia catappa*	West Indian Almond	55	28.1	Naturalized
T54	18.42048667	-77.15297333	*Terminalia catappa*	West Indian Almond	35	31.0	Naturalized
T55	18.420505	-77.15300667	*Terminalia catappa*	West Indian Almond	55	80.9	Naturalized
T56	18.42045	-77.15312	*Grias cauliflora*	Anchovy Pear	15	10.0	Endemic
T57	18.420365	-77.15163167	*Catalpa longissima*	Yoke Wood	60	38.0	Common
T58	18.42049167	-77.151715	*Tabebuia platyantha*	Endemic Poui	50	37.6	Endemic
T59	18.42037333	-77.15175833	*Tabebuia platyantha*	Endemic Poui	40	56.9	Endemic
T60	18.42048333	-77.151635	*Tabebuia rosea*	Pink Poui	40	28.0	Common
T61	18.42051	-77.15163333	*Tabebuia rosea*	Pink Poui	60	39.0	Common
T62	18.42057	-77.15166833	*Cecropia peltata*	Trumpet Tree	65	34.4	Common
T63	18.42061167	-77.151725	*Terminalia catappa*	West Indian Almond	50	28.5	Naturalized
T64	18.42062167	-77.151875	*Simarouba glauca*	Bitter Damson	45	99.6	Common
T65	18.42057833	-77.15185333	*Cecropia peltata*	Trumpet Tree	55	62.2	Common
T66	18.42055833	-77.15183667	*Simarouba glauca*	Bitter Damson	60	36.8	Common
T67	18.42056833	-77.1519	*Catalpa longissima*	Yoke Wood	45	30.0	Common
T68	18.42073833	-77.15191	*Ficus maxima*	Fig	55	100+	Common
T69	18.42070333	-77.151775	*Cecropia peltata*	Trumpet Tree	55	26.3	Common
T70	18.42077833	-77.15200833	*Catalpa longissima*	Yoke Wood	60	39.6	Common
T71	18.420775	-77.15202333	*Simarouba glauca*	Bitter Damson	40	80.0	Common
T72	18.42079667	-77.15205167	*Nectandra antillana*	Sweetwood	35	77.0	Common
T73	18.42077167	-77.15206833	*Omphalea triandra*	Pop Nut	7	1.0	Endemic
T74	18.42077833	-77.152055	*Nectandra sp.*	Sweetwood	30	24.0	Common

Tree Code	Latitude	Longitude	Species Name	Common Name	Tree Height	DBH	Conservation Status
T75	18.42069	-77.15211333	*Cecropia peltata*	Trumpet Tree	50	28.0	Common
T76	18.42082333	-77.15224667	*Terminalia catappa*	West Indian Almond	40	135.7	Common
T77	18.42077167	-77.15222333	*Cedrela odorata*	West Indian Cedar	15	36.0	Introduced; Common
T78	18.42073	-77.15226333	*Catalpa longissima*	Yoke Wood	70	67.0	Common
T79	18.42069667	-77.152285	*Catalpa longissima*	Yoke Wood	55	64.0	Common
T80	18.420705	-77.15241667	*Simarouba glauca*	Bitter Damson	45	40.0	Common
T81	18.420625	-77.15254167	*Terminalia catappa*	West Indian Almond	45	46.0	Naturalized
T82	18.420655	-77.15243	*Catalpa longissima*	Yoke Wood	45	79.0	Common
T83	18.42064167	-77.15263833	*Catalpa longissima*	Yoke Wood	50	31.5	Common
T84	18.42060667	-77.15264667	*Terminalia catappa*	West Indian Almond	40	31.3	Naturalized
T85	18.42056	-77.15273833	*Catalpa longissima*	Yoke Wood	40	56.0	Common
T86	18.42058	-77.15274167	*Nectandra sp.*	Sweetwood	45	59.2	Common
T87	18.42049667	-77.15261833	*Tabebuia rosea*	Pink Poui	30	42.5	Common
T88	18.42039	-77.152495	*Catalpa longissima*	Yoke Wood	35	36.1	Common
T89	18.42032167	-77.15233667	*Cecropia peltata*	Trumpet Tree	25	68.5	Common
T90	18.42034167	-77.15231	*Catalpa longissima*	Yoke Wood	20	34.5	Common
T91	18.420555	-77.15235833	*Chlorophora tinctoria*	Fustic Tree	25	34.0	Common
T92	18.42063333	-77.15232833	*Samanea saman*	Guango	20	57.0	Naturalized
T93	18.42065833	-77.15215833	*Bursera simaruba*	Red Birch	35	49.0	Common
T94	18.42054333	-77.151875	*Cecropia peltata*	Trumpet Tree	40	33.2	Common
T95	18.42043	-77.15182833	*Simarouba glauca*	Bitter Damson	30	33.0	Common
T96	18.42037667	-77.15184333	*Terminalia catappa*	West Indian Almond	35	50.5	Naturalized
T97	18.42034833	-77.15199833	*Ficus maxima*	Fig	25	200.0	Common
T98	18.42047167	-77.15183667	*Cedrela odorata*	West Indian Cedar	30	49.5	Introduced; Common

Tree Code	Latitude	Longitude	Species Name	Common Name	Tree Height	DBH	Conservation Status
T99	18.42032833	-77.15198667	*Cedrela odorata*	West Indian Cedar	30	25.5	Introduced; Common
T100	18.420145	-77.151835	*Catalpa longissima*	Yoke Wood	35	38.3	Common
T101	18.41068333	-77.15491167	*Samanea saman*	Guango	45	200.0	Naturalized
T102	18.41339667	-77.153135	*Samanea saman*	Guango	30	44.0	Naturalized
T103	18.41333833	-77.153185	*Samanea saman*	Guango	25	60.9	Naturalized
T104	18.41330167	-77.15319167	*Samanea saman*	Guango	35	37.8	Naturalized
T105	18.41329	-77.15319167	*Simarouba glauca*	Bitter Damson	30	62.3	Common
T106	18.413255	-77.1531	*Terminalia catappa*	West Indian Almond	35	30.5	Naturalized
T107	18.41336167	-77.15293333	*Samanea saman*	Guango	35	27.5	Naturalized
T108	18.413355	-77.15288167	*Samanea saman*	Guango	25	25.0	Naturalized
T109	18.41332167	-77.15288167	*Terminalia catappa*	West Indian Almond	25	28.3	Naturalized
T110	18.41322333	-77.15313833	*Terminalia catappa*	West Indian Almond	40	27.5	Naturalized
T111	18.41305167	-77.153125	*Samanea saman*	Guango	40	51.1	Naturalized
T112	18.41306667	-77.15316833	*Cedrela odorata*	West Indian Cedar	45	400.0	Introduced; Common
T113	18.41308167	-77.15296667	*Terminalia catappa*	West Indian Almond	35	27.6	Naturalized
T114	18.41308667	-77.15299833	*Samanea saman*	Guango	40	35.5	Naturalized
T115	18.41297167	-77.15311167	*Terminalia catappa*	West Indian Almond	25	32.0	Naturalized
T116	18.41286333	-77.153155	*Samanea saman*	Guango	45	32.0	Naturalized
T117	18.41281667	-77.15296333	*Ficus maxima*	Fig	25	150.0	Common
T118	18.412395	-77.15303	*Bursera simaruba*	Red Birch	30	25.0	Common
T119	18.41248167	-77.15290667	*Simarouba glauca*	Bitter Damson	25	49.8	Common
T120	18.41236833	-77.15286167	*Simarouba glauca*	Bitter Damson	35	64.0	Common
T121	18.41207	-77.152695	*Bursera simaruba*	Red Birch	25	27.1	Common

Tree Code	Latitude	Longitude	Species Name	Common Name	Tree Height	DBH	Conservation Status
T122	18.41210667	-77.1525	*Bursera simaruba*	Red Birch	40	34.5	Common
T123	18.41200667	-77.15252167	*Samanea saman*	Guango	35	30.0	Naturalized
T124	18.415575	-77.15212167	*Samanea saman*	Guango	25	37.2	Naturalized
T125	18.41641	-77.15139667	*Samanea saman*	Guango	40	200.0	Naturalized
T126	18.41684667	-77.151145	*Gliricidia sepium*	Quick Stick; Aaron's Rod	25	100.0	Common
T127	18.41637167	-77.15107167	*Samanea saman*	Guango	35	44.0	Naturalized
T128	18.41627667	-77.15102667	*Ceiba pentandra*	Silk Cotton Tree	50	100.0	Native
T129	18.41489333	-77.15036667	*Bursera simaruba*	Red Birch	60	63.6	Common
T130	18.41511	-77.15031	*Ficus maxima*	Fig	45	200.0	Common
T131	18.41510833	-77.15045167	*Ficus maxima*	Fig	45	100.0	Common
T132	18.41515667	-77.150525	*Simarouba glauca*	Bitter Damson	45	33.5	Common
T133	18.41520833	-77.15044	*Brosimum alicastrum*	Breadnut	50	100.0	Common
T134	18.41533333	-77.15061	*Brosimum alicastrum*	Breadnut	45	43.2	Common
T135	18.41536333	-77.15052333	*Brosimum alicastrum*	Breadnut	40	150.0	Common
T136	18.415165	-77.15076833	*Ficus aurea*	-	45	50.0	
T137	18.41529833	-77.15084	*Nectandra sp.*	Sweetwood	40	33.0	Common
T138	18.41526833	-77.15084833	*Nectandra sp.*	Sweetwood	40	62.7	Common
T139	18.4153	-77.15088833	*Catalpa longissima*	Yoke Wood	50	54.0	Common
T140	18.41539833	-77.15081667	*Ficus maxima*	Fig	55	250.0	Common
T141	18.415445	-77.15095667	*Ficus maxima*	Fig	60	450.0	Common
T142	18.41539	-77.15123333	*Chlorophora tinctoria*	Fustic Tree	40	39.2	Common
T143	18.41505833	-77.152495	*Samanea saman*	Guango	40	47.7	Naturalized
T144	18.41502833	-77.15243667	*Delonix regia*	Poinciana	50	36.8	Introduced
T145	18.41480333	-77.1523	*Samanea saman*	Guango	55	80.0	Naturalized
T146	18.414715	-77.15228333	*Samanea saman*	Guango	55	43.7	Naturalized
T147	18.41474667	-77.15246667	*Spondias mombin*	Hog Plum	50	54.1	Common
T148	18.4148	-77.15257833	*Cecropia peltata*	Trumpet Tree	30	42.0	Common
T149	18.41441167	-77.15275	*Samanea saman*	Guango	30	47.5	Naturalized

Tree Code	Latitude	Longitude	Species Name	Common Name	Tree Height	DBH	Conservation Status
T150	18.41446333	-77.15259667	*Samanea saman*	Guango	55	47.5	Naturalized
T151	18.41451	-77.15253833	*Samanea saman*	Guango	50	37.5	Naturalized
T152	18.41449	-77.15259833	*Samanea saman*	Guango	55	50.0	Naturalized
T153	18.41455833	-77.15255333	*Nectandra sp.*	Sweetwood	55	33.2	Common
T154	18.41452167	-77.15245333	*Samanea saman*	Guango	50	41.2	Naturalized
T155	18.41458	-77.152355	*Samanea saman*	Guango	50	53.9	Naturalized
T156	18.414595	-77.15229333	*Ficus maxima*	Fig	55	150.0	Common
T157	18.41426333	-77.151885	*Samanea saman*	Guango	55	30.1	Naturalized
T158	18.414045	-77.15198333	*Ficus maxima*	Fig	25	200.0	Common
T159	18.41352167	-77.152	*Samanea saman*	Guango	45	50.0	Naturalized
T160	18.41348667	-77.15230667	*Simarouba glauca*	Bitter Damson	35	30.4	Common
T161	18.41348167	-77.1523	*Simarouba glauca*	Bitter Damson	35	30.4	Common
T162	18.41366	-77.15243667	*Catalpa longissima*	Yoke Wood	55	36.1	Common
T163	18.41355167	-77.15246	*Bursera simaruba*	Red Birch	30	47.9	Common
T164	18.413555	-77.152475	*Bursera simaruba*	Red Birch	35	37.5	Common
T165	18.41870167	-77.15110667	*Terminalia catappa*	West Indian Almond	25	38.0	Naturalized
T166	18.41996	-77.15124833	*Delonix regia*	Poinciana	40	54.3	Introduced
T167	18.42005167	-77.15101167	*Ficus maxima*	Fig	40	500.0	Common
T168	18.41985167	-77.150825	*Nectandra sp.*	Sweetwood	40	30.0	Common
T169	18.41987	-77.15089167	*Nectandra sp.*	Sweetwood	30	32.7	Common
T170	18.419825	-77.15079833	*Grias cauliflora*	Anchovy Pear	25	27.0	Endemic
T171	18.41984	-77.15082833	*Nectandra sp.*	Sweetwood	40	68.9	Common
T172	18.41989333	-77.15069833	*Nectandra sp.*	Sweetwood	35	73.7	Common
T173	18.419705	-77.150795	*Cecropia peltata*	Trumpet Tree	40	39.4	Common
T174	18.41972	-77.15077833	*Cecropia peltata*	Trumpet Tree	35	33.0	Common
T175	18.41965167	-77.150805	*Cecropia peltata*	Trumpet Tree	45	52.2	Common
T176	18.41964167	-77.15077333	*Cecropia peltata*	Trumpet Tree	35	37.0	Common

Tree Code	Latitude	Longitude	Species Name	Common Name	Tree Height	DBH	Conservation Status
T177	18.41961333	-77.15077	*Terminalia catappa*	West Indian Almond	45	56.3	Naturalized
T178	18.41957333	-77.15072667	*Cecropia peltata*	Trumpet Tree	50	67.0	Common
T179	18.41953833	-77.15070333	*Cecropia peltata*	Trumpet Tree	40	47.0	Common
T180	18.41955167	-77.15070333	*Cecropia peltata*	Trumpet Tree	60	35.0	Common
T181	18.41940167	-77.15071833	*Samanea saman*	Guango	50	73.9	Naturalized
T182	18.419515	-77.15070333	*Nectandra sp.*	Sweetwood	45	40.0	Common
T183	18.41954167	-77.15071833	*Nectandra sp.*	Sweetwood	45	40.0	Common
T184	18.419535	-77.15074667	*Nectandra sp.*	Sweetwood	45	37.4	Common
T185	18.41941833	-77.15076667	*Cecropia peltata*	Trumpet Tree	35	42.0	Common
T186	18.419095	-77.15080833	*Samanea saman*	Guango	25	39.1	Naturalized
T187	18.41908333	-77.15069833	*Cecropia peltata*	Trumpet Tree	40	42.0	Common
T188	18.41905	-77.150655	*Nectandra sp.*	Sweetwood	25	100.0	Common
T189	18.41906	-77.15060333	*Nectandra sp.*	Sweetwood	40	60.0	Common
T190	18.41892333	-77.15051667	*Nectandra sp.*	Sweetwood	45	100.0	Common
T191	18.41885333	-77.15052167	*Grias cauliflora*	Anchovy Pear	25	41.4	Endemic
T192	18.41888	-77.15053333	*Grias cauliflora*	Anchovy Pear	30	40.0	Endemic
T193	18.41886667	-77.15048667	*Terminalia catappa*	West Indian Almond	40	40.6	Naturalized
T194	18.41889	-77.150485	*Cecropia peltata*	Trumpet Tree	45	44.0	Common
T195	18.41880167	-77.15052333	*Grias cauliflora*	Anchovy Pear	25	27.0	Endemic
T196	18.41882667	-77.15051	*Grias cauliflora*	Anchovy Pear	20	28.0	Endemic
T197	18.41879333	-77.15051	*Grias cauliflora*	Anchovy Pear	35	37.7	Endemic
T198	18.41881167	-77.15055333	*Brosimum alicastrum*	Breadnut	45	86.0	Common
T199	18.41851333	-77.15087667	*Cecropia peltata*	Trumpet Tree	40	72.0	Common
T200	18.41836167	-77.15092	*Samanea saman*	Guango	35	128.0	Naturalized
T201	18.41789667	-77.15083833	*Roystonea princeps*	Morass Royal; Royal Palm	55	36.0	Endemic

Prepared By:

Environmental Solutions Limited

Prepared For:

China Harbour Engineering Compan

M.Socioeconomic Survey Instrument for Mammee Bay Environmental Impact Assessment

Environmental Solutions Limited (ESL) has been contracted by the China Harbour Engineering Company (CHEC) Limited to conduct an Environmental Impact Assessment (EIA) for a Proposed Housing and Subdivision Project in Mammee Bay, St. Ann. A critical component of this assessment is conducting a survey to determine the socioeconomic environment of Mammee Bay and its surrounding areas. This assessment includes the administration of questionnaires to (i) Assess the 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 Mammee Bay 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:

Survey#:

Location:

Community Name:

SECTION 1 – DEMOGRAPHICS & HOUSEHOLD

1. What is your sex?
   - ☐ Male
   - ☐ Female

2. What is your age range?
   - ☐ 18-24
   - ☐ 25-34
   - ☐ 35-44
   - ☐ 45-54
   - ☐ 55-64
   - ☐ over 65

3. What is your / the head of household highest level of educational achievement /highest educational attainment?
   - ☐ Primary
   - ☐ Secondary
   - ☐ Vocational
   - ☐ Tertiary

4. Is the head of your household employed currently?
   - ☐ Yes
   - ☐ No

5. What is their/ your (main) current income generating activity? Please select one option from the list below
   - ☐ Bauxite mining
   - ☐ Farming
   - ☐ Tourism related activities
   - ☐ Commerce or retail activities
   - ☐ Other

6. Please specify the source of income, if not listed

7. How many members of your household currently attend basic school, primary school secondary school tertiary institutions?

8. How many members of your household have no academic qualifications at all?

9. How many children under the age of 18 live in your home?
   - ☐ 0
   - ☐ 1
   - ☐ 2
   - ☐ 3
   - ☐ 4
   - ☐ 5

10. How many adults over the age of 65 live in your home?
    - ☐ 0
    - ☐ 1
    - ☐ 2
    - ☐ 3

- ☐ 4
- ☐ 5

11. Do you have a disability? (If not please go to Question 14)
    a. Yes
    b. No

12. If you have a disability, please state the type of disability you have (Please select all that apply)
    a. Sight
    b. Hearing
    c. Speech
    d. Physical
    e. Intellectual disability
    f. Slowness of learning
    g. Other please specify

13. Were you born with this disability?
    a. Yes
    b. No

14. What is your employment status? (Please select all that apply)
    a. Employed (Full-time)
    b. Employed (Part-time)
    c. Unemployed
    d. Other. Please specify____________________________

15. What is your usual mode of transportation to and from Mammee Bay?
    ☐ Motor vehicle ☐ Public transportation ☐ Motor bike ☐ Bicycle
    ☐ Other. Please specify________________________________

16. How long have you lived in Mammee Bay? (years)

SECTION 2: PROJECT CONCEPT & APPROVAL (Explain and show Concept Drawing)

17. Do you approve of the project concept?
    - ☐ Highly Approve
    - ☐ Approve
    - ☐ Highly Disapprove

- ☐ Disapprove
- ☐ Neutral

18. How do you think that your community views the project?
    - ☐ Highly Approve
    - ☐ Approve
    - ☐ Disapprove
    - ☐ Highly Disapprove
    - ☐ Disapprove
    - ☐ Neutral

19. In your opinion do you think that this project is?
    - ☐ Very Necessary
    - ☐ Necessary
    - ☐ Highly Unnecessary
    - ☐ Unnecessary
    - ☐ Neutral

20. If you do not think that this project is necessary, please select reasons for your response from the following options
    - ☐ Design is not attractive
    - ☐ Waste of money
    - ☐ Government has misplaced priorities
    - ☐ Removes green space
    - ☐ Other

21. If the option is not provided, please provide another reason

22. What do you think would be a better use of the space? Please select (1) option from the listing below
    - ☐ Sports complex
    - ☐ Entertainment complex
    - ☐ Green Space
    - ☐ Business complex
    - ☐ Technical Vocational Centre (Skills Training Centre)
    - ☐ Police Command Centre
    - ☐ Fire Station
    - ☐ Fun Land
    - ☐ Bus Park
    - ☐ Military Camp
    - ☐ Shopping Mall
    - ☐ Modern Health Centre

☐ Amusement Park

SECTION 3 – INFORMATION TECHNOLOGY AND COMMUNICATION

23. Does your community have public internet access?
    a. Yes
    b. No
    c. Don't know

24. Do you or anyone in your household have a phone?
    a. Yes
    b. No

25. What type of phone is used in your household? (Please select all that apply)
    a. Landline
    b. Cell phone
    c. Smart cell phone (one that can access the internet)

26. Does your household have internet access?
    a. Yes
    b. No
    c. Don't know

SECTION 4- WATER CONSUMPTION AND SEWAGE

27. What is your household's main source of drinking water?

☐ Indoor piped water ☐ Outdoor piped water ☐ Standpipe ☐ Well
☐ Rainwater (tank) ☐ Trucked water (NWC) ☐ Trucked water (private)

☐ Bottled ☐ River water (Roaring River) ☐ Other, please specify

28. Is the service adequate?

☐ Yes ☐No ☐ Sometimes ☐ Don't know

29. If no or sometimes, why?

30. Do you utilize the Roaring River for any purpose?

a) Yes
b) No

If not, please proceed to Question 32

31. What do you use the Roaring River for?
    a. Recreation such as swimming
    b. Laundry
    c. Drinking
    d. Other, please specify

32. How frequently do you experience water lock-offs?
    a. Weekly
    b. Monthly
    c. More than every month but less than each year
    d. Yearly
    e. Primarily during droughts
    f. Has not experienced a water lock off

33. How is water stored when there is a lock-off?

☐ Tanks (concrete) ☐ Tanks (plastic) ☐ Bottles ☐ Buckets
☐ Other, please specify ☐ Do not store

34. What kind of sewage connections are used?

☐ Water Closet (WC) linked to central sewer network ☐ WC linked to on-site disposal system
☐ WC linked to off-site disposal system ☐ Pit
☐ Septic Tank
☐ Other, please specify

35. Are the toilet facilities used only by your household, or do other households use the same facilities?

☐ Shared ☐ Household use only

36. 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

SECTION 5: ENVIRONMENTAL CONCERNS

37. Are you concerned about how much this development will impact the Roaring River Great House and Wag Water Wheel?
    ☐ Yes
    ☐ No

27b. If you selected yes, please provide a reason

38. Have you experienced flooding in this community?
    a. ☐Yes
    b. ☐No

39. How often does flooding happen in your community?
    c. Yearly
    d. Monthly
    e. Weekly
    f. Every time during heavy rainfall

40. How would you rate the level of flooding in your community?
    ☐ Very bad ☐ Bad ☐ Not bad
    ☐ **Neutral**

41. Do you see flooding as a serious problem for the development of the area?
    ☐ Yes ☐ No ☐ Don't know

41b.If yes, please explain your answer

42. What are the likely natural hazards to affect the area? (Please select all that apply)
    ☐ Storm surge ☐ Earthquake ☐ Flash flooding ☐ Drought

43. Do you have any other environmental concerns for the community in relation to this development being implemented?
    ☐ Yes
    ☐ No

43b. 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 Wag Water Wheel and the Roaring River 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 6: SHOULD THE PROJECT GO AHEAD AS DESIGNED?

44. Based on your personal preference should the project proceed as designed?
    - ☐ YES
    - ☐ NO

45. If you selected NO, please select from below the (1) option which was most concerning:
    - ☐ Artistic design
    - ☐ Land use for the proposed housing development
    - ☐ Other

b) If the option was not provided, please provide an explanation

THANK YOU!

N. List of Flora recorded across the site

A.

Species Name	Common Name	DAFOR	Conservation Status	Habit
Terminalia catappa	West Indian Almond	A	Naturalized	Tree
Terminalia latifolia	Broadleaf	R	Endemic	
Tabebuia rosea	Pink Poui	O	Common	
Tabebuia platyantha	Endemic Poui	O	Endemic	
Spondias mombin	Hog Plum	R	Common	
Spathodea campanulate	African Tulip Tree	F	Invasive	
Simarouba glauca	Bitter Damson	F	Common	
Samanea saman	Guango	A	Naturalized	
Roystonea princeps	Morass Royal; Royal Palm	O	Endemic	
Psidium guajava	Guava	F	Common	
Piscidia piscipula	Dogwood	F	Native	
Pimenta dioica	Pimento	O	Common	
Omphalea triandra	Pop Nut	R	Endemic	
Nectandra sp.	-	O	Common	
Nectandra antillana	Long-leaved Sweetwood	F	Common	
Leucaena leucocephala	Lead Tree	F	Common	
Haematoxylum campechianum	Logwood	F	Introduced; Naturalized	
Guazuma ulmifolia	Bastard Cedar	R	Common	
Grias cauliflora	Anchovy Pear	F	Endemic	
Gliricidia sepium	Quick Stick; Aaron's Rod	R	Common	
Ficus maxima	Fig	F	Common	
Ficus aurea	-	R	Common	
Ficus americana	Jamaican Cherry Fig	O	Introduced	
Fagara martinicensis	Prickly Yellow, Yellow Hercules	F	Common	
Delonix regia	Poinciana	A	Introduced	
Cupania glabra	Wild Ackee		Common	
Comocladia pinnatifolia	Maiden Plum	F	Native	
Cocos nucifera	Coconut	O	Naturalized	
Clusia sp.	-	O	Common	
Chlorophora tinctoria	Fustic Tree	R	Common	
Ceiba pentandra	Silk Cotton Tree	R	Native	
Cedrela odorata	West Indian Cedar	O	Introduced; Common	
Cecropia peltata	Trumpet Tree	D	Common	
Catalpa longissima	Yoke Wood	F	Common	
Cassia emarginata	Senna Tree	O	Common	
Cassia fistula	Golden Shower Tree	F	Introduced	
Bursera simarouba	Red Birch	F	Common	
Brosimum alicastrum	Breadnut	O	Common	

Species Name	**Common Name**	**DAFOR**	**Conservation Status**	**Habit**
Bambusa vulgaris	Bamboo	F	Invasive	
Andira inermis	Cabbage Bark Tree	R	Introduced	
Acacia tortuosa	Wild Poponax	F	Common	
Adenanthera pavonina	Crab Eye Tree			
Artocarpus altilis	Breadfruit	O	Introduced	

B.

C.

Species Name	**Common Name**	**DAFOR**	**Habit**
Allamanda cathartica	Yellow Allamanda	A	Shrubs
Chromolaena odorata	Christmas Bush	F	
Colubrina asiatica	Hoop Withe	A	
Cordia bifurcate	-	O	
Cordia bullata	Black Sage	A	
Desmanthus virgatus	Wild tantan	F	
Lantana camara	Wild Sage, White Sage	A	
Lantana jamaicensis	-	R	
Piper amalago var. nigrinodum	Black Jointer	O	
Piper sp.	Piper	F	
Pisonia aculeata	Cockspur	F	
Sida acuta	Broomweed	D	
Sida sp.	-	A	
Solanum erianthum	Wild Susumber	F	
Solanum turvum	Susumber/Gully Bean	A	
Thunbergia alata	Black-eyed Susan	F	
Asclepias curassavica	Red Top, Redhead	O	Herbs
Bidens Pilosa	Spanish Needle	D	
Bryophyllum pinnatum	Leaf-of-Life	A	
Cenchrus echinatus	Southern sandbur	F	
Clitoria sp	Butterfly Pea	F	
Colocasia esculenta	Dasheen	F	
Commelina diffusa	Water Grass	F	
Conyza canadensis	Canada Fleabane	O	
Desmodium adscendens	Tick-clover; Sweetheart	F	
Desmodium sp.	Beggars lice	O	
Euphorbia cyathophora	Dwarf Poinsettia	O	
Euphorbia heterophylla	Milkweed	F	
Heliotropium angiospermum	Dog’s Tail	F	
Heliotropium indicum	Scorpion Weed, Wild Clary	O	
Hohenbergia sp	-	O	
Lippia strigulosa	-	F	
Lippia stoechadifolia	Fogfruit	F	

Species Name	Common Name	DAFOR	Habit
Mimosa pudica	Shame-o-lady, Shame Weed	A	
Musa sapientum	Banana	O	
Panicum maximum	Guinea Grass	A	
Plumbago sp.	Leadword	F	
Rhynchospora nervosa	Star Grass	F	
Saccharum officinarum	Sugar Cane	A	
Stachytarpheta jamaicensis	Vervine	F	
Stenotaphrum secundatum	Crab Grass	F	
Syngonium auritum	Five finger	A	
Vernonia sp.	Bitter leaf	O	
Wedelia trilobata	Marigold	F	
Abutilon sp.	Velvet leaf	A	Shrubby Herbs
Borreria verticillata	Wild Scabious	F	
Cassia ligustrina	Privet	F	
Cassia occidentalis	Dandelion	D	
Catharanthus roseus	Periwinkle	F	
Ruellia sp.	Wild Petunia	O	
Turnera ulmifolia	Ram-goat Dashalong	A	
Polypodium phyllitidis	Cow tongue fern	F	Ferns
Adiantum sp	Maidenhair Fern	F	
Thelypteris sp.	Maiden Fern	A	
Nephrolepsis sp.	Sword Fern	D	
Abrus precatorius	Crab Eyes, Red Bead Vine, Wild Liquorice	F	Epiphytes & Climbers
Centrosema virginianum	Spurred Butterfly Pea	A	
Hohenbergia sp.	Endemic Bromeliad	F	
Hylocereus triangularis	Endemic Epiphytic cacti	F	
Ipomoea sp.	Sweet Pea	A	
Momordica balsamina	Cerasee	A	
Passiflora sp.	Passion Flowers	O	
Phaseolus vulgaris	Red Peas	F	
Philodendron scandens	Wicker Vine	F	
Tournefortia volubilis	Chigger Nut	D	

3.

O. List of Birds recorded across the site

Scientific Name	Common Name	Status	Ranking
Falco sparverius	American Kestrel	Resident	R
Setophaga ruticilla	American Redstart	Migrant	O
Tachornis phoenicobia	Antillean Palm-Swift	Resident	O
Chordeiles gundlachii	Antillean Nighthawk	Migrant	F
Coereba flaveola	Bananaquit	Resident	F
Tyto alba	Barn Owl	Resident	R
Cypseloides niger	Black Swift	Resident	A
Mniotilta varia	Black-and-white Warbler	Migrant	R
Melanospiza bicolor	Black-faced Grassquit	Resident	O
Vireo altiloquus	Black-Whiskered Vireo	Resident	O
Leptotila jamaicensis	Caribbean Dove	Resident	R
Bubulcus ibis	Cattle Egret	Resident	A
Tyto alba	Common Barn Owl	Resident	R
Columbina passerina	Common Ground Dove	Resident	O
Tyrannus dominicensis	Gray Kingbird	Resident	O
Loxigilla violacea	Greater Antillean Bullfinch	Resident	R
Quiscalus niger	Greater Antillean Grackle	Resident	A
Forpus passerinus	Green-rumped Parrotlet	Introduced	R
Todus todus	Jamaica Tody	Endemic	R
Corvus jamaicensis	Jamaican Crow	Endemic	O
Myiopagis cotta	Jamaican Elania	Endemic	R
Euphonia Jamaica	Jamaican Euphonia	Endemic	F
Saurothera vetula	Jamaican Lizard-cuckoo	Endemic	R
Anthracothorax mango	Jamaican Mango	Endemic	R
Icterus leucopteryx	Jamaican Oriole	Resident	R
Eupsittula nana	Jamaican Parakeet	Endemic	O
Todus todus	Jamaican Tody	Endemic	R
Vireo modestus	Jamaican Vireo	Endemic	R
Melanerpes radiolatus	Jamaican Woodpecker	Endemic	O
Tyrannus caudifasciatus	Loggerhead Kingbird	Resident	O
Mimus polyglottos	Northern Mockingbird	Resident	O
Parkesia noveboracensis	Northern Waterthrush	Migrant	R
Dendroica discolor	Prairie Warbler	Migrant	R
Crotophaga ani	Smooth-billed Ani	Resident	O
Trochilus polytmus	Red-billed Streamertail	Endemic	R
Buteo jamaicensis	Red-tailed Hawk	Resident	R
Geotrygon montana	Ruddy Quail Dove	Resident	R
Myiarchus validus	Rufous-tailed Flycatcher	Endemic	R
Myiarchus barbirostris	Sand Flycatcher	Endemic	R
Crotophaga ani	Smooth-billed Ani	Resident	O
Myiarchus stolidus	Stolid Flycacther	Resident	R
Spindalis zena	Stripe-headed Tanager	Resident	R
Lonchura malacca	Tricolored Munia	Introduced	F
Carthartes aura	Turkey Vulture	Resident	F

Scientific Name	Common Name	Status	Ranking
Mellisuga minima	Vervain Hummingbird	Resident	O
Columba leucocephala	White Crowned Pigeon	Resident	O
Turdus aurantius	White-chinned Thrush	Endemic	F
Zenaida asiatica	White-Winged Dove	Resident	O
Tiaris olivacea	Yellow-faced Grassquit	Resident	F
Loxipasser anoxanthus	Yellow-shouldered Grassquit	Endemic	O
Zenaida aurita	Zenaida Dove	Resident	O

P. List of Other Fauna recorded across the site

Scientific Name	Common Name	Conservation Status	IUCN	DAFOR Rating
Amphibians				
Rhinella marina	Cane toad	Introduced	LC	F
Eleutherodactylus cundalli	Jamaican Rock Frog	Endemic	VU	O
Eleutherodactylus gossei gossei	Jamaican Forest Frog	Endemic	VU	D
Eleutherodactylus grabhami	Jamaican Pallid Frog	Endemic	EN	R
Eleutherodactylus jamaicensis	Jamaican Bromeliad Frog	Endemic	CR	A
Eleutherodactylus johnstonei	Lesser Antillean Whistling Frog	Introduced	LC	A
Eleutherodactylus junori	Rock Pocket Frog	Endemic	CR	R
Eleutherodactylus pantone	Jamaican Yellow-Bellied Frog	Endemic	-	O
Eleutherodactylus planirostris	Greenhouse Frog	-	LC	O
Eleutherodactylus sisyphodemus	Leaf Mimic Frog	Endemic	CR	R
Osteopilus crucialis	Jamaican Snoring Frog	Endemic	VU	R
Osteopilus marianae	Yellow Bromeliad Frog	Endemic	EN	R
Osteopilus ocellatus	Jamaican Laughing Frog	Endemic	NT	R
Osteopilus wilder	Green Bromeliad Frog	Endemic	VU	R
Reptiles				
Celestus barbouri	Limestone Forest Galliwasp	Endemic	EN	R
Celestus crusculus	German Galliwasp	Introduced	LC	O
Celestus hewardii	Heward's Galliwasp	-	EN	R
Chilabothrus subflavus	Jamaican Boa	Endemic	VU	R
Aristelliger praesignis	Croaking Lizard	Endemic	LC	O
Hemidactylus mabouia	Tropical House Gecko	Introduced	LC	O
Sphaerodactylus argus argus	Ocellated gecko	Native	LC	O
Sphaerodactylus goniorhynchus	Jamaican Forest Sphaero	Endemic	NT	R
Anolis garmani	Jamaican Giant Anole	Endemic	LC	F
Anolis grahami graham	Graham's Anole	Endemic	LC	F
Anolis lineatopus	Stripefoot Anole	Endemic	LC	O
Anolis opalinus	Bluefields Anole	Endemic	LC	F
Anolis sagrei	Brown Anole	Introduced	LC	F

Scientific Name	Common Name	Conservation Status	IUCN	DAFOR Rating
Anolis valencienni	Jamaican Twig Anole	Endemic	LC	R
Hypsirhynchus funereus	Jamaican Black Groundsnake	Endemic	LC	R
Typhlops jamaicensis	Jamaica Worm Snake	Endemic	LC	O
Butterflies and Moths				
Eurema nise	Mimosa Yellow	Introduced	-	O
Phoebis sennae sennae	Cloudless Sulphur	Introduced	LC	O
Ascia monuste eubotea	Antillean Great White/Cabbage Butterfly	-	-	O
Heliconius simulator	Jamaican Zebra Longwing	Endemic	-	O
Dryas iulia delia	Julia Longwing	Endemic	-	F
Dione vanillae	Gulf Fritillary	-	LC	O
Anartia jatrophae jamaicensis	Jamaican White Peacock	-	-	F
Mestra dorcas	Jamaican Mestra	Endemic	-	O
Urbanus proteus	Long-tailed Skipper	Introduced	-	R
Leptotes cassius theonus	Cassius Blue	Introduced	-	O
Dione vanillae insularis	Tropical Silverspot	-	-	A
Calisto zangis	Jamaican Satyr/Calisto	Endemic	-	O
Bats				
Artibeus jamaicensis	Jamaican Fruit Bat	Native	LC	R
Eumops glaucinus	Wagner's Bonneted Bat	Native	LC	R
Molossus milleri	Pallas' Mastiff Bat	Native	LC	R
Moormops blainvillei	Antillean Ghost-faced Bat	Native	LC	R
Noctilio leporinus	Fishing Bat	Native	LC	R
Nyctinomops macrotus	Big Free-tailed Bat	Native	LC	R
Pteronotus macleayii	MacLeay's Mustached Bat	Native	LC	R
Pteronotus parnellii	Parnell's Mustached Bat	Native	LC	R
Pteronotus quadridens	Sooty Mustached Bat	Native	LC	R
Tadarida brasiliensis	Free-tailed Bat	Native	LC	R

Land Snails	
Pleurodonte lucerne	F
Dentellaria invalida	F
Thelidomus aspera	F
Zachrysia provisora	D
Cyclochittya chittyi	F
Sagda spei spei	R
Urocoptis brevis	R
Urocoptis sp.	R
Alcadia atrinolabris	R
Alcadia hirsute	R
Lucidella aureola	F
Lucidella depressa	R
Eutrochatella pulchella	F
Hemitrochus graminicola	F
Parachondria fascia fascia	R
Varicella sp	R
Apoma agnesianum	O

D.

E.

Q. Description of Air Quality Sites

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
AQ1	18.423705, -77.159810	The pump was set up ~150ft north of a busy main road (Drax Hall to Ocho Rios A1) on a minor paved road bordering Villas located to the northwest of the proposed project location. ~20 ft to the south of the pump set up location was a bark with dried grass and cut branches. ~10ft north of the pump set up location was a wall partially covered with vines; cactus and flowers were planted in front of this wall. **Environmental Conditions: Light winds; very hot; scattered clouds** 	The pump was set up close to the northwest boundary of the property. A major roadway was located approximately 150ft south of the set-up location with heavy traffic. The pump was set up on a paved roadway, the bank south of the site has been cut recently and there was also dried grass approximately 5ft north of the site. Flowers and shrubs were also located north of the site. **Environmental conditions: Sunny with clear skies. Light SW winds.**

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
AQ2	18.422068, -77.153805	The pump was set up on a light post ~6ft north of an unpaved roadway. The ground surrounding the pump was covered in grass and shrubs. Branches immediately around the filter were cleared, however, there was a thickly vegetated area north of the set-up location. A major roadway was located approximately 30ft south of pump location. A river ran parallel to the pump set **Environmental Conditions: Cloudy skies; scattered light rainfall**	The pump was set up at location close to the northern boundary of property. The pump was set up on a light post just 5ft north of an unpaved roadway. The site was covered with shrubs approximately 20ft north, west, east and south of site. There was a dense population of mature trees beyond this region. Approximately 30ft south of location is a major roadway with vehicular traffic. A shallow rapidly moving stream ran parallel to the pump set up location. There was also dried branches and leaves in the area. **Environmental Conditions: Clear skies, sunny, light winds.**
AQ3	18.421710, -77.152955	The pump was set-up at the entrance to the Laughing Waters Villa, away from buildings, trees or objects will impede or restrict air flow around the pump. A paved roadway was located to the west of the pump set up location. A guard house was located to the east of the pump set up location. The Roaring River Hydroelectric Plant was located to the southwest of the pump set up location Beyond the plant was a densely vegetated area and a water source could be heard. ~200ft south of the pump set up location was the main roadway (Drax Hall to Ocho Rios A1 Road). The ground and vegetation in the area were damp. **Environmental Conditions: Cool, damp, overcast**	The pump was set up a site located at the northeast boundary of the property. The pump was set up at the entrance to Laughing Waters on a grassy, elevated area ~3ft from the paved ground. The paved roadway/entrance to the villa was approximately 2ft away from the pump location. The hydroelectric plant was located ~60ft west of the pump location. At the time of set up, a crane was in the area. There was loose dirt/ sand located approximately six feet (~6ft) north of the set-up location. There was a guardhouse approximately 15ft north of the pump set up location. Palm trees and/or shrubs were located 3- 5ft away from the pump, however the pump was not shaded by any of these. There was a major roadway with heavy traffic southwest of the pump location. **Environmental Conditions: Moderate winds, sunny with broken clouds**

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
			
AQ4	18.414274, -77.152955	The pump was set up on a post ~30ft east of the Highway 2000. Trees were located ~20ft west of the post. Area around pump is grassed and an unpaved roadway was located ~30ft east of the post. **Environmental Conditions: Sunny; partially cloudy skies; light winds**	This site was located at the western boundary of the property. The pump set up on a light post located approximately 50ft east of the highway. A moderate number of mature trees were located just east of the highway. The ground was covered with tall grasses. Dense vegetation located ~ 150 ft east of the pump set-up location. This vegetation was mainly dry but was damp in more densely vegetated areas and at the bases of trees. **Environmental Conditions: Light winds; sunny with broken clouds.**

<table>
<tr><th rowspan="2">Sample Location</th><th rowspan="2">GPS Coordinates</th><th colspan="2">Description</th></tr>
<tr><th>October 2022</th><th>January 2023</th></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>AQ7</td><td>18.424346,
-77.160552</td><td>The pump was set up on a pole ~15ft above ground; the base on this pole was anchored into a concrete structure. The structure was located in an open area northwest of the proposed project location on the lawn of a residential property. A light post was located to the SE of the pump set up location and trees were seen ~70ft away. The ground was grassed, and NW of the pump set up location was a 2-story house. A paved roadway was located towards ~50ft west of the pump location. Gardening activities were being done at the time of</td><td>The pump was set up at a site located close to the north-west boundary of the proposed development at the guard house located at the entrance to Old Fort Bay The roadway was paved and a major roadway was located approximately 15ft away from the pump set up location. There was a boundary wall just west of site while palm trees and grassed area were located approximately 10ft east of site.
Environmental Conditions: Sunny, broken clouds, moderate winds</td></tr>
</table>

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
		the assessment. A major roadway was located ~100ft south. A chain-link fence, shrubs and trees were seen at the boundary of the property and roadway.  **Environmental Conditions: Sunny; partially cloudy skies; light winds**	
AQ8	18.410236, -77.157270	The pump was set up close to the south-western boundary of the proposed project location in a cleared area. Shrubs and tall grasses were in the area surrounding the pump. Trees were located towards the south, west and east ~25ft in each direction. No branches from any of these trees shadowed the pump. ~5ft north of the pump set-up location was an unpaved roadway. The grass along the edge of this roadway was freshly cut. Dried leaves were also	The pump was set up in a cleared area at the SW project boundary. An unpaved roadway was located approximately 10ft north of the pump set up site. The area surrounding the pump set up location was covered with grass and shrubs. Mature trees were located ~25ft north, west and south of the set-up location. The grass was damp as well as the soil.

<table>
<tr><th rowspan="2">Sample Location</th><th rowspan="2">GPS Coordinates</th><th colspan="2">Description</th></tr>
<tr><th>October 2022</th><th>January 2023</th></tr>
<tr><td></td><td></td><td>seen along the roadway and to either side of the pump set up location. On the opposite side of the roadway, north of the pump set up location, was a heavily vegetated area consisting of shrubs, grass, and trees.
Environmental Conditions: Sunny with partially cloudy skies. Light winds.
</td><td>**Environmental Conditions: Cool, partially cloudy skies, light winds**</td></tr>
</table>

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
AQ9	18.409250, -77.154861	The pump was placed on the trunk of a lone palm tree ~20 ft to the north of the Roaring River Greathouse. The area north of the tree sloped downwards and was heavily vegetated. The sea could be clearly seen from the sampling area. The road adjacent to the pump station was grassy. There was an abandoned structure ~15 ft northwest of the pump station. **Environmental Conditions: Sunny with partially cloudy skies** 	The pump was set up on a palm tree close to the south boundary of the property. The vegetation was damp. A building was located just south of the pump set up location. **Environmental Conditions: Light north winds, cool temperatures, ground covered in grass and shrubs**.
AQ10	18.405610, -77.149802	The pump was placed in an open area with no trees shadowing the pump. The area in an approximate ~10ft diameter around the pump was clear. The area north of this clearing was densely vegetated with low lying plants, vine like plants and thin trunked tees further north of the sampling station. Litter was seen on the ground was seen to the west of the pump location. There was evidence of burning nearby to the sampling location (charred wood seen). The area to the west of the sampling location has tracks created by vehicles. A water	This site is located at the SW boundary of the property. Pump set up in a cleared area with grass covered ground. A few natural and man-made debris were present such as plastic containers. Approximately 6ft south of the pump set up location was a moderately moving stream of water within a canal. Approximately 30ft north, west and east of the pump location was mature trees. The vegetation was damp. **Environmental Conditions: Overcast, cool, light winds**

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
		channel was located to the east of the sampling location. The ground was covered with freshly cut grass, pieces of cardboard and dried leaves to the south and west of the pump location. **Environmental Conditions: Sunny with partially cloudy skies**	
AQ11	18.416944, -77.150555	The pump was set-up on a tree. The area ~15ft around the pump was unshaded, however, the area beyond this was densely vegetated. The trees and ground were damp from recent rainfall events. **Environmental Conditions: Cool, overcast, damp, light rains**	The pump was set up on a slender tree. The general area of the pump set up location was densely vegetated, however the 10ft radius around the pump set up location was relatively clear. The vegetation and soil in the area was damp. An unpaved walkway was approximately 3ft west of the pump location. **Environmental Conditions: Sunny with broken clouds, very light winds**

R. Description of Noise Survey Sites

Table 14-2: Description of Sources of Noise heard on Each Survey Day (October 2022)

Survey Site	Day 1 Noise Observations	Day 2 Noise Observations
Site 1	Noise heard from an electric saw, light chatter, vehicular noises and rustling of leaves.	Noise heard from light chatter, vehicular noises and rustling of leaves
Site 2	Noise heard from vehicles in the distance, throttling cars and a nearby river.	Noise heard from vehicles in the distance, throttling cars, rainfall on leaves, cars & ground, and a nearby river.
Site 3	Noise heard from hydroelectric plant, river in the distance, vehicles traversing on roadway ~200ft away, vehicles leaving the Laughing Waters Villa and light chatter.	Noise heard from hydroelectric plant, river in the distance, vehicles traversing on roadway ~200ft away, a car playing music and light chatter.
Site 4	Noise heard from vehicles traversing on the highway (especially heavy trucks) and leaves rustling.	Noise heard from vehicles traversing on the highway (especially heavy trucks), crickets, car throttling and leaves rustling.
Site 7	Noise heard from trucks and other vehicles in the distance, dogs barking nearby to survey location, light chatter, rustling leaves and birds chirping.	Same as Day 1.
Site 8	Noise heard from trucks in the distance, birds chirping and leaves rusting intermittently.	Noise heard from trucks in the distance, a truck horn, birds chirping, a cell phone ringing, crickets and leaves rusting intermittently.
Site 9	Noise heard from trucks in the distance, leaves rustling gently in the wind, birds chirping, babies babbling nearby and light chatter.	Noise heard from trucks in the distance, leaves rustling gently in the wind and birds chirping.
Site 10	Noise heard from stream adjacent to sampling location, birds chirping in the distances, leaves gently rustling, light chatter and crickets.	Same as Day 1.
Site 11	Noise not collected due to light rainfall at location at time of proposed survey.	Noise heard from crickets, birds, light chatter, rustling leaves, car horns, vehicles in the distance and leaves crunching on the ground.

All environmental conditions were the same as that of the AQ locations for Day 1.

Day 2 environmental conditions were overcast and cool with sporadic light rainfalls.

Table 14-3: Description of Sources of Noise heard on Each Survey Day (January/ February 2023)

Survey Site	Day 1 Noise Observations	Day 2 Noise Observations
Site 1	Noise heard from vehicular traffic and rustling of leaves.	Noise heard from light chatter, vehicular noises (including trucks) and rustling of leaves
Site 2	Noise heard from birds chirping, a nearby river, vehicular noises (including a helicopter) and leaves rustling.	Noise heard from birds chirping, a nearby river, vehicular noises and leaves rustling.
Site 3	Noise heard from hydroelectric plant, river in the distance and vehicles traversing on roadway ~200ft away.	Same as Day 1
Site 4	Noise heard from vehicles traversing on the highway (especially heavy trucks), distant music, vehicle horns and leaves rustling.	Noise heard from vehicles traversing on the highway (especially heavy trucks), chatter and leaves rustling.
Site 7	Noise heard from vehicles in the distance, rustling leaves and birds chirping.	Same as Day 1.
Site 8	Noise heard from vehicles in the distance, birds chirping and leaves rustling.	Noise heard from vehicles in the distance, vehicle horns and birds chirping.
Site 9	Noise heard from dogs barking, trucks and other vehicles in the distance, and leaves rustling.	Noise heard from trucks and other vehicles in the distance, water running and leaves rustling.
Site 10	Noise heard from stream adjacent to sampling location, birds chirping in the distance and crickets.	Noise heard from stream adjacent to sampling location, birds chirping in the distance and rustling leaves.
Site 11	Noise heard from birds chirping, vehicles in the distance and leaves rustling.	Noise heard from birds chirping, light chatter and vehicles in the distance.

All environmental conditions were the same as that of the AQ locations for Day 1.

Day 2 environmental conditions were sunny with broken clouds and light winds.

S. Description of Water Quality Locations

Table 14-4 Description of Fresh Water Quality Sample Locations

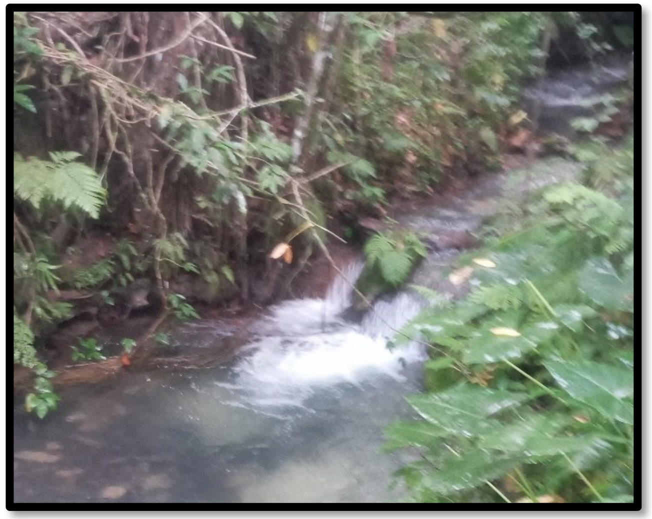
Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
WQ1	18.408737, -77.155282	This sampling site was upstream of the proposed project location. The sampling location was located ~15ft from a roadway. River stones were observed, and vegetation was seen along the banking of the river. The river banking was partially exposed, and the water bottom was clearly seen. The sample collected was faint yellow and clear and had no discernible odors. **Environmental Conditions: Sunny with clear skies** 	This sampling site was upstream of the proposed project location. The sample location was a small shallow stream located towards the west of the Roaring River Greathouse. This stream feeds into a culvert that brings water under a road located to the north of this stream. The area was heavily vegetated and natural debris was seen along the banking. This banking also had some exposed areas. The point that the sample was taken at was about 3 inches deep and 2 feet wide. The water in this area was fast flowing at the time of the sampling exercise and the bottom of the sampling area was clearly seen. Moss was observed growing on large rocks. Upstream of the sampling point, the stream was about 5-6 ft wide. Shrubs and plants up to 4 feet high was seen growing in the water way. No man-made debris was observed, however, a metal pipe that has some amount of rust and moss growth on it was seen just north of the sampling area. The sample collected was clear and colorless. **Environmental Conditions: Overcast, cool, evidence of earlier rainfall**

Sample Location	**GPS Coordinates**	**Description**	
		October 2022	**January 2023**
			
WQ2	18.403558, -77.14977	This sampling area was upstream of the proposed project location. The sampling location was a ~20-40ft wide dammed area. A portion of this dam channels water into the Roaring River Pipeline or the Roaring River hydro-electric plant while the other portion is channeled back into the natural environment. The river had a moderate flow. The river banking was comprised of concrete and stone structures while the vegetation next to this banking (east of the river) comprised of tall thin trunked trees and other water loving plants. Butterflies were seen at this location and fruit trees were observed in the general vicinity of the sampling area. Plant litter was seen in the water. The bottom of the water could not be seen, and the sample collected appeared slightly cloudy with few suspended solids.	This sampling area was upstream of the proposed project location. The sampling location was a ~20-40ft wide dammed area and appeared to be very deep. A portion of this dam channels water into the Roaring River Pipeline or the Roaring River hydro-electric plant while the other portion is channeled back into the natural environment. The river had a moderate flow. The river banking was comprised of concrete and stone structures while the vegetation next to this banking (east of the river) comprised of tall thin trunked trees and other water loving plants. Plant litter was seen in the water and at the bar screen where the dam flows into the man-made structure. The bottom of the water could not be seen, and the sample collected appeared slightly cloudy with no distinct color.

<table>
<tr><th rowspan="2">Sample Location</th><th rowspan="2">GPS Coordinates</th><th colspan="2">Description</th></tr>
<tr><th>October 2022</th><th>January 2023</th></tr>
<tr><td></td><td></td><td>To the west of the river was an open grassy area. There was evidence of recent burning in this open area and domestic garbage was seen in this open area. There was also a concrete structure with a metal door southwest of the sampling location. Low hanging electrical wires were also observed towards the south of the sampling location.
Environmental Conditions: Sunny, hot, very little winds
</td><td>To the west of the river was an open grassy area. There was evidence of recent burning in this open area and domestic garbage was seen in this open area. There was also a concrete structure with a metal door southwest of the sampling location. Low hanging electrical wires were also observed towards the south of the sampling location.
Environmental Conditions: Cool, overcast
</td></tr>
</table>

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
WQ4	18.405594, -77.149887	The sampling site was upstream of the proposed project location. The sampling location was a ~10-20ft wide dammed area. A portion of this dam channels water into the Roaring River Pipeline or the Roaring River hydro-electric plant while the other portion is channeled back into the natural environment. A lot of plant litter was seen at the bar screen that channels water into the pipeline or plant. The river had a moderate flow. Dragonflies, insects that glide on water and water beetles were seen on the water. The bottom of the water could not be seen, and the sample collected appeared slightly cloudy with few suspended solids. The river banking was made of concrete and stone and had moss growth on it. Several channels converge into the area that the sample was collected from. . East of this stream was vegetated with vine like plant and small & medium trunked tall trees. The sampling area was shaded by these trees. To the west of the sampling area was an open grassy area with maintained shrubs while further west was a roadway that had tracks created by vehicular use. Litter was seen on the grassy area to the west of the sampling location. To the south of the sampling location was a rusting metal bridge with a concrete base. This bridge was overgrown with vegetation. **Environmental Conditions: Cool, light winds, no clouds overhead, sunny**	The sampling site was upstream of the proposed project location. The sampling location was a ~10-20ft wide dammed area. A portion of this dam channels water into the Roaring River Pipeline or the Roaring River hydro-electric plant while the other portion is channeled back into the natural environment. The river had a moderate flow. The bottom of the water was slightly obscured, and the sample collected appeared clear and colorless. The river banking was made of concrete and stone and had moss growth on it. Several channels converge into the area that the sample was collected from. East of this stream was vegetated with vine like plant and small & medium trunked tall trees. The sampling area was shaded by these trees. To the west of the sampling area was an open grassy area with maintained shrubs while further west was a roadway that had tracks created by vehicular use. Litter was seen on the grassy area to the west of the sampling location. To the south of the sampling location was a rusting metal bridge with a concrete base. This bridge was overgrown with vegetation. **Environmental Conditions: Cool, light winds, overcast**

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
			
WQ5	18.416787, -77.150164	This sampling location was downstream of the proposed project location. This sampling location was ~4-6ft wide. This area of the river was fast flowing. Large rocks were present at this sampling location creating a small waterfall. The bottom of the river was clearly seen. Vegetation in the riparian zone consisted of ferns, large trees and other water loving plants. The river banking was naturally created and vegetated. All areas surrounding this sampling location consisted of densely vegetated areas, however, a pathway was created to obtain access to this location. The sample collected at this point was clear and colorless.	This sampling location was downstream of the proposed project location. This sampling location was ~4-6ft wide and approximately 2-3 ft deep. This area of the river was fast flowing. Large rocks were present at this sampling location creating a small waterfall. The bottom of the river was clearly seen. Vegetation in the riparian zone consisted of ferns, large trees and other water loving plants. The river banking was naturally created and vegetated. All areas surrounding this sampling location consisted of densely vegetated areas, however, a pathway was created to obtain access to this location. Natural debris was seen on the surface of the water way. The sample collected at this point was clear and colorless.

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
		 **Environmental Conditions: Cool, overcast**	 **Environmental Conditions: Cool, sunny, light winds (tall trees provide natural shading at this location)**
WQ7	18.421781, -77.154150	This sampling location was downstream of the proposed project location. This sample was taken from the outfall of a presumed culvert in the area. The sample was collected midway of the fall and weir. The clear water was fast flowing, and the sampling area was very shallow. The section above the weir was covered with mud and silt. Moss covered rocks were observed in the area. The sampling location was ~8ft north of a busy roadway. The natural banking at this sampling location was slightly exposed. The sample collected at this point was clear and colorless. **Environmental Conditions: Cool, overcast, light rains**	This sampling location was downstream of the proposed project location. This sample was taken from the outfall of a presumed culvert in the area north of the main road. The sample was collected midway of the fall and weir. Trees and other plants were seen growing in the manmade structure. The clear water was fast flowing, and the sampling area was very shallow. The water surface was relatively clear and had natural debris on it. To the east of the sampling area was overgrown with lush plants. Moss covered rocks were observed in the area. The sampling location was north of a busy roadway. The natural banking at this sampling location was slightly exposed. A tire and other man-made

<table>
<tr><th rowspan="2">Sample Location</th><th rowspan="2">GPS Coordinates</th><th colspan="2">Description</th></tr>
<tr><th>October 2022</th><th>January 2023</th></tr>
<tr><td></td><td></td><td></td><td>debris was seen in the water and along the banking. The sample collected at this point was clear and colorless.
Environmental Conditions: Sunny, cool, clear skies
</td></tr>
<tr><td>WQ11</td><td>18.417268,
-77.149306</td><td>This sampling location was to the east (downstream) of the proposed project location.
This sampling area was ~5-8 ft wide. The water at this location was clear and sand at the bottom of the sampling area could clearly be seen. Stones with moss growth were also observed at the sampling area. Small waterfalls were created at this sampling location due to rock formations in the area. The area</td><td>This sampling location was to the east (downstream) of the proposed project location.
This sampling area was ~5-8 ft wide and 2-3ft deep. The water at this location was clear and the bottom of the sampling area could clearly be seen. Large trees with moss growth were also observed along the sides of the sampling area. Natural debris was seen on the surface of the waterway. Man made</td></tr>
</table>

Sample Location	GPS Coordinates	Description	
		October 2022	January 2023
		to the north of the sampling area had domestic litter on the ground. Large trunked trees were observed at this sampling location. The sample collected at this point was clear and colorless. The Roaring River Pipeline could clearly be seen to the west of the sampling location.  **Environmental Conditions: Overcast, cloudy, cool**	debris was seen along the ground close to the sampling area and within the water. Banking was exposed in some areas. The sample collected at this point was clear and colorless.  **Environmental Conditions: Cool, sunny, few clouds overhead (coverage of trees create natural shading), light winds**

Table 14-5: Description of Marine Water Quality Sample Locations

Sample Location	GPS Coordinates	Description	
		October 2022	February 2023
WQ3	18.423881, -77.147837	The sampling area was open seas ~300-400 ft north of Crab Key Beach. The area the sample was taken from was ~12ft deep and the bottom of the water clearly seen. Sand and seagrass were observed at this location. **Environmental Conditions: Southern winds, clear skies, humid, warm temperatures**	The sampling area was rough open seas ~400 ft north of Crab Key Beach. **Environmental Conditions: Strong winds, overcast**
WQ8	18.425173, -77.153426	This sampling area was open seas ~200-300ft north of a private beach. The area the sample was taken from was ~9ft deep and the bottom of the water was clearly seen. Large amounts of corals and seagrass were seen at this sample location. **Environmental Conditions: Southern winds, clear skies, humid, warm temperatures**	Rough open seas 200-300 ft north of private beach. **Environmental Conditions: Overcast, windy**
WQ9	18.426526, -77.153720	The sampling area was open seas ~200-300ft north of cliff structures in between Old Fort Bay Beach and the private beach where a sample was collected ~200-300ft north of. The area the sample was taken from was ~8ft deep and the bottom of this location was clearly seen. **Environmental Conditions: Southern winds, clear skies, humid, warm temperatures**	**Sample not collected due to roughness of weather and the proximity of sampling point to rocks.**

Sample Location	GPS Coordinates	Description	
		October 2022	February 2023
WQ10	18.429031, -77.148405	This sampling area was open seas ~2000-2500 ft north of the Little James Bond Beach and ~1000ft north of the reef barrier. The seas were calm, and the sampling area was ~60ft deep. **Environmental Conditions: Southern winds, clear skies, humid, cool temperatures**	This sampling area was open seas ~2000-2500 ft north of the Little James Bond Beach and ~1000ft north of the reef barrier. The seas were rough, and the sampling area was ~60ft deep. **Environmental Conditions: Overcast, windy, light rain**
WQ12	18.423672, -77.149531	This sampling area was open seas ~300-400ft north of Little James Bond Beach. The area the sample was taken from was directly north of the Laughing Waters Waterfall. The depth of the sampling point was ~10 ft deep and the bottom of the water was clearly seen. Seagrass was observed at the bottom of this sampling location. **Environmental Conditions: Southern winds, clear skies, humid, warm temperatures**	This sampling area was rough open seas ~300-400ft north of a Little James Bond Beach. The area the sample was taken from was directly north of the Laughing Waters Waterfall. **Environmental Conditions: Overcast, windy**

T. Water Quality Information for 'Roaring River nr Ocho Rios' Data Supplied by WRA

Figure 14-15 Location of site with water quality information (Source: WRA)

Water Quality Data from the WRA for the Roaring River Site

Location	Basin	WMU	Parish	Easting	Northing	Other	Date	pH	Conductivity
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2017-04-01	7.76	0.3839
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2016-11-01	8.1	0.3778
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2016-04-01	7.93	0.3794
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2017-04-01	7.83	0.4123
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2016-11-01	8.21	0.382
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2016-04-01	7.89	0.3855
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2017-04-01	8.03	0.518
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2016-11-01	8.21	0.378
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2016-04-01	7.96	0.3845
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2019-11-03	7.74	0.3717
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734152	696648.6		2019-11-11	7.72	0.372
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734139.8	696639.8		2016-03-05	0	0
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734109.7	696615.4		2020-03-16	7.45	386
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734109.7	696615.4		2020-06-08	7.46	386
Roaring River	Dry Harbour Mountains	Rio Bueno-	Saint Ann	734109.7	696615.4		2020-09-16	7.59	385

BOD5	TDS	Hardness	Chloride	Fluoride	Sulphate	Calcium	Iron	Magnesium	Manganese	Potassium	Sodium	Ammonia
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		0	0		0	0	0	0				
		184	10.7		3.63	63	0.3	5.9		0.33	6.03	
	214	0	0		0	0	0	0				
	222	0	0		0	0	0	0				

Nitrate	FC	TC	Remarks
0			
0			
0			
0			
0			
0			
0			
0			
0			
0			
0			
0	<1.1		
4.41			
4.91			
4.82			

U. Results Certificate and Information on Sampling Equipment Used

REPORT/DOCUMENT
Water Quality Certificate of Sample Analysis (Freshwater - October 2022)
Water Quality Certificate of Sample Analysis (Marine water - October 2022)
Water Quality Certificate of Sample Analysis (Freshwater - January 2023)
Water Quality Certificate of Sample Analysis (Marine water - February 2023)
PM_{10} and Noise Certificate of Sample Analysis (October 2022)
PM_{10} and Noise Certificate of Sample Analysis (January/February 2023)
Modular Impactor and SKC Legacy Pump Information • Air Pump • Deployable Particulate Sampler (DPS) Information • Modular Impactors Information • Certification of Calibration: Defender 530 (2022) • Certification of Calibration: Defender 530 (2023)
Air Metrics Pump Information
Noise Calibration Certificate

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ISO 17025
ACCREDITED LABORATORY

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Certificate of Sample Analysis

CSA#: ESL-EHAS 22102001-06

Attention :

Mrs. Jaidene Webster-Jones
Environmental Solutions Ltd
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Kingston 10

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Sample(s) Information

Job Number:	**22102001-06**
SPN:	**-**
Date of Report:	18/11/2022
Revision Date:	**Not Applicable**
Sample(s) Collected:	19/10/2022
Sample(s) Submitted:	20/10/2022
Temperature on Arrival:	0.0^{o}C
Number of Samples:	6
Analysis Started:	20/10/2022
Analysis Completed:	04/11/2022
Prepared By:	**Tara-Lee Hylton, Technical Assistant**

Verified By ………S. Robinson…………………
Shanice Robinson,
Chemistry Analyst

Approved By……S. Ellis……………….
Shadain Ellis,
Senior Analyst

Results of Sample Analysis

Sample ID (Matrix) - Qualifier: CHEC-WQ 11 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	NRCA Ambient Water Standard
pH (pH units)	DR	7.99 @ 24.7ºC	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	6.40 @ 24.7ºC	c	**-**
Conductivity (mS/cm)	DR	380 @ 24.7ºC	c	**150.0-600**
Salinity (ppt)	DR	0.18 @ 24.7ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	248.30 @ 24.7ºC	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8192	<1.3	BDL	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		<0.3		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.02	-	**0.01- 0.8**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01	-	**-**
Faecal Coliform (MPN/100ml)	SM-9221	540	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	<1.6	BDL	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	1.1	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: WQ7 (Surface Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (units)	Test Method	Results	Qualifier	NRCA Ambient Water Standard
pH (pH units)	DR	8.27 @ 24.8ºC	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	6.93 @ 24.8ºC	c	**-**
Conductivity (mS/cm)	DR	348 @ 24.8ºC	c	**150.0-600**
Salinity (ppt)	DR	0.17 @ 24.8ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	227.50 @ 24.8ºC	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8192	1.8	P(1)	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.4		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	**0.01- 0.8**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		<0.01	BDL	**-**
Faecal Coliform (MPN/100ml)	SM-9221	94	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	2.8	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	1.3	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	4	a	**-**

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Sample ID (Matrix) - Qualifier: CHEC-WQ 5 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	NRCA Ambient Water Standard
pH (pH units)	DR	7.70 @ 23.6ºC	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	6.32 @ 23.6ºC	c	**-**
Conductivity (mS/cm)	DR	312 @ 23.6ºC	c	**150.0-600**
Salinity (ppt)	DR	0.15 @ 23.6ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	208.65 @ 23.6ºC	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8192	1.3	-	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.3		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	**0.01- 0.8**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		<0.01	BDL	**-**
Faecal Coliform (MPN/100ml)	SM-9221	110	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	1.9	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	1.6	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

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Sample ID (Matrix) - Qualifier: WQ 4 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	NRCA Ambient Water Standard
pH (pH units)	DR	7.66 @ 22.7ºC	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	6.80 @ 22.7ºC	c	**-**
Conductivity (mS/cm)	DR	331 @ 22.7ºC	c	**150.0-600**
Salinity (ppt)	DR	0.17 @ 22.7ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	225.55 @ 22.7ºC	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8192	<1.3	UMR	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		<0.3		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.04	-	**0.01- 0.8**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01	-	**-**
Faecal Coliform (MPN/100ml)	SM-9221	33	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	7.0	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	1.6	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

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Sample ID (Matrix) - Qualifier: WQ 2 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	NRCA Ambient Water Standard
pH (pH units)	DR	7.64 @ 22.6°C	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	7.60 @ 22.6°C	c	**-**
Conductivity (mS/cm)	DR	330 @ 22.6°C	c	**150.0-600**
Salinity (ppt)	DR	0.16 @ 22.6°C	c	**-**
Total Dissolved Solids (mg/L)	DR	224.90 @ 22.6°C	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8192	<1.3	BDL	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		<0.3		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	**0.01- 0.8**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		<0.01	BDL	**-**
Faecal Coliform (MPN/100ml)	SM-9221	13	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	5.5	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	1.3	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	2	a	**-**

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Sample ID (Matrix) - Qualifier: WQ 1 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	NRCA Ambient Water Standard
pH (pH units)	DR	7.84 @ 23.7°C	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	7.00 @ 23.7°C	c	**-**
Conductivity (mS/cm)	DR	407 @ 23.7°C	c	**150.0-600**
Salinity (ppt)	DR	0.20 @ 23.7°C	c	**-**
Total Dissolved Solids (mg/L)	DR	270.40 @ 23.7°C	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8192	1.6	-	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.4		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.02	-	**0.01- 0.8**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01	-	**-**
Faecal Coliform (MPN/100ml)	SM-9221	>1600	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	2.0	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	2.9	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

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Certificate of Quality

Parameter: Biochemical Oxygen Demand (H-8043)
QEHL Personnel: R. Ford, S. Crooks, J. Webster-Jones **Date of Analysis: 21/10/2022**

Parameter: Total Suspended Solids (SM-2540 D)
QEHL Personnel: S. Robinson **Date of Analysis: 21/10/2022**

	Standard Concentration (mg/L)	Determined Concentration (mg/L)	RPD (%)
MB		<1.6	
FB		<1.6	
FD		10.5	1.0
		10.4	
BD		137.0	1.4
		139.0	
SRS	47.8-59.8	51.0	

Parameter: Orthophosphates (H-8048)
QEHL Personnel: M. Brown **Date of Analysis: 20/10/2022**

	Standard Concentration (mg PO_4^{3-}/L)	Determined Concentration (mg PO_4^{3-}/L)	RPD (%)
MB		<0.02	
RB		<0.02	
BD		28.60	0.0
		28.60	
SRS	1.96-2.04	1.96	

Parameter: HR Nitrate (H-8039)
QEHL Personnel: T. Cox **Date of Analysis: 20/10/2022**

	Standard Concentration (mg NO_3^--N/L)	Determined Concentration (mg NO_3^--N/L)	RPD (%)
MB		0.3	
RB		0.3	
BD		0.4	28.6*
		0.3	
SRS	8.7-11.3	10.4	

***Duplicates accepted based on the sensitivity of the analytical method used.**

Parameter: Faecal Coliform (SM-9221)

QEHL Personnel: R. Dawkins **Date of Analysis: 20/10/2022**

Media/Test Item (Batch#)	DS LTB (14/10/2022)	SS LTB (14/10/2022)	EC Broth (19/10/2022)
Sterile (Yes/No)	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical

Parameter: pH (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 19/10/2022**

Standard (Buffer)	**pH After Calibration**	**Temperature (°C)**
6.95-7.05	6.99	31.3

Parameter: Dissolved Oxygen (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 19/10/2022**

Action Limit (DO%)	**Saturation (DO%)**	**Temperature (°C)**
95.0-105.0	99.0	31.9

Parameter: Conductivity (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 19/10/2022**

Standard (mS/cm)	**Instrument Reading (mS/cm)**	**Temperature (°C)**
1.98-2.00	1.99	28.1

Parameter: Salinity (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 19/10/2022**

Standard (mS/cm)	**Instrument Reading (mS/cm)**	**Temperature (°C)**
1.98-2.00	1.99	28.1

Parameter: Total Dissolved Solids (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 19/10/2022**

Standard (mS/cm)	**Instrument Reading (mS/cm)**	**Temperature (°C)**
1.98-2.00	1.99	28.1

Glossary

%	Percentage
µg/L	microgram per litre
µS/cm	Micro siemens per centimetre
a	Parameter subcontracted
ADB	Azide Dextrose Broth
AIM	The Aquaculture, Inland & Marine Products & By-Products Act (Regulations)
AOAC	American Organization of Analytical Chemists
b (1)	Parameter analysed outside of hold-time; samples submitted outside of the analysis hold-time
b (2)	Parameter analysed outside of hold-time; analysis authorised by Client
BAM	Bacteriological Analytical Manual
BD	Batch Duplicate
BDL	Analyte concentration below laboratory determined limit of detection
BDLS	Analyte detected below method detection limit (MDL). MDL greater than standard value.
BEA	Bile Esculin Azide Agar
BG	Brilliant Green Bile Broth
BGSA	Brilliant Green Sulfa Agar
BHI	Brain Heart Infusion Broth
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BSA	Bismuth Sulfite Agar
c	parameter analysed in the field
C(B)	Samples collected by the client and picked up by an ESL bearer
C(C)	Samples collected by the client and delivered to ESL
C(H)	Analytical sample submitted in incorrect container. This may affect data quality.
C(L)	Samples collected by ESL
C(S)	Sample collected by the client then sub-sampled and delivered by ESL.
CFU	Colony Forming Units
CMMEF	Compendium of Methods for the Microbiological Examination of Foods
Col	Colourimetry
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
D(I)	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference
D(C)	Sample diluted due to high concentration of target analyte
DR	Direct Reading
DS ADB	Double Strength Azide Dextrose Broth
DS LTB	Double Strength Lauryl Tryptose Broth
DS PAB	Double Strength Pseudomonas Asparagine Broth
EB	Equipment Blank
E(E1)	Estimated Value. Data acquisition affected by equipment malfunction.
E(L1)	Estimated Value. Analyte recovery in the laboratory control sample (LCS) was outside of QC limits. Results for this may be affected by same bias.
E(L2)	Estimated Value due to the nature of the sample matrix.
E(M1)	Estimated Value. Result calculated using calibration curve.
E(M2)	Estimated Value. Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
E(M3)	Estimated Value. Sample performance indicate presence of interference
E(R)	Estimated Value. RPD value was outside control limits.
EC	*E. coli* Media
E(V)	Estimated Value. Count(s) obtained is/are outside of the method counting range.
EC-MUG	*E. coli* Media with 4-**m**ethyl**u**mbelliferyl-β-D-**g**lucuronide
EHU	Environmental Health Unit
EPA	(US) Environmental Protection Agency
FAAS	Flame Atomic Absorption Spectroscopy
FAES	Flame Atomic Emission Spectroscopy
FB	Field Blank
FD	Field Duplicate
FL-PRO	Florida Petroleum Range Organic Method
GC-MS	Gas Chromatography Mass Spectrometry
H	Hach Water Analysis Workbook
H(A)	Off-scale high data obtained. Actual value may be greater than value given.

ICP	Inductively Coupled Plasma
ISE	Ion Selective Electrode
LCA	Listeria Chromogenic Agar
LE	Data not available due to laboratory error
LIA	Lysine Iron Agar
MAC	MacConkey Agar
MB	Method Blank
mEndo	mEndo Agar/Broth
MFHPB	Microbiology Food Health Protection Branch, Government of Canada
mmhos/cm	Millimhos per centimetre
mg/kg	milligram per kilogram
mg/L	milligrams per litre
MPN	Most Probable Number
mS/cm	millisiemens per centimetre
N/A (1)	Data not yet Available. Analysis not complete.
N/A (2)	Data not Available. Sample matrix interferences prevented data acquisition.
N/A (3)	Data not Available. Insufficient sample submitted.
N/A (4)	Data not Available. Equipment malfunction prevented data acquisition.
N/A (5)	Data not Available. Analysis not complete due to force majeure.
N/A (6)	Data not available due to issues with the shipment of the sample(s).
N/A (7)	Data not available. Technical difficulties experienced by subcontractor.
NA	Nutrient Agar
NB	Nutrient Broth
NEPA	National Environment and Planning Agency
NRCA	Natural Resources Conservation Authority
NTU	Nephelometric Turbidity Units
NWC	National Water Commission (Jamaica)
NST	No Time given for collection of samples
P(P)	Sample preserved prior to analysis
P(1)	Non-routine sample pre-treatment required
PAB	Pseudomonas Asparagine Broth
PCA	Plate Count Agar
PDA + C	Potato Dextrose Agar with Chloramphenicol
Pep Water	Peptone Water
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RED	Parameter Non-compliant
RPD	Relative Percentage Difference
RSD	Relative Standard Deviation
SM	Standard Methods for the Examination of Water and Wastewater 23rd Edition
SRS	Standard Reference Solution
SS	Sample Submerged upon receival at the laboratory
SS ADB	Single Strength Azide Dextrose Broth
SS LTB	Single Strength Lauryl Tryptose Broth
SS PAB	Single Strength Pseudomonas Asparagine Broth
T(H)	Samples arrived at ESL-QEHL outside holding temperature (≤4.0°C).
TIT	Titrimetry
TPH	Total Petroleum Hydrocarbon
TSA	Tryptic Soy Agar
TSB	Tryptic Soy Broth
TSA + YE	Tryptic Soy Agar + Yeast Extract
TTC	2,3,5 Triphenyl-2H-Tetrazolium Chloride
UMR	Analyte detection was below the measuring range of instrument. This is indicative of possible matrix interference within the sample.
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

End of Report

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

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Certificate of Sample Analysis

CSA#: ESL-EHAS 22102101-05

Attention :

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ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

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Sample(s) Information

Job Number:	**22102101-05**
SPN:	**-**
Date of Report:	18/11/2022
Revision Date:	**Not Applicable**
Sample(s) Collected:	20/10/2022
Sample(s) Submitted:	21/10/2022
Temperature on Arrival:	1.2^{o}C
Number of Samples:	5
Analysis Started:	21/10/2022
Analysis Completed:	04/11/2022
Prepared By:	**Tara-Lee Hylton, Technical Assistant**

Verified By ……… S. Robinson ……………………
Shanice Robinson,
Chemistry Analyst

Approved By……S. Ellis……….
Shadain Ellis,
Senior Analyst

Results of Sample Analysis

Sample ID (Matrix) - Qualifier: CHEC-WQ 3 (Marine Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (units)	Test Method	Results	Qualifier	NRCA Marine Water Standard
pH (pH units)	DR	7.79 @ 30.3ºC	c	**8.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	4.40 @ 30.3ºC	c	**-**
Conductivity (mS/cm)	DR	54.9 @ 30.3ºC	c	**-**
Salinity (ppt)	DR	32.35 @ 30.3ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	32305 @ 30.3ºC	c	**-**
Nitrate (mg NO_3^-/L)	H-8192	0.18	P(P), P(1), E(M1)	**-**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.04		**0.007-0.014**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		<0.01	BDLS	**0.001-0.003**
Enterococci (MPN/100mL)	SM-9230 B	11	-	**-**
Total Coliform (MPN/100ml)	SM-9221	1600	-	**2-256**
Faecal Coliform (MPN/100ml)	SM-9221	49	-	**<2-13**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.8	-	**0.0-1.16**
Fats, Oil & Grease (mg/L)	SM-5520 B	4	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC-WQ 8 (Marine Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	NRCA Marine Water Standard
pH (pH units)	DR	8.09 @ 30.3ºC	c	**8.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	4.30 @ 30.3ºC	c	**-**
Conductivity (mS/cm)	DR	55.5 @ 30.3ºC	c	**-**
Salinity (ppt)	DR	32.88 @ 30.3ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	32760 @ 30.3ºC	c	**-**
Nitrate (mg NO_3^-/L)	H-8192	0.09	P(P), P(1), E(M1)	**-**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.02		**0.007-0.014**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		<0.01	BDLS	**0.001-0.003**
Enterococci (MPN/100mL)	SM-9230 B	<1.8	-	**-**
Total Coliform (MPN/100ml)	SM-9221	23	-	**2-256**
Faecal Coliform (MPN/100ml)	SM-9221	4.5	-	**<2-13**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.9	-	**0.0-1.16**
Fats, Oil & Grease (mg/L)	SM-5520 B	2	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC-WQ 9 (Marine Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (units)	Test Method	Results	Qualifier	NRCA Marine Water Standard
pH (pH units)	DR	7.96 @ 30.1ºC	c	**8.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	4.33 @ 30.1ºC	c	**-**
Conductivity (mS/cm)	DR	55.3 @ 30.1ºC	c	**-**
Salinity (ppt)	DR	32.87 @ 30.1ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	32760 @ 30.1ºC	c	**-**
Nitrate (mg NO_3^-/L)	H-8192	0.09	P(P), P(1), E(M1)	**-**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.02		**0.007-0.014**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P /L)		<0.01	BDLS	**0.001-0.003**
Enterococci (MPN/100mL)	SM-9230 B	<1.8	-	**-**
Total Coliform (MPN/100ml)	SM-9221	17	-	**2-256**
Faecal Coliform (MPN/100ml)	SM-9221	<1.8	-	**<2-13**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.7	-	**0.0-1.16**
Fats, Oil & Grease (mg/L)	SM-5520 B	4	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC-WQ 10 (Marine Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	NRCA Marine Water Standard
pH (pH units)	DR	7.64 @ 30.0ºC	c	**8.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	4.92 @ 30.0ºC	c	**-**
Conductivity (mS/cm)	DR	55.4 @ 30.0ºC	c	**-**
Salinity (ppt)	DR	32.94 @ 30.0ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	32825 @ 30.0ºC	c	**-**
Nitrate (mg NO_3^-/L)	H-8192	0.09	P(P), P(1), E(M1)	**-**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.02		**0.007-0.014**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		<0.01	BDLS	**0.001-0.003**
Enterococci (MPN/100mL)	SM-9230 B	2.0	-	**-**
Total Coliform (MPN/100ml)	SM-9221	220	-	**2-256**
Faecal Coliform (MPN/100ml)	SM-9221	21	-	**<2-13**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.5	-	**0.0-1.16**
Fats, Oil & Grease (mg/L)	SM-5520 B	1	a	**-**

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Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC-WQ 12 (Marine Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (units)	Test Method	Results	Qualifier	NRCA Marine Water Standard
pH (pH units)	DR	7.96 @ 30.1ºC	c	**8.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	4.22 @ 30.1ºC	c	**-**
Conductivity (mS/cm)	DR	55.5 @ 30.1ºC	c	**-**
Salinity (ppt)	DR	33.01 @ 30.1ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	32890 @ 30.1ºC	c	**-**
Nitrate (mg NO_3^-/L)	H-8192	0.50	P(P), P(1), E(M1)	**-**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.11		**0.007-0.014**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	<0.02	BDL	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		<0.01	BDLS	**0.001-0.003**
Enterococci (MPN/100mL)	SM-9230 B	33	-	**-**
Total Coliform (MPN/100ml)	SM-9221	920	-	**2-256**
Faecal Coliform (MPN/100ml)	SM-9221	33	-	**<2-13**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.9	-	**0.0-1.16**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	BDL, a	**-**

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Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Certificate of Quality

Parameter: LR Nitrate (H-8192)

QEHL Personnel: J. Webster- Jones **Date of Analysis: 03/11/2022**

	Standard Concentration (mg NO_3^-+NO_2^--N /L)	Determined Concentration (mg NO_3^-+NO_2^--N /L)	RPD (%)
RB		0.01	
BD		0.12	18.18*
		0.10	
SRS	0.35 – 0.45	0.36	

***Duplicates accepted based on the sensitivity of the analytical method used.**

Parameter: Orthophosphates (H-8048)

QEHL Personnel: M. Brown **Date of Analysis: 21/10/2022**

	Standard Concentration (mg PO_4^{3-}/L)	Determined Concentration (mg PO_4^{3-}/L)	RPD (%)
MB		<0.02	
RB		<0.02	
BD		<0.02	-
		<0.02	
SRS	1.96-2.04	1.97	

Parameter: Total Suspended Solids (SM-2540 D)

QEHL Personnel: S. Robinson **Date of Analysis: 21/10/2022**

	Standard Concentration (mg/L)	Determined Concentration (mg/L)	RPD (%)
MB		<1.6	
FB		<1.6	
FD		10.5	1.0
		10.4	
BD		137.0	1.4
		139.0	
SRS	47.8-59.8	51.0	

Parameter: Biochemical Oxygen Demand (H-8043)

QEHL Personnel: R. Ford, S. Crooks, J. Webster-Jones **Date of Analysis: 21/10/2022**

Parameter: Faecal and Total Coliform (SM-9221)

QEHL Personnel: K. Simpson **Date of Analysis: 21/10/2022**

Media/Test Item (Batch#)	DS LTB (14/10/2022)	SS LTB (14/10/2022)	EC (19/10/2022)	BG (20/10/2022)
Sterile (Yes/No)	Yes	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical	Typical

Parameter: Faecal Enterococci (SM-9230 B)

QEHL Personnel: K. Simpson **Date of Analysis: 21/10/2022**

Media/Test Item (Batch #)	DS ADB (19/10/2022)
Sterile (Yes/No)	Yes
Media performance (Typical, not typical)	Typical

Parameter: pH (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 20/10/2022**

Standard (Buffer)	**pH After Calibration**	**Temperature (°C)**
6.95-7.05	6.99	31.3

Parameter: Dissolved Oxygen (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 20/10/2022**

Action Limit (DO%)	**Saturation (DO%)**	**Temperature (°C)**
95.0-105.0	99.0	31.9

Parameter: Conductivity (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 20/10/2022**

Standard (mS/cm)	**Instrument Reading (mS/cm)**	**Temperature (°C)**
1.98-2.00	1.99	28.1

Parameter: Salinity (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 20/10/2022**

Standard (mS/cm)	**Instrument Reading (mS/cm)**	**Temperature (°C)**
1.98-2.00	1.99	28.1

Parameter: Total Dissolved Solids (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 20/10/2022**

Standard (mS/cm)	Instrument Reading (mS/cm)	Temperature (°C)
1.98-2.00	1.99	28.1

Glossary

%	Percentage
µg/L	microgram per litre
µS/cm	Micro siemens per centimetre
a	Parameter subcontracted
ADB	Azide Dextrose Broth
AIM	The Aquaculture, Inland & Marine Products & By-Products Act (Regulations)
AOAC	American Organization of Analytical Chemists
b (1)	Parameter analysed outside of hold-time; samples submitted outside of the analysis hold-time
b (2)	Parameter analysed outside of hold-time; analysis authorised by Client
BAM	Bacteriological Analytical Manual
BD	Batch Duplicate
BDL	Analyte concentration below laboratory determined limit of detection
BDLS	Analyte detected below method detection limit (MDL). MDL greater than standard value.
BEA	Bile Esculin Azide Agar
BG	Brilliant Green Bile Broth
BGSA	Brilliant Green Sulfa Agar
BHI	Brain Heart Infusion Broth
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BSA	Bismuth Sulfite Agar
c	parameter analysed in the field
C(B)	Samples collected by the client and picked up by an ESL bearer
C(C)	Samples collected by the client and delivered to ESL
C(H)	Analytical sample submitted in incorrect container. This may affect data quality.
C(L)	Samples collected by ESL
C(S)	Sample collected by the client then sub-sampled and delivered by ESL.
CFU	Colony Forming Units
CMMEF	Compendium of Methods for the Microbiological Examination of Foods
Col	Colourimetry
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
D(I)	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference
D(C)	Sample diluted due to high concentration of target analyte
DR	Direct Reading
DS ADB	Double Strength Azide Dextrose Broth
DS LTB	Double Strength Lauryl Tryptose Broth
DS PAB	Double Strength Pseudomonas Asparagine Broth
EB	Equipment Blank
E(E1)	Estimated Value. Data acquisition affected by equipment malfunction.
E(L1)	Estimated Value. Analyte recovery in the laboratory control sample (LCS) was outside of QC limits. Results for this may be affected by same bias.
E(L2)	Estimated Value due to the nature of the sample matrix.
E(M1)	Estimated Value. Result calculated using calibration curve.
E(M2)	Estimated Value. Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
E(M3)	Estimated Value. Sample performance indicate presence of interference
E(R)	Estimated Value. RPD value was outside control limits.
EC	*E. coli* Media
E(V)	Estimated Value. Count(s) obtained is/are outside of the method counting range.
EC-MUG	*E. coli* Media with 4-**m**ethyl**u**mbelliferyl-β-D-**g**lucuronide
EHU	Environmental Health Unit
EPA	(US) Environmental Protection Agency
FAAS	Flame Atomic Absorption Spectroscopy
FAES	Flame Atomic Emission Spectroscopy
FB	Field Blank
FD	Field Duplicate
FL-PRO	Florida Petroleum Range Organic Method
GC-MS	Gas Chromatography Mass Spectrometry
H	Hach Water Analysis Workbook
H(A)	Off-scale high data obtained. Actual value may be greater than value given.

ICP	Inductively Coupled Plasma
ISE	Ion Selective Electrode
LCA	Listeria Chromogenic Agar
LE	Data not available due to laboratory error
LIA	Lysine Iron Agar
MAC	MacConkey Agar
MB	Method Blank
mEndo	mEndo Agar/Broth
MFHPB	Microbiology Food Health Protection Branch, Government of Canada
mmhos/cm	Millimhos per centimetre
mg/kg	milligram per kilogram
mg/L	milligrams per litre
MPN	Most Probable Number
mS/cm	millisiemens per centimetre
N/A (1)	Data not yet Available. Analysis not complete.
N/A (2)	Data not Available. Sample matrix interferences prevented data acquisition.
N/A (3)	Data not Available. Insufficient sample submitted.
N/A (4)	Data not Available. Equipment malfunction prevented data acquisition.
N/A (5)	Data not Available. Analysis not complete due to force majeure.
N/A (6)	Data not available due to issues with the shipment of the sample(s).
N/A (7)	Data not available. Technical difficulties experienced by subcontractor.
NA	Nutrient Agar
NB	Nutrient Broth
NEPA	National Environment and Planning Agency
NRCA	Natural Resources Conservation Authority
NTU	Nephelometric Turbidity Units
NWC	National Water Commission (Jamaica)
NST	No Time given for collection of samples
P(P)	Sample preserved prior to analysis
P(1)	Non-routine sample pre-treatment required
PAB	Pseudomonas Asparagine Broth
PCA	Plate Count Agar
PDA + C	Potato Dextrose Agar with Chloramphenicol
Pep Water	Peptone Water
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RED	Parameter Non-compliant
RPD	Relative Percentage Difference
RSD	Relative Standard Deviation
SM	Standard Methods for the Examination of Water and Wastewater 23rd Edition
SRS	Standard Reference Solution
SS	Sample Submerged upon receival at the laboratory
SS ADB	Single Strength Azide Dextrose Broth
SS LTB	Single Strength Lauryl Tryptose Broth
SS PAB	Single Strength Pseudomonas Asparagine Broth
T(H)	Samples arrived at ESL-QEHL outside holding temperature (≤4.0°C).
TIT	Titrimetry
TPH	Total Petroleum Hydrocarbon
TSA	Tryptic Soy Agar
TSB	Tryptic Soy Broth
TSA + YE	Tryptic Soy Agar + Yeast Extract
TTC	2,3,5 Triphenyl-2H-Tetrazolium Chloride
UMR	Analyte detection was below the measuring range of instrument. This is indicative of possible matrix interference within the sample.
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

End of Report

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

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ISO 17025
ACCREDITED LABORATORY

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Certificate of Sample Analysis

CSA#: ESL-EHAS 23013116-21

Attention :

Jaidene Webster Jones
Quality Control Officer
Environmental Solutions Ltd
7 Hillview Avenue,
Kingston 10

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Sample(s) Information

Job Number: **23013116-21**

SPN: **-**

Date of Report: 27/02/2023

Revision Date: **Not Applicable**

Sample(s) Collected: 31/01/2023

Sample(s) Submitted: 31/01/2023

Temperature on Arrival: 1.5°C

Number of Samples: 6

Analysis Started: 31/01/2023

Analysis Completed: 27/02/2023

Prepared By: **Trevor Mighty, Laboratory Technician**

Verified By ……S. Robinson………………

Shanice Robinson,
Chemistry Analyst

Approved By………S. Ellis…………..

Shadain Ellis,
Senior Analyst

Results of Sample Analysis

Sample ID (Matrix) - Qualifier: CHEC-WQ1 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard
pH (pH units)	DR	7.27 @ 23.1°C	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	7.43 @ 23.1°C	c	**-**
Conductivity (µS/cm)	DR	417 @ 23.1°C	c	**150.0-600**
Salinity (ppt)	DR	0.21 @ 23.1°C	c	**-**
Total Dissolved Solids (mg/L)	DR	281.45 @ 23.1°C	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8039	1.8	P(1)	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.4		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.03	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01		**-**
Faecal Coliform (MPN/100ml)	SM-9221	240	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	<1.6	BDL	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.8	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

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Sample ID (Matrix) - Qualifier: CHEC-WQ2 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard
pH (pH units)	DR	7.67 @ 22.4ºC	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	8.02 @ 22.4ºC	c	**-**
Conductivity (µS/cm)	DR	360 @ 22.4ºC	c	**150.0-600**
Salinity (ppt)	DR	0.18 @ 22.4ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	246.70 @ 22.4ºC	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8039	4.0	P(1)	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.9		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.04	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01		**-**
Faecal Coliform (MPN/100ml)	SM-9221	7.8	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	3.2	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.5	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	4	a	**-**

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Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC-WQ4 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	**Test Method**	**Results**	**Qualifier**	**National Ambient Water Quality Standard**
pH (pH units)	DR	7.72 @ 22.4ºC	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	7.25 @ 22.4ºC	c	**-**
Conductivity (µS/cm)	DR	360 @ 22.4ºC	c	**150.0-600**
Salinity (ppt)	DR	0.18 @ 22.4ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	246.35 @ 22.4ºC	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8039	3.1	P(1)	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.7		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.06	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.02		**-**
Faecal Coliform (MPN/100ml)	SM-9221	33	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	2.5	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.7	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC-WQ5 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard
pH (pH units)	DR	7.74 @ 23.4°C	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	7.71 @ 23.4°C	c	**-**
Conductivity (µS/cm)	DR	401 @ 23.4°C	c	**150.0-600**
Salinity (ppt)	DR	0.20 @ 23.4°C	c	**-**
Total Dissolved Solids (mg/L)	DR	269.10 @ 23.4°C	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8039	1.3	P(1)	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.3		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.04	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01		**-**
Faecal Coliform (MPN/100ml)	SM-9221	6.8	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	<1.6	BDL	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	1.0	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC-WQ11 (Surface Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard
pH (pH units)	DR	7.79 @ 23.0ºC	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	8.30 @ 23.0ºC	c	**-**
Conductivity (µS/cm)	DR	351 @ 23.0ºC	c	**150.0-600**
Salinity (ppt)	DR	0.17 @ 23.0ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	237.26 @ 23.0ºC	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8039	2.2	P(1)	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.5		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.03	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P /L)		0.01		**-**
Faecal Coliform (MPN/100ml)	SM-9221	79	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	<1.6	BDL	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	1.0	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC-WQ7 (Surface Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard
pH (pH units)	DR	7.46 @ 23.5°C	c	**7.00-8.40**
Dissolved Oxygen (mg O_2/L)	DR	8.33 @ 23.5°C	c	**-**
Conductivity (μS/cm)	DR	356 @ 23.5°C	c	**150.0-600**
Salinity (ppt)	DR	0.17 @ 23.5°C	c	**-**
Total Dissolved Solids (mg/L)	DR	237.90 @ 23.5°C	c	**120.0-300**
Nitrate (mg NO_3^-/L)	H-8039	2.0	P(1)	**0.1-7.5**
Nitrate as Nitrogen (mg NO_3^-N/L)		0.4		**-**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.04	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01		**-**
Faecal Coliform (MPN/100ml)	SM-9221	49	-	**-**
Total Suspended Solids (mg/L)	SM-2540 D	5.7	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.5	-	**0.8-1.7**
Fats, Oil & Grease (mg/L)	SM-5520 B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Certificate of Quality

Parameter: HR Nitrate (H-8039)

QEHL Personnel: N. McCalla **Date of Analysis: 01/02/2023**

	Standard Concentration (mg NO_3^--N/L)	Determined Concentration (mg NO_3^--N/L)	RPD (%)
MB		0.5	
RB		0.3	
BD		2.4	0.0
		2.4	
SRS	9.1-10.9	9.5	

Parameter: Total Suspended Solids (SM-2540 D)

QEHL Personnel: M. Brown **Date of Analysis: 03/02/2023**

	Standard Concentration (mg/L)	Determined Concentration (mg/L)	RPD (%)
MB		<1.6	
BD		65.6	1.8
		66.8	
SRS	47.8-59.8	53.0	

Parameter: Conductivity (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 31/01/2023**

Standard (mS/cm)	Instrument Reading (mS/cm)	Temperature (°C)
1.98-2.00	1.99	25.4

Parameter: Salinity (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 31/01/2023**

Standard (mS/cm)	Instrument Reading (mS/cm)	Temperature (°C)
1.98-2.00	1.99	25.4

Parameter: Total Dissolved Solids (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 31/01/2023**

Standard (mS/cm)	Instrument Reading (mS/cm)	Temperature (°C)
1.98-2.00	1.99	25.4

Parameter: pH (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis:31/01/2023**

Standard (Buffer)	pH After Calibration	Temperature (°C)
6.96 – 7.04	7.02	25.8

Parameter: Dissolved Oxygen (DR)

QEHL Personnel: J. Webster-Jones **Date of Analysis:31/01/2023**

Action Limit %	Saturation %	Temperature (°C)
95.0 – 105.0	99.7	26.0

Parameter: Faecal Coliform (SM-9221)

QEHL Personnel: K. Williams **Date of Analysis: 01/02/2023**

Media/Test Item (Batch#)	DS LTB (31/01/2023)	SS LTB (24/01/2023)	EC Broth (06/02/2023)
Sterile (Yes/No)	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical

Parameter: Orthophosphates (H-8048)

QEHL Personnel: R. Ford **Date of Analysis: 01/02/2023**

	Standard Concentration (mg PO_4^{3-}/L)	Determined Concentration (mg PO_4^{3-}/L)	RPD (%)
MB		<0.02	
RB		<0.02	
BD		0.04	0.0
		0.04	
SRS	1.91-2.01	1.97	

Glossary

%	Percentage
µg/L	microgram per litre
µS/cm	Micro siemens per centimetre
a	Parameter subcontracted
ADB	Azide Dextrose Broth
AIM	The Aquaculture, Inland & Marine Products & By-Products Act (Regulations)
AOAC	American Organization of Analytical Chemists
b (1)	Parameter analysed outside of hold-time; samples submitted outside of the analysis hold-time
b (2)	Parameter analysed outside of hold-time; analysis authorised by Client
BAM	Bacteriological Analytical Manual
BD	Batch Duplicate
BDL	Analyte concentration below laboratory determined limit of detection
BDLS	Analyte detected below method detection limit (MDL). MDL greater than standard value.
BEA	Bile Esculin Azide Agar
BG	Brilliant Green Bile Broth
BGSA	Brilliant Green Sulfa Agar
BHI	Brain Heart Infusion Broth
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BSA	Bismuth Sulfite Agar
c	parameter analysed in the field
C(B)	Samples collected by the client and picked up by an ESL bearer
C(C)	Samples collected by the client and delivered to ESL
C(H)	Analytical sample submitted in incorrect container. This may affect data quality.
C(L)	Samples collected by ESL
C(S)	Sample collected by the client then sub-sampled and delivered by ESL.
CFU	Colony Forming Units
CMMEF	Compendium of Methods for the Microbiological Examination of Foods
Col	Colourimetry
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
D(I)	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference
D(C)	Sample diluted due to high concentration of target analyte
DR	Direct Reading
DS ADB	Double Strength Azide Dextrose Broth
DS LTB	Double Strength Lauryl Tryptose Broth
DS PAB	Double Strength Pseudomonas Asparagine Broth
EB	Equipment Blank
E(E1)	Estimated Value. Data acquisition affected by equipment malfunction.
E(L1)	Estimated Value. Analyte recovery in the laboratory control sample (LCS) was outside of QC limits. Results for this may be affected by same bias.
E(L2)	Estimated Value due to the nature of the sample matrix.
E(M1)	Estimated Value. Result calculated using calibration curve.
E(M2)	Estimated Value. Matrix spike recovery exceeded QC limits. Batch accepted based on laboratory control sample (LCS) recovery.
E(M3)	Estimated Value. Sample performance indicate presence of interference
E(R)	Estimated Value. RPD value was outside control limits.
EC	*E. coli* Media
E(V)	Estimated Value. Count(s) obtained is/are outside of the method counting range.
EC-MUG	*E. coli* Media with 4-**m**ethyl**u**mbelliferyl-β-D-**g**lucuronide
EHU	Environmental Health Unit
EPA	(US) Environmental Protection Agency
FAAS	Flame Atomic Absorption Spectroscopy
FAES	Flame Atomic Emission Spectroscopy
FB	Field Blank
FD	Field Duplicate
FL-PRO	Florida Petroleum Range Organic Method
GC-MS	Gas Chromatography Mass Spectrometry
H	Hach Water Analysis Workbook
H(A)	Off-scale high data obtained. Actual value may be greater than value given.

ICP	Inductively Coupled Plasma
ISE	Ion Selective Electrode
LCA	Listeria Chromogenic Agar
LE	Data not available due to laboratory error
LIA	Lysine Iron Agar
MAC	MacConkey Agar
MB	Method Blank
mEndo	mEndo Agar/Broth
MFHPB	Microbiology Food Health Protection Branch, Government of Canada
mmhos/cm	Millimhos per centimetre
mg/kg	milligram per kilogram
mg/L	milligrams per litre
MPN	Most Probable Number
mS/cm	millisiemens per centimetre
N/A (1)	Data not yet Available. Analysis not complete.
N/A (2)	Data not Available. Sample matrix interferences prevented data acquisition.
N/A (3)	Data not Available. Insufficient sample submitted.
N/A (4)	Data not Available. Equipment malfunction prevented data acquisition.
N/A (5)	Data not Available. Analysis not complete due to force majeure.
N/A (6)	Data not available due to issues with the shipment of the sample(s).
N/A (7)	Data not available. Technical difficulties experienced by subcontractor.
NA	Nutrient Agar
NB	Nutrient Broth
NEPA	National Environment and Planning Agency
NRCA	Natural Resources Conservation Authority
NTU	Nephelometric Turbidity Units
NWC	National Water Commission (Jamaica)
NST	No Time given for collection of samples
P(P)	Sample preserved prior to analysis
P(1)	Non-routine sample pre-treatment required
PAB	Pseudomonas Asparagine Broth
PCA	Plate Count Agar
PDA + C	Potato Dextrose Agar with Chloramphenicol
Pep Water	Peptone Water
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RED	Parameter Non-compliant
RPD	Relative Percentage Difference
RSD	Relative Standard Deviation
SM	Standard Methods for the Examination of Water and Wastewater 23rd Edition
SRS	Standard Reference Solution
SS	Sample Submerged upon receival at the laboratory
SS ADB	Single Strength Azide Dextrose Broth
SS LTB	Single Strength Lauryl Tryptose Broth
SS PAB	Single Strength Pseudomonas Asparagine Broth
T(H)	Samples arrived at ESL-QEHL outside holding temperature (≤4.0°C).
TIT	Titrimetry
TPH	Total Petroleum Hydrocarbon
TSA	Tryptic Soy Agar
TSB	Tryptic Soy Broth
TSA + YE	Tryptic Soy Agar + Yeast Extract
TTC	2,3,5 Triphenyl-2H-Tetrazolium Chloride
UMR	Analyte detection was below the measuring range of instrument. This is indicative of possible matrix interference within the sample.
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

End of Report

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

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Certificate of Sample Analysis

CSA#: ESL-EHAS 23020118-21

Attention:

Jaidene Webster Jones
Environmental Solutions Ltd
7 Hillview Avenue
Kingston 10

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

A division of

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Sample(s) Information

Job Number: **23020118-21**

SPN: **-**

Date of Report: 07/03/2023

Revision Date: **Not Applicable**

Sample(s) Collected: 01/02/2023

Sample(s) Submitted: 01/02/2023

Temperature on Arrival: 0.1ºC

Number of Samples: 4

Analysis Started: 01/02/2023

Analysis Completed: 15/02/2023

Prepared By: **Trevor Mighty, Laboratory Technician**

Verified By ……… S. Robinson ………………

Shanice Robinson,
Analyst

Approved By……R Dunkley………

Raylee Dunkley,
Team Lead, Chemistry

Results of Sample Analysis

Sample ID (Matrix) - Qualifier: CHEC WQ 8 (Marine Water) **-☐C(B) ☐C(C) ☒C(L)**

Parameters (Units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard-Marine Water
pH (pH units)	DR	8.06 @ 24.0ºC	b(1)	**8.00 - 8.40**
Dissolved Oxygen (mg O_2/L)	DR	6.10 @ 26.3ºC	c	**-**
Conductivity (µS/cm)	DR	47.38 @ 26.3ºC	c	**-**
Salinity (ppt)	DR	29.94 @ 26.3ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	30036.50 @ 26.3ºC	c	**-**
Faecal Coliform (MPN/100ml)	SM-9221	1.8	-	**<2 – 13**
Total Coliform (MPN/100ml)	SM-9221	79	-	**2-256**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.02	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01		**0.001 – 0.003**
Nitrate and Nitrite (mg NO_3^-+ NO_2^-/L)	H-8192	0.09	P(P), P(1), E(M1)	-
Nitrate and Nitrite as Nitrogen (mg NO_3^-+ NO_2^--N/L)		0.02		**0.007-0.014**
Faecal Enterococci (MPN/100mL)	SM-9230 B	7.8	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.6	E(M3)	**0.0 – 1.16**
Fats, Oil & Grease (mg/L)	SM5520-B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

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Sample ID (Matrix) - Qualifier: CHEC WQ 10 (Marine Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (Units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard- Marine Water
pH (pH Units)	DR	8.09 @ 24.1°C	b(1)	**8.00 - 8.40**
Dissolved Oxygen (mg O_2/L)	DR	6.15 @ 27.1°C	c	**-**
Conductivity (µS/cm)	DR	53.4 @ 27.1°C	c	**-**
Salinity (ppt)	DR	33.34 @ 27.1°C	c	**-**
Total Dissolved Solids (mg/L)	DR	32500.00 @ 27.1°C	c	**-**
Faecal Coliform (MPN/100ml)	SM-9221	2.0	-	**<2 – 13**
Total Coliform (MPN/100ml)	SM-9221	6.1	-	**2-256**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.03	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01		**0.001 – 0.003**
Nitrate and Nitrite (mg NO_3^-+ NO_2^-/L)	H-8192	0.09	P(P), P(1), E(M1)	**-**
Nitrate and Nitrite as Nitrogen (mg NO_3^-+ NO_2^--N/L)		0.02		**0.007-0.014**
Faecal Enterococci (MPN/100mL)	SM-9230 B	<1.8	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.8	-	**0.0 – 1.16**
Fats, Oil & Grease (mg/L)	SM5520-B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC WQ 3 (Marine Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (Units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard-Marine Water
pH (pH Units)	DR	8.10 @ 23.2°C	b(1)	**8.00 - 8.40**
Dissolved Oxygen (mg O_2/L)	DR	9.86 @ 27.2 ºC	c	**-**
Conductivity (µS/cm)	DR	53.3 @ 27.2 ºC	c	**-**
Salinity (ppt)	DR	33.56 @ 27.2 ºC	c	**-**
Total Dissolved Solids (mg/L)	DR	33280.00 @ 27.2 ºC	c	**-**
Faecal Coliform (MPN/100ml)	SM-9221	3.7	-	**<2 – 13**
Total Coliform (MPN/100ml)	SM-9221	22	-	**2-256**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.05	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.02		**0.001 – 0.003**
Nitrate and Nitrite (mg NO_3^-+ NO_2^-/L)	H-8192	0.18	P(P), P(1), E(M1)	**-**
Nitrate and Nitrite as Nitrogen (mg NO_3^-+ NO_2^--N/L)		0.04		**0.007-0.014**
Faecal Enterococci (MPN/100mL)	SM-9230 B	2.0	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.6	-	**0.0 – 1.16**
Fats, Oil & Grease (mg/L)	SM5520-B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Sample ID (Matrix) - Qualifier: CHEC WQ 12 (Marine Water) -☐C(B) ☐C(C) ☒C(L)

Parameters (Units)	Test Method	Results	Qualifier	National Ambient Water Quality Standard- Marine Water
pH (pH Units)	DR	8.10 @ 24.4°C	b(1)	**8.00 - 8.40**
Dissolved Oxygen (mg O_2/L)	DR	7.53 @ 27.1°C	c	**-**
Conductivity (µS/cm)	DR	53.1 @ 27.1°C	c	**-**
Salinity (ppt)	DR	33.48 @ 27.1°C	c	**-**
Total Dissolved Solids (mg/L)	DR	33215.00 @ 27.1°C	c	**-**
Faecal Coliform (MPN/100mL)	SM-9221	<1.8	-	**<2 – 13**
Total Coliform (MPN/100mL)	SM-9221	23	-	**2-256**
Orthophosphate (mg PO_4^{3-}/L)	H-8048	0.04	-	**-**
Orthophosphate as Phosphorus (mg PO_4^{3-}-P/L)		0.01		**0.001 – 0.003**
Nitrate and Nitrite (mg $NO_3^- + NO_2^-$/L)	H-8192	0.14	P(P), P(1), E(M1)	**-**
Nitrate and Nitrite as Nitrogen (mg $NO_3^- + NO_2^-$-N/L)		0.03		**0.007-0.014**
Faecal Enterococci (MPN/100mL)	SM-9230 B	1.8	-	**-**
Biochemical Oxygen Demand (mg O_2/L)	H-8043	0.2	-	**0.0 – 1.16**
Fats, Oil & Grease (mg/L)	SM5520-B	<1	a	**-**

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Certificate of Quality

Parameter: Orthophosphates (H-8048)

QEHL Personnel: R. Ford **Date of Analysis: 01/02/2023**

	Standard Concentration (mg PO_4^{3-}/L)	**Determined Concentration (mg PO_4^{3-}/L)**	**RPD (%)**
MB		<0.02	
RB		<0.02	
BD		0.04	0.0
		0.04	
SRS	1.91-2.01	1.97	

Parameter: LR Nitrate (H-8192)

QEHL Personnel: J. Webster-Jones **Date of Analysis: 13/02/2023**

	Standard Concentration (mg NO_3^--N/L)	**Determined Concentration (mg NO_3^--N/L)**	**RPD (%)**
RB		0.01	
BD		0.02	66.7*
		0.04	
SRS	0.35 – 0.45	0.35	

***Duplicates are accepted based on the sensitivity of analytical method used**

Parameter: Faecal and Total Coliform (SM-9221)

QEHL Personnel: T. Garnett **Date of Analysis: 02/02/2023**

Media/Test Item (Batch #)	DS LTB (31/01/2023)	SS LTB (31/01/2023)	EC Broth (06/02/2023)	BG Broth (07/02/2023)
Sterile (Yes/No)	Yes	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical	Typical

Parameter: Biochemical Oxygen Demand (H-8043)

QEHL Personnel: T. Thompson, J. Webster-Jones, S. Crooks **Date of Analysis: 02/02/2023**

Parameter: pH (DR)

QEHL Personnel: S. Crooks **Date of Analysis: 01/02/2023**

Standard (Buffer)	**pH After Calibration**	**Temperature (°C)**
3.96 – 4.04	4.04	25.0
6.96 – 7.04	7.04	24.8
9.95 – 10.05	10.04	24.0

Parameter: Faecal Enterococci (SM-9230 B)

QEHL Personnel: T. Garnett **Date of Analysis: 02/02/2023**

Media/Test Item (Batch #)	SS ADB (01/02/2023)	DS ADB (25/01/2023)	BEA (06/02/2023)	BHI Broth (09/11/2022)	BHI Broth + NaCl (09/11/2022)
Sterile (Yes/No)	Yes	Yes	Yes	Yes	Yes
Media performance (Typical, not typical)	Typical	Typical	Typical	Typical	Typical

Glossary

%	Percentage
µg/L	microgram per litre
µS/cm	Micro siemens per centimetre
a	Parameter subcontracted
ADB	Azide Dextrose Broth
AIM	The Aquaculture, Inland & Marine Products & By-Products Act (Regulations)
AOAC	American Organization of Analytical Chemists
b (1)	Parameter analysed outside of hold-time; samples submitted outside of the analysis hold-time
b (2)	Parameter analysed outside of hold-time; analysis authorised by Client
BAM	Bacteriological Analytical Manual
BD	Batch Duplicate
BDL	Analyte concentration below laboratory determined limit of detection
BDLS	Analyte detected below method detection limit (MDL). MDL greater than standard value.
BEA	Bile Esculin Azide Agar
BG	Brilliant Green Bile Broth
BGSA	Brilliant Green Sulfa Agar
BHI	Brain Heart Infusion Broth
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
BSA	Bismuth Sulfite Agar
c	parameter analysed in the field
C(B)	Samples collected by the client and picked up by an ESL bearer
C(C)	Samples collected by the client and delivered to ESL
C(H)	Analytical sample submitted in incorrect container. This may affect data quality.
C(L)	Samples collected by ESL
C(S)	Sample collected by the client then sub-sampled and delivered by ESL.
CFU	Colony Forming Units
CMMEF	Compendium of Methods for the Microbiological Examination of Foods
Col	Colourimetry
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
D(I)	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference
D(C)	Sample diluted due to high concentration of target analyte
DR	Direct Reading
DS ADB	Double Strength Azide Dextrose Broth
DS LTB	Double Strength Lauryl Tryptose Broth
DS PAB	Double Strength Pseudomonas Asparagine Broth
EB	Equipment Blank
E(E1)	Estimated Value. Data acquisition affected by equipment malfunction.
E(L1)	Estimated Value. Analyte recovery in the laboratory control sample (LCS) was outside of QC limits. Results for this may be affected by same bias.
E(L2)	Estimated Value due to the nature of the sample matrix.
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E(R)	Estimated Value. RPD value was outside control limits.
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E(V)	Estimated Value. Count(s) obtained is/are outside of the method counting range.
EC-MUG	*E. coli* Media with 4-**m**ethyl**u**mbelliferyl-β-D-**g**lucuronide
EHU	Environmental Health Unit
EPA	(US) Environmental Protection Agency
FAAS	Flame Atomic Absorption Spectroscopy
FAES	Flame Atomic Emission Spectroscopy
FB	Field Blank
FD	Field Duplicate
FL-PRO	Florida Petroleum Range Organic Method
GC-MS	Gas Chromatography Mass Spectrometry
H	Hach Water Analysis Workbook
H(A)	Off-scale high data obtained. Actual value may be greater than value given.

ICP	Inductively Coupled Plasma
ISE	Ion Selective Electrode
LCA	Listeria Chromogenic Agar
LE	Data not available due to laboratory error
LIA	Lysine Iron Agar
MAC	MacConkey Agar
MB	Method Blank
mEndo	mEndo Agar/Broth
MFHPB	Microbiology Food Health Protection Branch, Government of Canada
mmhos/cm	Millimhos per centimetre
mg/kg	milligram per kilogram
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MPN	Most Probable Number
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N/A (6)	Data not available due to issues with the shipment of the sample(s).
N/A (7)	Data not available. Technical difficulties experienced by subcontractor.
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NB	Nutrient Broth
NEPA	National Environment and Planning Agency
NRCA	Natural Resources Conservation Authority
NTU	Nephelometric Turbidity Units
NWC	National Water Commission (Jamaica)
NST	No Time given for collection of samples
P(P)	Sample preserved prior to analysis
P(1)	Non-routine sample pre-treatment required
PAB	Pseudomonas Asparagine Broth
PCA	Plate Count Agar
PDA + C	Potato Dextrose Agar with Chloramphenicol
Pep Water	Peptone Water
ppb	parts per billion
ppm	parts per million
ppt	parts per thousand
RED	Parameter Non-compliant
RPD	Relative Percentage Difference
RSD	Relative Standard Deviation
SM	Standard Methods for the Examination of Water and Wastewater 23rd Edition
SRS	Standard Reference Solution
SS	Sample Submerged upon receival at the laboratory
SS ADB	Single Strength Azide Dextrose Broth
SS LTB	Single Strength Lauryl Tryptose Broth
SS PAB	Single Strength Pseudomonas Asparagine Broth
T(H)	Samples arrived at ESL-QEHL outside holding temperature (≤4.0°C).
TIT	Titrimetry
TPH	Total Petroleum Hydrocarbon
TSA	Tryptic Soy Agar
TSB	Tryptic Soy Broth
TSA + YE	Tryptic Soy Agar + Yeast Extract
TTC	2,3,5 Triphenyl-2H-Tetrazolium Chloride
UMR	Analyte detection was below the measuring range of instrument. This is indicative of possible matrix interference within the sample.
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

End of Report

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

A division of

esl environmental SOLUTIONS

ISO 17025
ACCREDITED LABORATORY

**7 Hillview Avenue,
Kingston 10, Jamaica
Tel: (876) 978-9519, 978-6297, 978-5902
Fax: (876) 946-3745
E-mail: envirsol@cwjamaica.com**

Certificate of Sample Analysis

CSA#: ESL-EHAS 22102107-11 & 13-16

Attention :

Mrs. Jaidene Webster-Jones
Environmental Solutions Ltd
7 Hillview Avenue,
Kingston 10

ESL QUALITY & ENVIRONMENTAL HEALTH LABORATORY

A division of

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Sample(s) Information

Job Number: **22102107-17 & 19-20**

SPN: **-**

Date of Report: 28/02/2023

Revision Date: **Not Applicable**

Sample(s) Collected: 19-20/10/2022

Sample(s) Submitted: 21/10/2022

Temperature on Arrival: Ambient

Number of Samples: 9

Analysis Started: 19/10/2022

Analysis Completed: 11/18/2022

Prepared By: **Tara-Lee Hylton, Technical Assistant**

Verified By ……… D. Robinson ………………
Shanice Robinson,
Client Manager

Approved By………… E. Terrelonge …………..
Eleanor Terrelonge,
Team Lead, Microbiology

Results of Sample Analysis

Qualifier : ☐C(B) ☐C(C) ☒C(L)

Sample ID (Matrix)	Test Method	PM$_{10}$ Concentration (μgm^{-3})	Qualifier	USEPA/NEPA Standard μgm^{-3}/24 hr.
AQ1 (Air)	Gravimetry	1.4	a	**Once exceedance standard** **150**
AQ2 (Air)		3.5	a	
AQ3 (Air)		62.3	a	
AQ4 (Air)		60.1	a	
AQ7 (Air)		5.6	a	
AQ8 (Air)		6.9	a	
AQ9 (Air)		9.7	a	
AQ10 (Air)		5.6	a	
AQ11 (Air)		12.7	a	

Please note that the data presented in the table above are determined to be compliant or non-compliant based on the value provided without the incorporation of the measurement uncertainty.

Qualifier : ☐C(B) ☐C(C) ☒C(L)

Sample ID (Matrix)	Test Method	Noise Level (dBA)		NEPA Ambient Noise Standard (Residential) (dBA)
		Day 1	Day 2	
AQ1 (Air)	DR	59.0	56.9	55
AQ2 (Air)		62.3	65.7	
AQ3 (Air)		61.0	61.5	
AQ4 (Air)		72.1	56.6	
AQ7 (Air)		69.2	59.1	
AQ8 (Air)		52.7	59.3	
AQ9 (Air)		53.4	66.8	
AQ10 (Air)		58.4	60.9	
AQ11 (Air)		-	52.6	

***Blue shaded parameters are ISO/IEC 17025:2017 accredited.**

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Glossary

%	Percentage
µg/L	microgram per litre
µS/cm	Micro siemens per centimetre
a	Parameter subcontracted
ADB	Azide Dextrose Broth
AIM	The Aquaculture, Inland & Marine Products & By-Products Act (Regulations)
AOAC	American Organization of Analytical Chemists
b (1)	Parameter analysed outside of hold-time; samples submitted outside of the analysis hold-time
b (2)	Parameter analysed outside of hold-time; analysis authorised by Client
BAM	Bacteriological Analytical Manual
BD	Batch Duplicate
BDL	Analyte concentration below laboratory determined limit of detection
BDLS	Analyte detected below method detection limit (MDL). MDL greater than standard value.
BEA	Bile Esculin Azide Agar
BG	Brilliant Green Bile Broth
BGSA	Brilliant Green Sulfa Agar
BHI	Brain Heart Infusion Broth
BTEX	Benzene, Toluene, Ethylbenzene, Xylene
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Col	Colourimetry
CVAAS	Cold Vapour Atomic Absorption Spectroscopy
D(I)	Sample was diluted due to the presence of high levels of non-target analytes or other matrix interference
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TSA	Tryptic Soy Agar
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TTC	2,3,5 Triphenyl-2H-Tetrazolium Chloride
UMR	Analyte detection was below the measuring range of instrument. This is indicative of possible matrix interference within the sample.
WHO	World Health Organization
XLD	Xylose Lysine Deoxycholate

End of Report

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Certificate of Sample Analysis

CSA#: ESL-EHAS 23020122-27 & 30-32

Attention :

Jaidene Webster Jones
Environmental Solutions Ltd
7 Hillview Avenue,
Kingston 10

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Sample(s) Information

Job Number:	**23020122-27 & 30-32**
SPN:	**-**
Date of Report:	28/03/2023
Revision Date:	**Not Applicable**
Sample(s) Collected:	31/01/2023 – 01/02/2023
Sample(s) Submitted:	01/02/2023
Temperature on Arrival:	Ambient
Number of Samples:	9
Analysis Started:	31/01/2023
Analysis Completed:	28/02/2023
Prepared By:	**Trevor Mighty, Laboratory Technician**

Verified By ……… ………………… Robinson
Shanice Robinson,
Client Manager

Approved By………… …………
Eleanor Terrelonge,
Team Lead, Microbiology

Results of Sample Analysis

Qualifier : ☐C(B) ☐C(C) ☒C(L)

Sample ID (Matrix)	Test Method	PM_{10} Concentration (µgm^{-3})	Qualifier	USEPA/NEPA Standard µgm^{-3}/24 hr.
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AQ3 (Air)		33.4	a	
AQ4 (Air)		37.2	a	
AQ7 (Air)		51.4	a	
AQ8 (Air)		23.7	a	
AQ9 (Air)		2.2	a	
AQ10 (Air)		21.1	a	
AQ11 (Air)		14.1	a	

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AQ3 (Air)		61.2	67.4	
AQ4 (Air)		66.4	69.8	
AQ7 (Air)		58.0	54.9	
AQ8 (Air)		50.6	53.0	
AQ9 (Air)		51.1	64.6	
AQ10 (Air)		54.4	54.1	
AQ11 (Air)		50.2	47.7	

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WHO	World Health Organization
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End of Report

Modular Impactor and SKC Legacy Pump Information

Publication 1620 Rev 1910

Leland Legacy Sample Pump

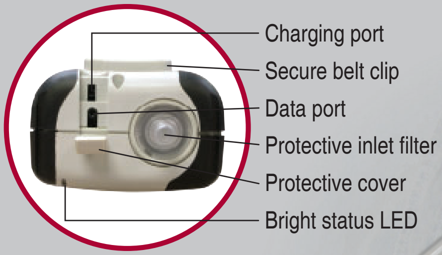
High Flows, Long Runs Enhance Measurement Sensitivity!

Flows: 5 to 15 L/min

Certifications

CE

ETV✓ *performance verified*



Top view

Leland Legacy® is the perfect partner for the Sioutas Impactor

- **High flows — 5 to 15 L/min**
  - Provides the high flows and long run times of a vacuum-style pump in a compact, portable, battery-operated sampler within specified back pressure range
- **Designed for use with impactors, spore traps, 37-mm filters, low-volume PUF tubes, and other low-pressure applications†**
- **Long 24-hour runs on one charge with Li-Ion battery**
  - Suitable for unattended ambient air sampling
- **Low noise, size, and weight**
  - Ideal for indoor air studies or unattended ambient air sampling
- **Longer runs + Higher flows = Enhanced sensitivity for measuring low concentrations**
- **Highly accurate isothermal flow control system**
- **Flexible programming options**
  - Manual three-button programmability using the large built-in keypad
  - PC programmability with DataTrac Software for Leland Legacy
    - Create complete running sequences, download sampling history, and generate exposure reports for ISO 9000 or quality programs
- **Large easy-to-read LCD**
  - Displays battery status indicator, flow fault, run time data, and sampling parameters
- **CalChek automatic calibration feature**
  - Provides hands-free direct communication to a Defender calibrator
- **Adjustable datalogging interval from 3 seconds to 8 hours with DataTrac Software**
- **Rugged and convenient case design**
  - Tough rubber overmolding protects the pump and provides a sure grip
  - Anti-static thermoplastic material
  - Inlet port with removable protective cover
  - Easy-access computer interface and battery charging jack under protective cover
- **Performance with Sioutas Impactor verified by EPA-ETV**
- **Featured in deployable sampler systems**
- **CE marked**

† *Leland Legacy is not recommended for high back pressure applications such as asbestos clearance sampling.*

SKC

SKC Inc. 724-941-9701 **SKC-West** 714-992-2780 **SKC Gulf Coast** 281-859-8050 **SKC South** 434-352-7149

www.skcinc.com

Leland Legacy Sample Pump

Performance Profile	
Flow Rate Accuracy	± 5% of set-point after calibration
Timing Accuracy	1 min/mo at 25 C
Atmospheric Pressure Accuracy	± 3% in Hg
Typical Run Time	***Battery:*** 24 hrs at 9 L/min with Sioutas Impactor (approx. 13 in water back pressure) 24 hrs at 5 L/min with low-volume PUF tube 24 hrs at 10 L/min with IMPACT Sampler in DPS System 24 hrs at 8 L/min with 8 L/min Respirable PPI ***Using charger with AC power:*** Extended run times
Charge Time *(varies with battery capacity and level of discharge)*	15 hrs with approved charger
Temperature Range	***Operating:*** 32 to 104 F (0 to 40 C) ***Storage:*** -4 to 95 F (-20 to 35 C) ***Charging:*** 32 to 113 F (0 to 45 C)
Altitude	The pump can apply correction to volumetric flow during sampling for weather-related or altitude variations from the atmospheric pressure established at calibration up to at least 7500 feet (2286 meters) above and 5000 feet (1524 meters) below sea level.
Timer Display Range	1 to 99999 min (69 days); if run time exceeds 69 days, timer display rolls over
Time Display	Time of day in hours and minutes (12 or 24-hr clock) with AM and PM indicators
Volume Display	Continually updated based on corrected flow rate multiplied by sampling time When volume exceeds 99,999 liters, the pump will continue to run normally but an O_FlO Error will appear on the LCD.
Noise Level	62.5 dBA‡ - pump without case 52 dBA‡ - pump housed in noise-reducing case (optional accessory)
Flow Fault	After 15 sec, pump goes into Hold, retains accumulated run time and historical data, and displays fault icon. Auto-restart is attempted every 20 sec up to 10 times (adjustable with DataTrac Software)
Flow Control	An internal isothermal flow sensor measures flow directly and continuously. Sensor readings are used in a flow monitoring algorithm to maintain calibrated volumetric flow. In addition, built-in atmospheric temperature and pressure sensors provide readings to correct volumetric flow for these parameters when they vary from point of calibration.
Weight	36 oz (1 kg)

‡ *Measured 3 feet (1 meter) from pump operating at 10 L/min and 12 inches water back pressure*

Ordering Information

Leland Legacy requires 3/8-inch ID tubing.

Pump and Kits		Cat. No.
Leland Legacy Pump** with Li-Ion battery pack and screwdriver set, *requires charger*		**100-3002**
Starter Kit includes pump, single charger, Tygon tubing (3 feet, 3/8-inch ID), and collar clip with cable tie	**100-240 V**	**100-3002-S**
Single Pump Kit*** includes Leland Legacy pump and single charger, in a Pelican carry case	**100-240 V**	**100-3002K**
5-pack Pump Kit*** includes 5 Leland Legacy pumps, Take Charge 5 Multi-charger, and DataTrac Software, in a deluxe Pelican case	**100-240 V**	**100-3002K5**
Accessories		
TSI 4146 Calibration Kit, flow measurement from 0.01 to 20 L/min, includes calibrator, soft-side case, mounting lugs, 1/4-inch ID tubing, battery pack, 6 AA batteries, inlet filter, dampening module, NIST certificate, and manual		**740-4146**
Chargers		
Single	**100-240 V**	**223-241**
Take Charge 5 Multi-charger	**100-240 V**	**223-441**
CalChek Communication Cable, *required for CalChek calibration*		**210-502**
Tubing Adapter, adapts 3/8-inch ID tubing to 1/4-inch ID tubing		**P31211**
Replacement Parts		
Replacement Battery Pack,** Li-Ion *Replacing batteries with non-approved battery packs voids any warranty.*		**P75692**
Replacement Filter/O-ring Set, 5 filters and 1 O-ring		**P40021B**
Replacement Inlet Filters, pk/50		**P40021A**

** *Leland Legacy pumps contain Li-Ion batteries and are subject to special shipping regulations.*

SKC Limited Warranty and Return Policy

SKC products are subject to the SKC Limited Warranty and Return Policy, which provides SKC's sole liability and the buyer's exclusive remedy. To view the complete SKC Limited Warranty and Return Policy, go to http://www.skcinc.com/warranty.

Quick View

Flow Rate (ml/min)	5 to 15 (L/min)
Weight in Ounces (grams)	36 (1000)
Compensation Range (inches water)	Up to 12 at 10 L
Built-in Timer/Clock	Clock
Constant Flow	Yes
Programmable	Yes
PC-compatible	Yes
Multi-tube Sampling	N/A
Flow Fault Feature	Yes
RFI/EMI Shielded	Yes
Intrinsic Safety	N/A
MSHA-approved Models Available	N/A
ATEX Models Available	N/A
CE Marked	Yes
Corrects for Changes in Atmospheric Pressure	Yes
Corrects for Changes in Temperature	Yes
Battery Type	Li-Ion (7.4 V, 12 Ah, 89 Wh)
Battery Check	Yes
Tubing	Requires 3/8-inch ID tubing

Recommended Accessories

- Chargers
- Battery Charging Adapter
  Cat. No. 223-248
- CalChek Communication Cable
  Cat. No. 210-502
- Noise-reducing Case
- TSI 4146 Calibration Kit
  Cat. No. 740-4146
- DataTrac Software for Leland Legacy
  Cat. No. 877-92
- Low-volume PUF Tube Holder
  Cat. No. 224-29P
- Tubing Adapter
  Cat. No. P31211
- Filter Holders
- Tubing

DEPLOYABLE PARTICULATE SAMPLER (DPS)

A NEW COST-EFFECTIVE, SIMPLE-TO-OPERATE PORTABLE PM SAMPLING SYSTEM

Saulius Trakumas, Donald L. Smith, Charles W. Nachreiner, Peter M. Hall, SKC Inc., 863 Valley View Road, Eighty Four, PA 15330,
Joseph B. Sutphin, J. Christopher Weir, CDR, USACHPPM, 5158 Blackhawk Road, APG, MD 21010-5403.

Category: Informational
Discipline: Environmental Programs
Sub-Discipline: Air sampling/Instrumentation; Deployment support

This submission is pertinent to the Conference theme: "Emerging Global Health Issues: Meeting the Challenge through Preventive Medicine" because it presents a newly developed deployable particulate sampling system that is highly suitable for monitoring PM exposure of military personnel deployed in various regions.

Background: Particulate matter (PM) monitoring is an important component in assessing potential exposure that may affect the health of deployed personnel.

Objective: The objective was to develop a PM measuring system that improved upon existing non-Federal Reference Method (non-FRM) systems and met requirements such as accuracy, portability, simple operation, and quick deployability.

Methodology: The Deployable Particulate Sampler (DPS) System was developed and tested. A compact inertial impactor (Fig. 1, U.S. patent pending), comprised of a PM2.5 or PM10 inlet, outlet, and 47-mm filter cassette, was designed to accurately collect PM2.5, PM10, or PM coarse. Its removable filter cassette can be preloaded and incorporates replaceable impaction substrate for simple operation. The system's battery-operated pump provides a constant 10.0 L/min flow rate to ensure accuracy during monitoring up to 24 hours. All components fit in a 47 x 35.7 x 17.6 cm case weighing 6.1 kg and take only a few minutes to deploy (Fig. 2).

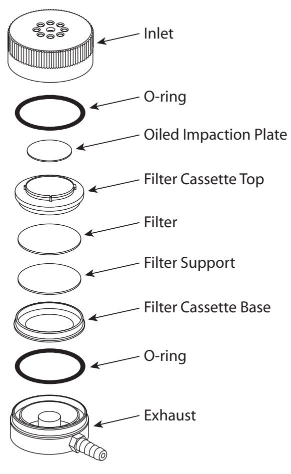


Figure 1. Schematic of DPS Impactor

Figure 2. Deployable Particulate Sampler

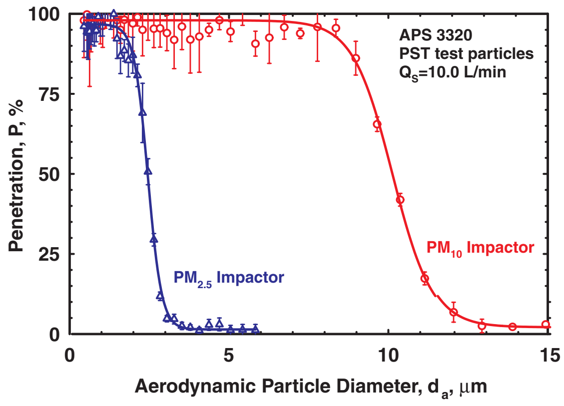
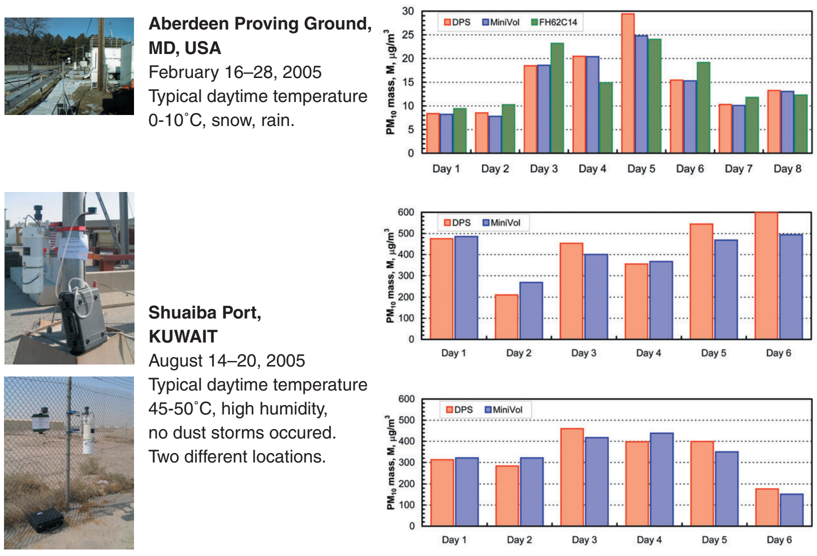


Figure 3. Calibration of PM2.5 and PM10 Impactors

Results: The DPS PM2.5 and PM10 impactors were calibrated in the laboratory (Fig. 3) using an APS 3320 (TSI Inc.). The field test included comparison of the 24-hour ambient PM10 concentration from collocated DPS (SKC Inc.), MiniVol (Airmetrics, Inc.), and FH 62 C14 continuous ambient PM monitor (Thermo Andersen). Field data, including monitoring PM exposure of military personnel in Kuwait, revealed good agreement between the DPS System and other collocated non-FRM samplers (Fig. 4 and 5).


Aberdeen Proving Ground, MD, USA
February 16–28, 2005
Typical daytime temperature 0-10˚C, snow, rain.

Shuaiba Port, KUWAIT
August 14–20, 2005
Typical daytime temperature 45-50˚C, high humidity, no dust storms occured.
Two different locations.

Figure 4. Comparison of 24-hour PM10 mass concentrations from collocated samplers

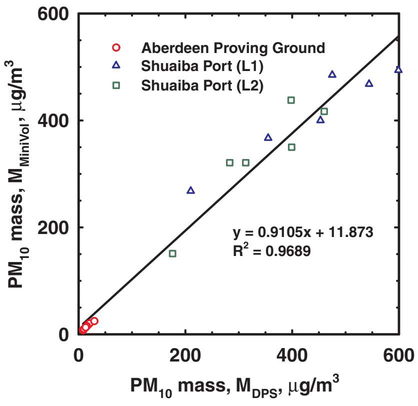


Figure 5. Comparison of PM10 mass from DPS and MiniVol

Discussion/Conclusion: Results of this study show DPS System performance is comparable to existing non-FRM systems for monitoring PM exposure of military personnel deployed in various regions.

Recommendation: Because of the DPS System's demonstrated effectiveness in monitoring PM exposure, it is recommended that the DPS System be considered an accurate system that improves upon the portability, deployability, and operation of existing non-FRM systems.

Modular Impactors — Accurate, Simple-to-operate, and Cost-effective Environmental PM Samplers

Saulius Trakumas and Donald L. Smith, SKC Inc., 863 Valley View Road, Eighty Four, PA 15330

Abstract

The EPA has defined PM2.5, PM10, and PM Coarse to monitor environmental exposure to particulate matter. Despite the PM2.5 and PM10 definition being somewhat different from the respirable, thoracic, and inhalable fractions defined by ACGIH, monitoring environmental PM provides important information leading to better assessment of overall worker exposure to particulate matter.

This study presents a series of new inertial impactors developed to monitor exposure to PM2.5, PM10, and PM Coarse. The impactors feature modular construction that includes an inlet, outlet, and filter cassette with incorporated support for an impaction substrate. To achieve optimal impactor performance, an oiled porous plastic support disk is recommended for use as the disposable impaction substrate.

The impactors were calibrated in the laboratory using an Aerodynamic Particle Sizer APS 3320. Data indicate good agreement with PM2.5 and PM10 as defined by EPA for both personal and area impactors. Field data obtained in different environmental conditions reveal good agreement between the newly developed modular IMPACT PM10 Impactor, and a collocated MiniVol Sampler (Airmetrics, Inc.) and FH 62 C14 Continuous Ambient PM Monitor (Thermo Andersen).

www.skcinc.com

Inertial Impactor Design Theory

Particle-laden air enters the impactor through the inlet nozzles. Larger particles with enough inertia deviate from the airstream lines and impact on the impaction plate while smaller particles follow the airstream lines around the impaction plate and collect on the filter (Figure 1). Impactor cut-off size can be adjusted by changing air velocity (particle velocity) inside the acceleration nozzle. An increase of particle velocity inside the nozzle will lead to collection of smaller particles due to an increase of their inertia. In contrast, the size of particles able to follow the airstream lines will increase with decreased velocity.

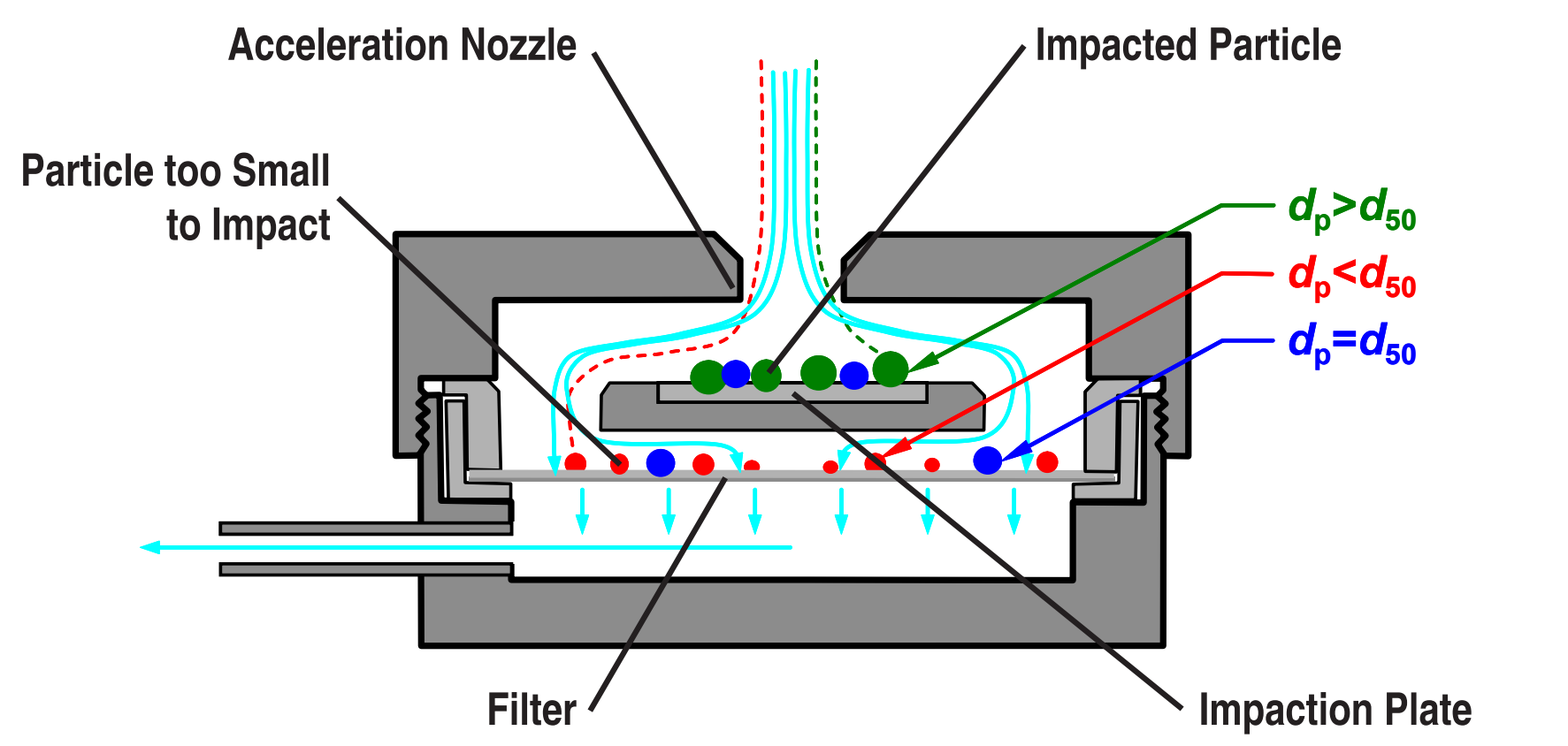


Figure 1. Schematic of inertial impactor

Performance of an inertial impactor is defined in terms of 50% cut-off size, ***d_{50}***; 50% of particles with ***d_{50}*** penetrate through the impactor and another 50% are collected. ***d_{50}*** can be calculated using the following formula (Rader and Marple 1985):

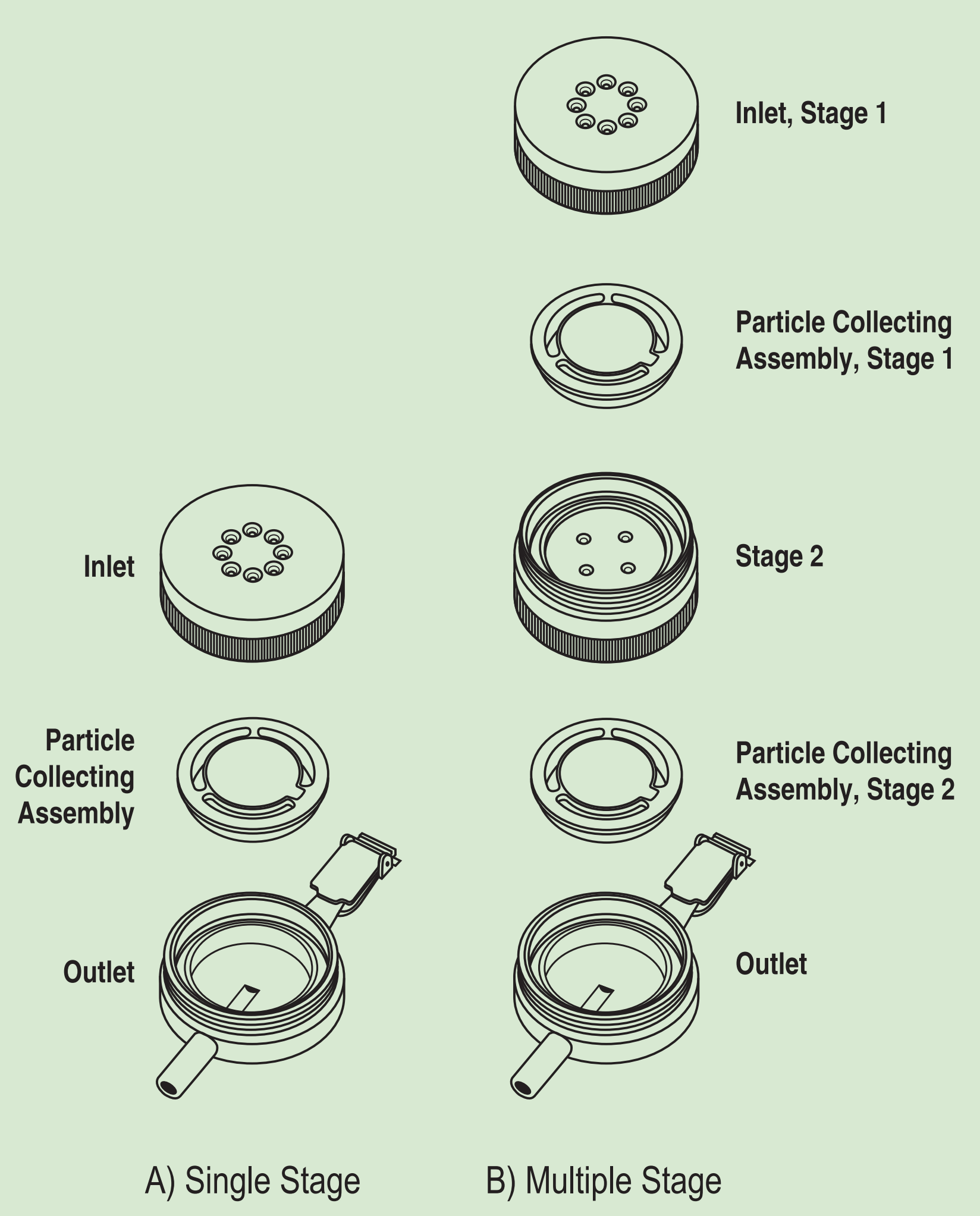
$$d_{50} = \sqrt{\frac{9\mu W Stk_{50}}{\rho_p V_o C}}$$

Formula 1

where μ is air viscosity, W is the width or diameter of the impactor nozzle, Stk_{50} is the Stokes number corresponding to a 50% particle cut-off, ρ_p is the particle density, V_o is average air velocity in the nozzle, and C is the size-dependent Cunningham slip correction factor. Stk_{50} depends on the Reynolds number of the flow through the nozzle, Re, jet-to-plate distance, S, and impactor nozzle throat length, T.

Modular Impactor Design

The new modular impactors (U.S. Patent No. 7,334,453) are comprised of two modules: a housing and a particle collecting assembly. The inlet attaches to the outlet by screwing the two parts together and the particle collecting assembly is housed inside (Figure 2A). Particle-laden air enters the impactor through the inlet nozzles. Larger particles collect on the impaction substrate while smaller ones follow the airstream lines through the annular opening around the impaction substrate and collect on the filter. An oiled porous plastic support disk is recommended for use as the disposable impaction substrate to achieve optimal impactor performance. After sampling, the impactor inlet is unscrewed from the outlet and the particle collecting assembly (filter cassette with incorporated collection substrate) is readily available for quick replacement of the filter and impaction substrate. In addition to a single-stage impactor, a multiple-stage sampler can be assembled using similar modules (Figure 2B). The two-stage impactor featuring a PM10 inlet as Stage 1 and a PM2.5 impactor as Stage 2 will collect PM Coarse and PM2.5 simultaneously. The modular impactor design was applied to build samplers for personal and area sampling. Formula 1 was employed to determine the size and number of nozzles for each particular impactor. Personal Modular Impactors (PMI) operate at a 3.0 L/min flow rate and use a 37-mm filter and 25-mm impaction substrate (Figure 3). PMI 2.5 has four nozzles with a 1.5-mm diameter each. There are eight 2.8-mm diameter nozzles in the PMI 10. The IMPACT Samplers (Figure 4) operate at a flow rate of 10.0 L/min, are designed for area sampling, and employ a 47-mm filter and 37-mm impaction substrate. IMPACT 2.5 has eight 1.8-mm diameter nozzles and IMPACT 10 features eight nozzles with a diameter of 4.3-mm each. The IMPACT Sampler together with a battery operated pump form a compact, portable, and simple-to-operate particle sampling system known as the Deployable Particulate Sampler or DPS (Figure 5).



A) Single Stage
B) Multiple Stage

Figure 2. Modular impactor design

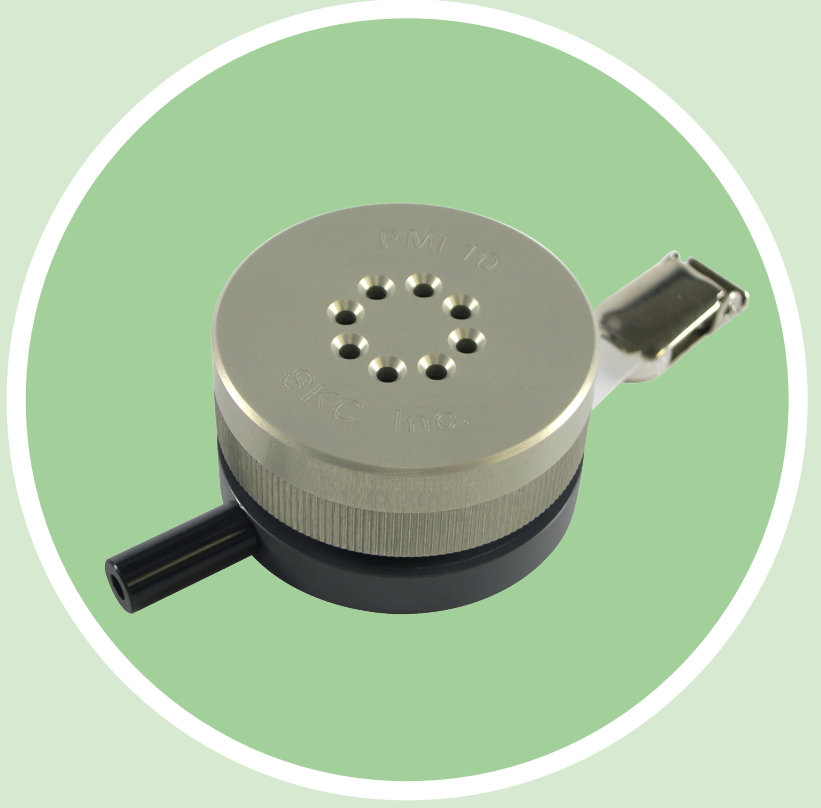


Figure 3. Personal Modular Impactor (PMI)

Figure 4. IMPACT Sampler

Figure 5. Deployable Particulate Sampler (DPS)

Test Methods

The newly developed impactors were calibrated in an aerosol test chamber (Figure 6) using an APS 3320 (TSI Inc.). Field tests included comparison of the 2-hour ambient PM10 concentration from a collocated DPS System (SKC Inc.), MiniVol Sampler (Airmetrics, Inc.), and FH 62 C14 Continuous Ambient PM Monitor (Thermo Andersen). Three series of field tests were performed in different geographical locations and ambient conditions.

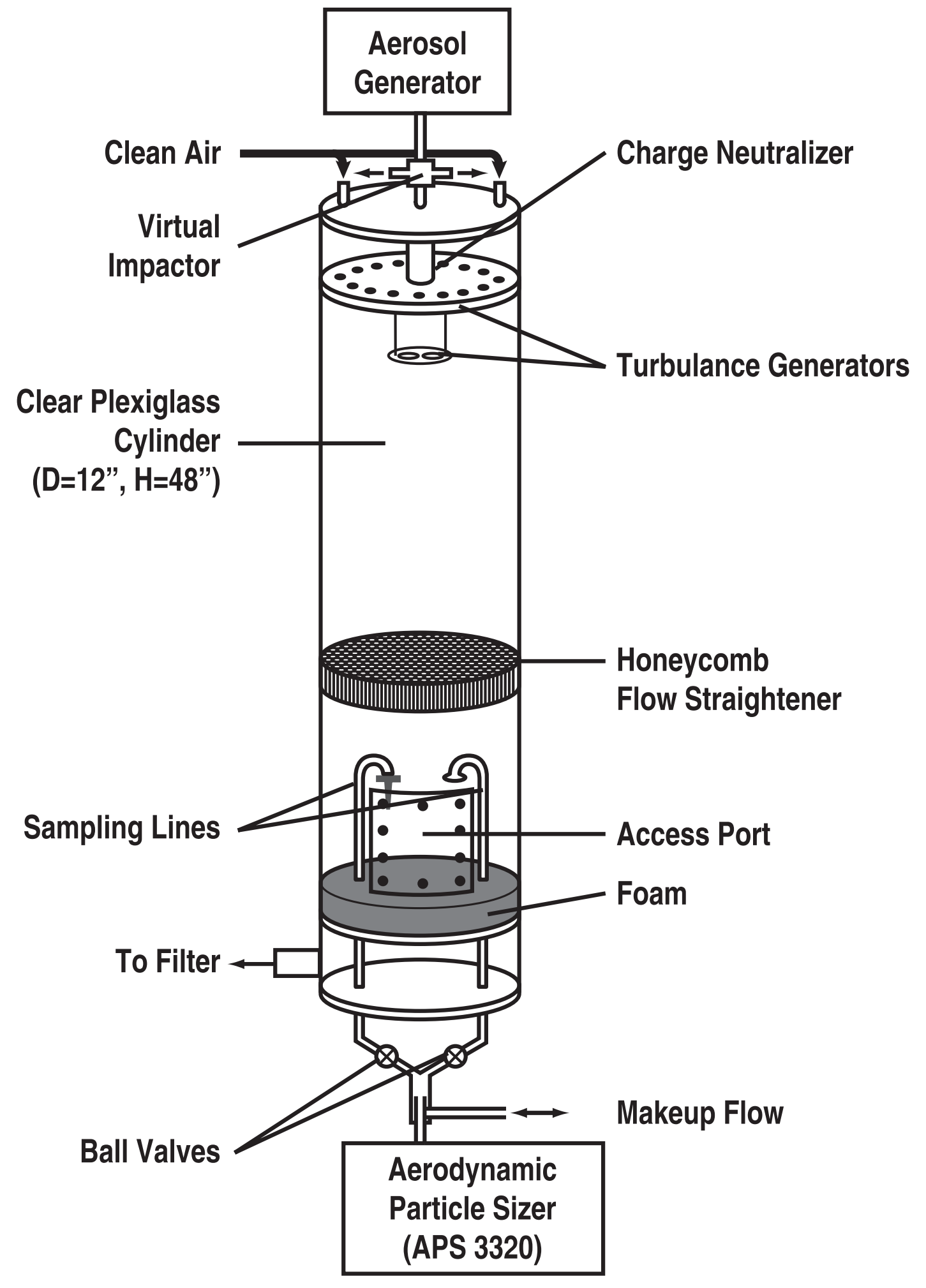


Figure 6. Schematic of aerosol test chamber

Performance of Newly Developed Modular Impactors

Figure 7 shows the sampling efficiency of the newly developed modular impactors measured in the test chamber. As shown, both PM2.5 samplers, 3.0 L/min and 10.0 L/min versions, follow closely EPA's PM2.5 curve. The sampling efficiency curves of the PM10 impactors are somewhat sharper than the PM10 curve defined by EPA. Nevertheless, side-by-side comparison of the IMPACT PM10 Sampler with the performance of a collocated MiniVol Sampler and FH 62 C14 Continuous Ambient PM Monitor show good agreement between data obtained with all of these samplers (Figure 8).

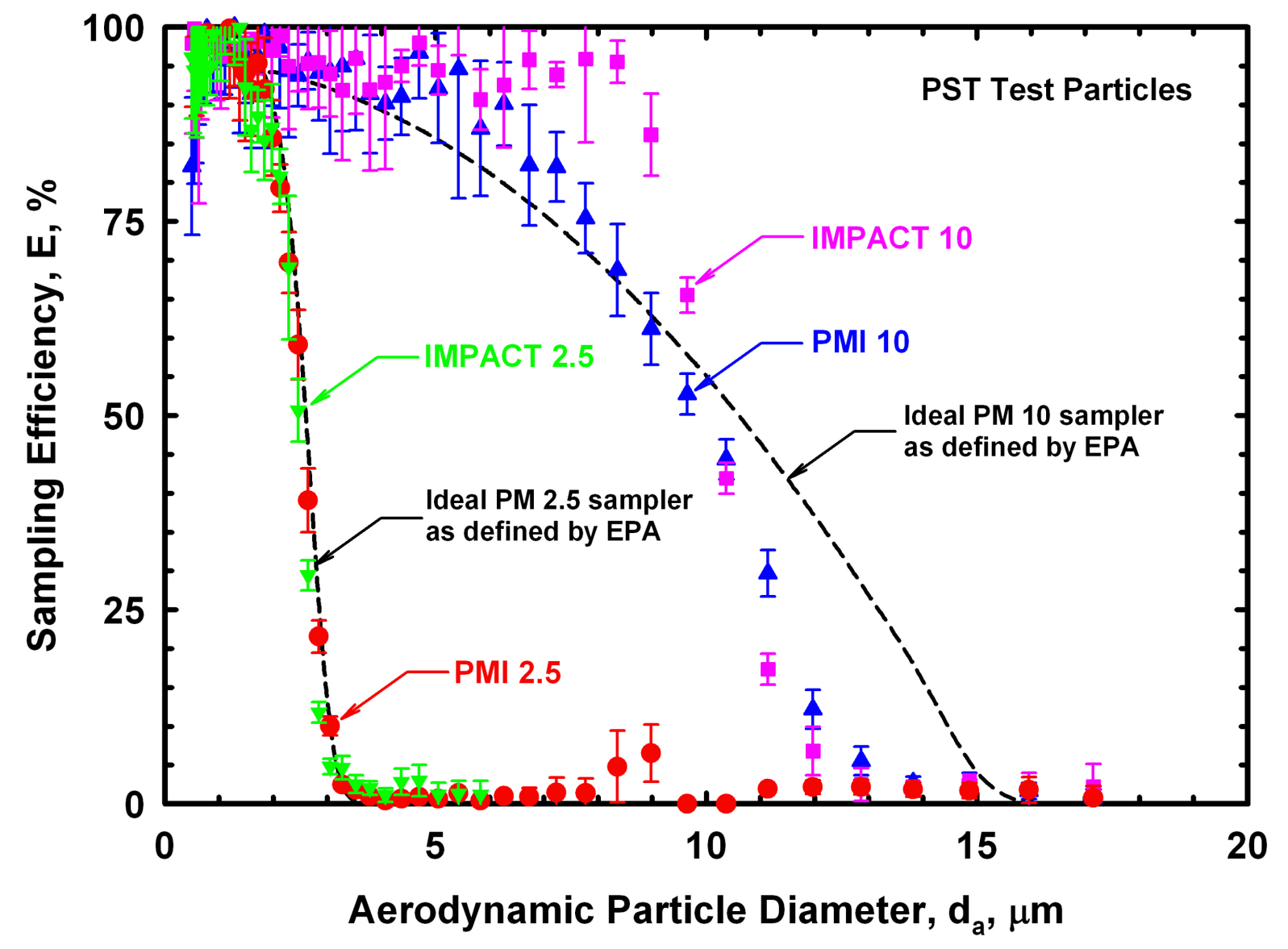
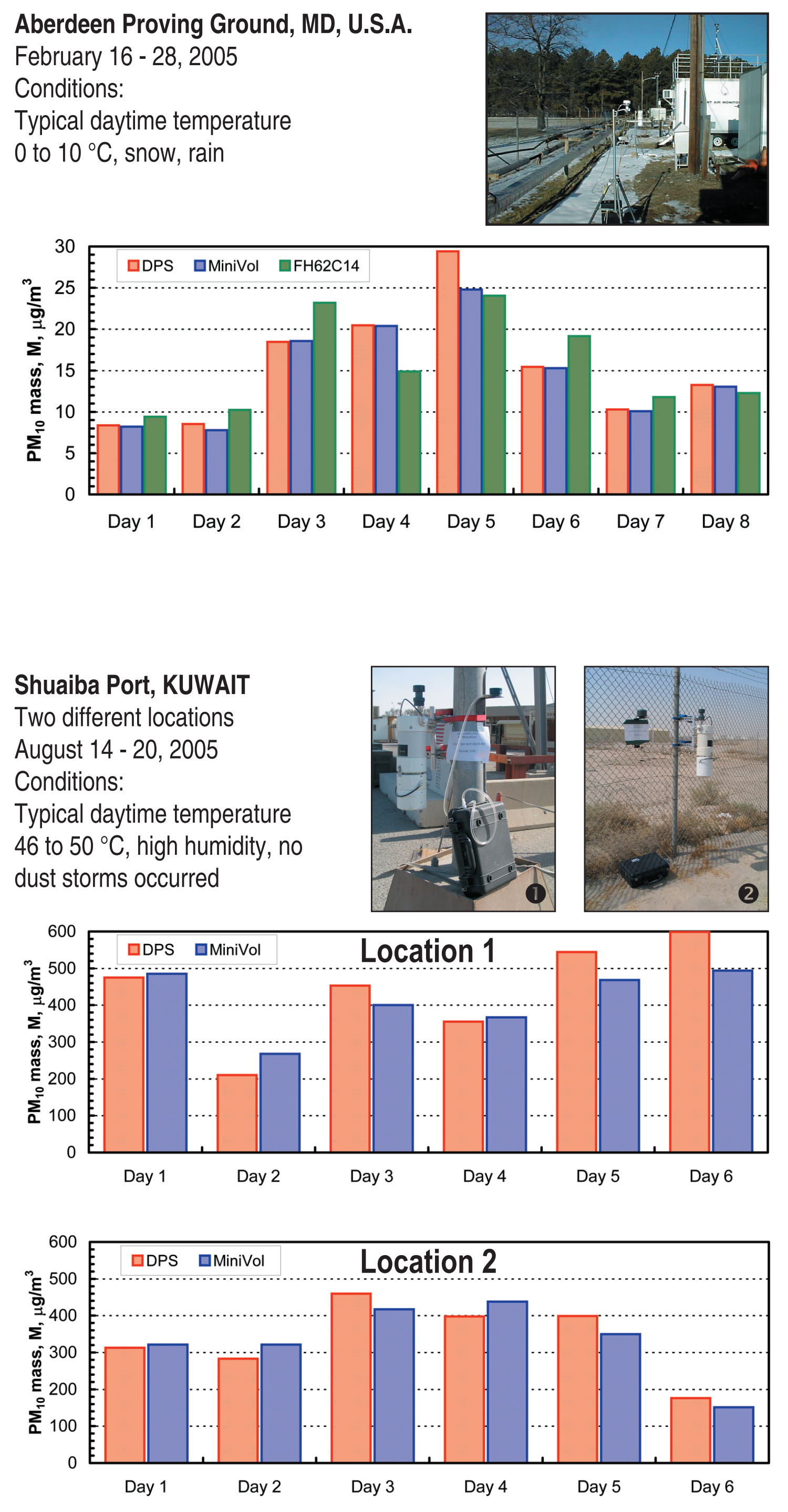


Figure 7. Sampling efficiency of new modular impactors



Aberdeen Proving Ground, MD, U.S.A.
February 16 - 28, 2005
Conditions:
Typical daytime temperature
0 to 10 °C, snow, rain

Shuaiba Port, KUWAIT
Two different locations
August 14 - 20, 2005
Conditions:
Typical daytime temperature
46 to 50 °C, high humidity, no
dust storms occurred

Figure 8. Comparison of IMPACT PM10 (in DPS System) with MiniVol Sampler and FH 62 C14 Monitor

Conclusion

A series of new inertial impactors were developed, manufactured, and tested. The modular design of the new impactors has been proven to provide an accurate, simple-to-operate, and economical solution for monitoring exposure to PM2.5, PM10, and PM Coarse.

Reference — Rader, D.J. and Marple, V.A. (1985). Effects of Ultra-Stokesian Drag and Particle Interception on Impaction Characteristics. *Aerosol Sci. Techno.* 4:141-156.

NISTLab/SAI
Wilner-Greene Engineering Services

Certificate of Calibration

ISO 9001 CERTIFIED

Order Number: 20220537
Certificate Number 129773

Issued To:
SAFEWARE GAINSVILLE, GA
2445 HILTON DRIVE
STE 119
GAINESVILLE, GA 30501-6276

Date Received: 1/11/2022
Date Issued: 1/25/2022
Valid Until: Jan 2023

Equipment:
Manufacturer: MESA LABS
Model Number: DEFENDER 530
SerialNumber: 134798
Control #

Test Conditions :

Temperature:	21.3	C
Humidity:	42.9	%
Barometric Pressure:	978.3	mBar

As Found:
WEAK BATTERY

As Returned:
FULLY FUNCTIONAL AND WITHIN TOLERANCE.

Special Conditions:
NONE

Work Performed:
REPLACED WEAK BATTERY AND CALIBRATED PER CALIBRATION PROCEDURE FC-002.

CALIBRATED TO: +/- 3.0% AS REFERENCED TO PRIMARY BUBBLE FLOW CELL @ 0.3% UNCERTAINTY AT AMBIENT C

MeasurementUncertainties: AIR FLOW RATE +/- 0.3%

Device, Description, Report Number, Date Due
Reference Standards:

1011, AF-PVM100, PRECISION MICROMANOMETER, 13930C-001, 5/31/2022
1012, PTU200, Vaisala PTU200 environ standard w/HMP45D probe, 20212843-125613, 5/18/2022
1030, GILIAN IHCP 300HL, MAGNEHELIC GAUGE, 20191223-106827, 8/4/2022
9105, ML-800-44, PRIMARY VOLUMETRIC STANDARD, 20212843-124821, 7/5/2022
9109, 5200-2, GAS FLOW MULTIMETER, 52002025001-17062020, 7/31/2022

Reviewed by: 1/25/2022

Authorized Signature: Brian Stanhope

This report certifies that all calibration equipment used in the test is traceable to the National Institue of Standards (NIST) , and applies only to the unit identified under "Equipment" above. This report must not be reproduced except in it's entirety without express written approval.

Certificate of Calibration

ISO 9001 CERTIFIED

NISTLab/SAI
Wilner-Greene Engineering Services

Calibration Report

Order-Certificate # 20220537-129773 Page 2

Model: Defender 530 **Date:** 1/25/2022
Serial # 134798

Test Results As Received

Reference Cell cc/min	Cell Under test cc/min	Relative Difference cc/min	Percent Difference
1055.3	1063.4	8.1	0.77%
1056.5	1065.0	8.4	0.80%
1055.4	1062.5	7.1	0.67%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
1055.7	1063.6	0.75%	
9879.9	9923.6	43.6	0.44%
9837.7	9881.4	43.7	0.44%
9808.8	9873.8	65.1	0.66%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
9842.1	9892.9	0.52%	
19662.0	19793	131.0	0.67%
19580.3	19775	194.6	0.99%
19512.4	19704	192.0	0.98%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
19584.9	19757	0.88%	

Test Results As Returned

Reference Cell cc/min	Cell Under test cc/min	Relative Difference cc/min	Percent Difference
1055.2	1062.5	7.3	0.69%
1056.4	1054.9	-1.4	-0.14%
1058.9	1057.5	-1.4	-0.13%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
1056.8	1058.3	0.14%	
9891.8	9900.0	8.2	0.08%
9835.4	9876.5	41.2	0.42%
9889.8	9924.2	34.4	0.35%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
9872.3	9900.2	0.28%	
19597.1	19574	-23.2	-0.12%
19524.1	19676	152.3	0.78%
19514.3	19658	144.1	0.74%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
19545.2	19636	0.47%	

	REF	DUT REC.	DUT RET.	Delta RET.
Press Amb (mmHG)	735.5	734.3	734.3	-1.2
TEMP AMB (C)	21.0	21.0	21.0	0.0

Tolerance Limits Flow rate: 0.75%, Press:+/- 3.5 mmHg (typical) +/- 7.0mmHg (MAX),

Temp: +/- 0.8 C (Typical), +/- 1.3 C (Max).

This report is valid only as an attachment to the Calibration Certificate number indicated above.

Rec'd: 27/3/23
SE

NISTLab/SAI
Wilner-Greene Engineering Services

Certificate of Calibration

ISO 9001 CERTIFIED

Order Number: 20230677
Certificate Number: 141103

Issued To:
SAFEWARE GAINSVILLE, GA
2445 HILTON DRIVE
STE 119
GAINESVILLE, GA 30501-6276

Date Received: 1/23/2023
Date Issued: 2/8/2023
Valid Until: Feb 2024

Equipment:
Manufacturer: MESA LABS
Model Number: DEFENDER 530
SerialNumber: 134798
Control #:

Test Conditions :

Temperature:	20.2	C
Humidity:	36.6	%
Barometric Pressure:	1008.7	mBar

As Found:
FULLY FUNCTIONAL AND IN TOLERANCE.

As Returned:
FULLY FUNCTIONAL AND WITHIN TOLERANCE.

Special Conditions:
NONE

Work Performed:
CALIBRATED PER CALIBRATION PROCEDURE FC-002.

CALIBRATED TO: MANUFACTURERS SPECIFICATIONS

MeasurementUncertainties: AIR FLOW RATE +/- 0.3%

Device, Description, Report Number, Date Due
Reference Standards:
1011, AF-PVM100, PRECISION MICROMANOMETER, 14721c-001, 5/31/2023
1012, PTU200, Vaisala PTU200 environ standard w/HMP45D probe, 20221412-133691, 5/31/2023
1030, GILIAN IHCP 300HL, MAGNEHELIC GAUGE, 20221412-135707, 7/31/2023
9105, ML-800-44, PRIMARY VOLUMETRIC STANDARD, 170562-01062022, 6/30/2023

Reviewed by: 2/8/2023

Authorized Signature: Brian Stanhope

This report certifies that all calibration equipment used in the test is traceable to the National Institue of Standards (NIST) , and applies only to the unit identified under "Equipment" above. This report must not be reproduced except in it's entirety without express written approval.

Certificate of Calibration

ISO 9001 CERTIFIED

Calibration Report

Order-Certificate # 20230677-141103

Model: Defender 530
Serial # 134798
Date: 2/8/2023

Test Results As Received

Reference Cell cc/min	Cell Under test cc/min	Relative Difference cc/min	Percent Difference
1986.1	1989.9	3.8	0.19%
1985.4	1990.0	4.5	0.23%
1985.7	1986.9	1.1	0.06%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
1985.7	1988.9	0.16%	
9959.2	9968.4	9.2	0.09%
9959.7	9966.2	6.5	0.07%
9959.2	9965.0	5.7	0.06%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
9959.4	9966.5	0.07%	
19430.4	19357.1	-73.4	-0.38%
19430.8	19348.7	-82.1	-0.42%
19430.4	19354.9	-75.5	-0.39%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
19430.5	19353.5	-0.40%	

Test Results As Returned

Reference Cell cc/min	Cell Under test cc/min	Relative Difference cc/min	Percent Difference
1985.9	1988.2	2.3	0.12%
1988.1	1987.6	-0.4	-0.02%
1985.5	1987.7	2.3	0.11%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
1986.5	1987.9	0.07%	
9959.1	9966.8	7.6	0.08%
9959.1	9965.2	6.1	0.06%
9959.6	9964.9	5.4	0.05%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
9959.3	9965.6	0.06%	
19430.7	19357.6	-73.2	-0.38%
19432.0	19358.6	-73.4	-0.38%
19430.2	19351.2	-79.0	-0.41%
MEAN	**MEAN**	**PERCENT DIFF. OF AVERAGE**	
19431.0	19355.8	-0.39%	

	REF	DUT REC.	DUT RET.	Delta RET.
Press Amb (mmHG)	735.8	742.0	742.0	6.2
TEMP AMB (C)	21.6	21.5	21.5	-0.1

Tolerance Limits Press:+/- 3.5 mmHg (typical) +/- 7.0mmHg (MAX),
Temp: +/- 0.8 C (Typical), +/- 1.3 C (Max).

This report is valid only as an attachment to the Calibration Certificate number indicated above.

Air Metrics Pump Information

1: INTRODUCTION

The MiniVol Portable Air Sampler is an ambient air sampler for particulate matter and non-reactive gases. The patented low flow technology used in the MiniVol was developed jointly by the U. S. Environmental Protection Agency (EPA) and the Lane Regional Air Protection Agency in an effort to address the need for portable air pollution sampling technology.

While not a reference method sampler, the MiniVol gives results that closely approximate reference method air quality data. Both accurate and precise, the battery operated, lightweight MiniVol is ideal for sampling at remote sites or areas without power. In addition, the low cost of the sampler allows a network of MiniVols to be deployed at a fraction of the cost for a similar reference station network.

The MiniVol features a 7-day programmable timer, a constant flow control system, an elapsed time totalizer, rechargeable battery packs, and all-weather PVC construction. The MiniVol can be configured to sample for just particulate matter, just gases, or both simultaneously.

Principles of Operation

The MiniVol Portable Air Sampler is basically a pump controlled by a programmable timer which can be set to make up to six "runs" within 24 hours or throughout a week. When used outdoors it may be hung from a bracket mounted on a variety of structures—utility poles, trees, fence posts, etc.

The sampler is equipped to operate from either AC or DC power sources. In the DC operational mode, the sampler operates from a battery pack, thus making the sampling site independent of line power. In the AC mode the battery pack is connected to line power and mated to the sampler unit. This configuration charges the battery while using AC power. The MiniVol comes with two battery packs to accomplish continuous field sampling. A charged battery pack is capable of operating the sampler for up to 24 sampling hours on a single charge.

The sampler is equipped with two "fault circuits":

- A **low battery circuit** automatically shuts the sampler down should the rechargeable lead-acid battery fail to supply sufficient voltage (above 10.3 volts) to the pump. This feature protects the battery which could be damaged if used continuously at low voltage. A "low-battery" indicator lights to alert the operator of this condition.

- A **low flow circuit** monitors the flow rate. Should excessive accumulation of particulate matter or some restriction in the tubing cause the air flow to fall below approximately 10% of the set flow rate, the sampler shuts down and a "low flow" indicator lights to alert the operator.

An **Elapsed Time Totalizer** linked in parallel with the pump records the total time in hours of pump operation.

PARTICULATE MATTER SAMPLING MODE

In the particulate matter (PM) sampling mode, air is drawn through a particle size separator and then through a filter medium. Particle size separation is achieved by impaction. Critical to the collection of the correct particle size is the correct flow rate through the impactor. For the MiniVol, the actual volumetric flow rate must be 5 liters per minute (5 lpm) at ambient conditions. To assure a constant 5 lpm flow rate through the size separator at differing air temperatures and atmospheric pressures, the sampler must be adjusted for each sampling project.

NOTE: The terms SIZE SEPARATOR, PRESEPARATOR and IMPACTOR are used interchangeably in this manual.

Impactors are available with a 10 micron cut-point (PM_{10}) and a 2.5 micron cut-point ($PM_{2.5}$). Operating the sampler without an impactor allows for collection of total suspended particulate matter (TSP).

The inlet tube downstream from the filter takes the air to the twin cylinder diaphragm pump. From the pump, air is forced through a standard flowmeter where it is exhausted to the atmosphere inside the sampler body.

The programmable timer will automatically turn the pump off at the end of a sampling period. The sampler must then be serviced and set up for the next sampling period. Servicing includes removing the sampler from its hanging bracket, removing the filter holder with the exposed filter inside from the sampler, and attaching a new filter holder with a fresh filter. The battery pack is also changed at this time.

The sampling technique used by the MiniVol is a modification of the PM_{10} reference method described in the U. S. Code of Federal Regulations (40 CFR part 50, Appendix J). Under this criteria, a PM_{10} sampler must have: 1) a sample air inlet system to provide particle size discrimination, 2) a flow control device capable of maintaining a flow rate within specified limits, 3) means to measure the flow rate during the sampling period, and 4) a timing control device capable of starting and stopping the sampler.

The Airmetrics MiniVol Portable Air Sampler meets all of these specifications. It is equipped with: 1) an inlet impactor capable of separating particulate matter to $\leq$10 µm, 2) a flow control device which will maintain a specified flow rate, 3) a flowmeter to measure the flow rate during the sampling period, 4) an elapsed time meter, and 5) a programmable timer that starts and stops the sampler unattended.

The MiniVol's flow rate Is generally less than the flow rates used by reference method devices. The lower flow rate results in a greater deviation in accuracy at low concentrations of particulate matter where precision can be lost through the handling and weighing of the sample. However, at high particulate concentrations the sampler produces results that are precise and comparable to reference method samplers. While the MiniVol's sampling method is not a reference or equivalent method, it has proven to be an excellent indicator of absolute ambient PM_{10} concentrations. The data collected by the sampler still serve as a useful supplement to data generated by PM_{10} reference methods.

INTEGRATED GAS SAMPLING MODE

In the integrated gas sampling mode, the sampler can accommodate one or two bag modules. The bags may be filled one at a time or simultaneously within a programmable period. There are two circuits which control the gas sampling:

1. A tuneable intervalometer, or pulse circuit, determines the rate at which a bag is filled. The circuit sends an electronic pulse to open a solenoid on the valve driver board. The duration of each pulse can be adjusted from approximately 50 to 750 milliseconds. The pulses can also be adjusted for frequency, from one pulse every 15 seconds to continuously on.

2. A bag sequencer determines which of the two bags is being filled during any programmed interval.

While the bags that are supplied with the samplers are made of relatively non-reactive Tedlar® (polyvinyl fluoride), other parts of the air path are made of PVC, polyethylene, silicone rubber, and other substances that are more reactive. Consequently, you should not use the MiniVol to collect gas samples that are to be analyzed for reactive gases like ozone or sulfur dioxide.

In the gas sampling mode, the air that is used to fill the bags is diverted from the normal air path just before the air is vented into the sampler case—at the end of the air path. Because of this, you may simultaneously collect a PM sample (the filter holder is situated at the beginning of the air path) while collecting a gas sample.

Noise Calibration Certificate

Certificate of Calibration

ISO 9001 Certified

NISTLab/SAI
Wilner-Greene Engineering Services

Order Number: 20222315
Certificate Number: 136522

Issued To:
SAFEWARE GAINSVILLE, GA
2445 HILTON DRIVE
STE 119
GAINESVILLE, GA 30501-6276

Date Received: 8/24/2022
Date Issued: 9/8/2022
Valid Until: Sep 2023

Equipment:
Manufacturer: QUEST
Model Number: QC-10
SerialNumber: QE6080246
Control #:

Test Conditions :

Temperature:	20.2	C
Humidity:	36.6	%
Barometric Pressure:	1008.7	mBar

As Found:
FULLY FUNCTIONAL AND IN TOLERANCE.

As Returned:
FULLY FUNCTIONAL AND WITHIN TOLERANCE.

Special Conditions:
NONE

Work Performed:
CALIBRATED PER CALIBRATION PROCEDURE CN-005.

CALIBRATED TO: ANSI S1.40-1984

MeasurementUncertainties: ACOUSTIC +/- 0.15 DB, FREQUENCY +/- 0.1HZ, DC VOLTAGE 0.1%, AC VOLTAGE 0.5%

Device, Description, Report Number, Date Due
Reference Standards:
1004, QUEST QE-4170, 1" PRECISION MICROPHONE, 32315-1, 9/30/2023
1010, HP 8903B, Audio Analyzer, 1433097, 6/30/2023
1024, HP 3456A, PRECISION DIGITAL VOLTMETER, 638300, 4/30/2023
9108, 42AC, PISTONPHONE, HIGH PRESSURE, CLASS 1, 33026-1, 5/31/2023

Reviewed by: 9/8/2022

Authorized Signature: Brian Stanhope

This report certifies that all calibration equipment used in the test is traceable to the National Institue of Standards (NIST) , and applies only to the unit identified under "Equipment" above. This report must not be reproduced except in it's entirety without express written approval.

102 Pilgrim Road
Greenville, SC 29607

www.nistlab.com
800-238-7550

Certificate of Calibration

ISO 9001 Certified

NISTLab/SAI
Wilner-Greene Engineering Services

Order Number: 20222315
Certificate Number: 136521

Issued To:
SAFEWARE GAINSVILLE, GA
2445 HILTON DRIVE
STE 119
GAINESVILLE, GA 30501-6276

Date Received: 8/24/2022

Date Issued: 9/8/2022

Valid Until: Sep 2023

Equipment:

Manufacturer: QUEST

Model Number: SP-DL-2

SerialNumber: BGN030010

Control #:

Test Conditions :

Temperature:	20.2	C
Humidity:	36.6	%
Barometric Pressure:	1008.7	mBar

As Found:
FULLY FUNCTIONAL AND IN TOLERANCE.

As Returned:
FULLY FUNCTIONAL AND WITHIN TOLERANCE.

Special Conditions:
NONE

Work Performed:
CALIBRATED PER CALIBRATION PROCEDURE SL-008.

CALIBRATED TO: ANSI S1.4-1983 TYPE 2

MeasurementUncertainties: ACOUSTIC 1.0 DB, FREQUENCY +/- 0.1 HZ, DC VOLTAGE 0.1%, AC VOLTAGE 0.5%

Device, Description, Report Number, Date Due

Reference Standards:

1004, QUEST QE-4170, 1" PRECISION MICROPHONE, 32315-1, 9/30/2023

1010, HP 8903B, Audio Analyzer, 1433097, 6/30/2023

1024, HP 3456A, PRECISION DIGITAL VOLTMETER, 638300, 4/30/2023

1051, 1800, TYPE 1 SOUND LEVEL METER, 20212843-130282, 1/31/2023

1052, OB-100, 1:1 OCTAVE BAND FILTER, 20212843-130281, 1/31/2023

Reviewed by: 9/8/2022

Authorized Signature: Brian Stanhope

This report certifies that all calibration equipment used in the test is traceable to the National Institue of Standards (NIST) , and applies only to the unit identified under "Equipment" above. This report must not be reproduced except in it's entirety without express written approval.