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Rosewood Barbuda Resort

Environmental and Social Impact Assessment

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Smart Solutions to Environmental Risks

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Rosewood Barbuda Resort

by Murbee Resorts

Environmental and Social Impact Assessment (ESIA)

Submitted to

Development Control Authority Antigua & Barbuda, Antigua

By

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This ESIA was prepared by Deborah Brosnan & Associates and with the assessments and reports of several technical experts from ecological, climate risk, engineering, socio-economic and archaeological fields. The research and baseline studies were completed by: Holly Trew, Ph.D., Alanna Waldman, M.Sc., and Kendall Young (biological, ecological and marine); Dr. Reginald Murphy M.S (archaeology); Federico Scodelaro and Cristina Esteban (socio-economic); Deborah Brosnan Ph.D and DB&A team (Nature-based-Solutions and climate); David Taylor and team, Harris Civil Engineers (civil engineering); Ingenuity Engineers Inc (electrical and telecommunications); Manuel Castena and team, Moffatt & Nicol, and Everon Zachariah Civil Engineering & Associated Services Ltd. Dr. Holly Trew and Kendall Young compiled the ESIA.

The DCA has required that all requests for copies or additional information be directed to the DCA Antigua

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EXECUTIVE SUMMARY

Murbee Resorts Inc. submitted a G-application (#G05-2024) to the Development Control Authority (DCA) of Antigua and Barbuda for the creation of the Rosewood Barbuda Resort on Barbuda. The Department of Environment conducted a site visit and subsequently issued a report to the DCA (May 13, 2024). The DoE report indicated that the project should proceed to the next phase and conduct an Environmental and Social Impact Assessment (ESIA) with the DoE issuing a Terms of Reference for the ESIA.

Murbee Resorts Inc. requested Deborah Brosnan & Associates to complete the ESIA. Deborah Brosnan & Associates engaged its in-house technical team and associated technical experts (including in archaeology and in socio-economic assessment). Others (e.g. civil engineering) were engaged directly by Murbee's representatives CM&D. Deborah Brosnan & Associates also consulted with the DCA and DoE to seek clarity on certain scope and requirements. The ESIA completed here follows the format and topics requested in the ToR provided.

Project Description: Murbee Resorts Inc. proposes to build the Rosewood Barbuda Resort on the southwest coast of Barbuda. The development will be constructed on a 160.48-acre plot in four phases. It will include 50 keys/suites, guest pools, an organic farm, restaurants, a spa and fitness facility, a kids club, sports courts, employee housing, and a house area. The developers aim to create a luxury resort and residences that deliver an exquisite and unrivalled guest experience. The project will provide public beach access at the western edge of the property and the port access location on the eastern edge will not be impacted.

About Murbee Resorts Inc.: Murbee Resorts Inc comprises – Mr. Purcell Bird (Barbudan), Mr. Kiril Domuschiev, Mr. Georgi Domuschiev, and Mr. Armand Arton. The local Antigua and Barbuda Directors are Mr. Purcell Bird and Ms Elizabeth Makoul. The Murbee project management representatives are CM&D New York – Mr. Geoff Ross; and the owners' representative is Mr. Dario Bertucci (A Small World Hospitality).

The land leases comprise three main parcels. Mr. Purcell Bird confirmed that the leases have been secured from local Barbudans and other users, that necessary arrangements made for the sale or transfer of leases (see Appendix 1), and that the leases have been filed with the DCA.

The original G application included an inland marina but based on the input of the ecologists and other concerns, this was later eliminated from the plans. A new masterplan was submitted to the DCA without a marina, and as a revision under the same G-application.

The DoE report cited four main areas of concern/interest to be addressed within the ESIA. These were: drainage and hydrology; wastewater; marine impact (from the proposed marina); and climate change. However, because the inland marina was removed from the plan and revised submission, it is not included. A new main road is planned to bypass the resort and is now to be located outside of the property boundary. The authors were informed that this has been discussed by the owners with the Barbuda Council. Because of its external location and separate planning, the new roads fall outside of the scope of this ESIA. One part of the lease area, on the eastern side, contains an operational batch plant. The authors have been advised that there is agreement in place, or pending, with the existing operators to relocate the batch plant. As this agreement has not been finalized and no timeline is available, any environmental or other permits regarding the batch plant will need to be considered separately by DoE and DCA at the appropriate time. A summary of main impacts and mitigation measures based on the DoE's ToR is included in Table 0.1.

A technical team was assembled to complete the ESIA studies and included: Deborah Brosnan & Associates (ecology, biology, nature-based solutions, climate, and overall ESIA completion) with Dr. Reginald Murphy (archaeology); and Mr. Federico Scodelaro and Ms.

Christina Esteban (socio-economic assessment). In addition, the project engaged Harris Civil Engineering (for civil engineering assessments including drainage, energy etc.), Ingenuity Engineers Inc. (telecommunications, electrical), Moffatt & Nicol (coastal vulnerability analysis), and Everon Zachariah, Civil Engineering and Associated Services, Antigua (geotechnical studies).

The 160.48 acres (64.94 hectares) that comprise the project fall within five different zones as identified by the Sustainable Island Resource Management and Zoning Plan (SIRMZP). These zones include industrial, tourism, transportation, settlement, and environmental protection. Approximately 55 acres (22.25 hectares) are in the environmental zone, including in the Ramsar and Codrington Lagoon National Park boundaries, and the remainder (105.48 acres/42.69 hectares) are in the first four zones. The historic Martello tower is nested within the boundary but is not part of the development; the Murbee team have offered to assist with restoration for cultural and tourism benefit to the Barbuda Council and community.

Project benefits: The project benefits to Antigua and Barbuda include: Increasing high-end tourism within Barbuda and that showcase the use of nature-based solutions: The project will benefit the local economy by directly providing 200-250 construction jobs in Phase I of the development and 50 jobs in Phases II, III and IV, as well as 1,752 jobs on-site at the resort when all phases of the construction are completed. Jobs will include training and skills for jobs that are focused on natural resources stewardship including native plant nursery, mangrove restoration and management. An additional 2,630 indirect job benefits are anticipated including for food and beverage suppliers, local tour guides, transportation and logistics companies, laundry services, handicraft production, construction companies, and others. The development will also offer a direct market for local fisheries including for conch and lobsters. The project will engage with and provide community support, including for the restoration of the Martello tower and other projects to be identified by the Barbuda community.

A centerpiece of the development will be the incorporation of nature-based solutions (NbS). (NbS) are practices that use natural processes and features to address environmental, climate change, and social risks. They leverage the services provided by nature, such as flood control, storm surge protection, sea level rise, water filtration, carbon sequestration etc. to enhance project resilience and provide multiple benefits. The ecological team identified two key NbS features to integrate into the master plan and project. These are the inclusion and expansion of mangrove lagoons (that provide flood management, water filtration, carbon sequestration, and habitat for a diversity of wildlife and protected mangrove species), and the protection of the sand dune barrier and restoration of native vegetation. In addition, the ecological team recommends the protection and management of the nearshore coral reef habitats in front of the property beach as coral gardens for biodiversity and education-based tourism.

Environmental baseline: The environmental baseline comprised a comprehensive set of biological, water, noise, geotechnical surveys and other surveys as well as desktop research. Ecological field studies were conducted on-site to identify and map marine and terrestrial habitats and assess vegetation, marine benthic composition, and fish species richness

- The vegetation on the site was found to include 58 plant species. 7 of these species are protected under the EPMA (2019), and an additional 9 species are regionally endemic and should be salvaged or protected where possible. The most common species were Torchwood and White cedar (regionally endemic), Buttonwood (protected under the EPMA (2019)), Seagrape, Hop bush, and Alabamba (invasive, previously known as acacia). 3 invasive species, Alabamba, Neem and Logwood were pervasive throughout the site.

- Bird surveys detected 185 individual birds comprising 23 species were recorded during bird surveys. Of these 7 species are protected under the EPMA (2019). The endemic Barbuda warbler was recorded on the site.

- Marine habitat and species surveys were conducted. Seagrass was the primary benthic cover (44%) in the nearshore area. Seagrass beds were healthy except in the area adjacent to the port. Patch reefs covered 32% of the substrate and the remainder was a mix of hard bottom (15%), sand (5%) and mud (2%). The patch reefs had low coral cover, and were predominantly overgrown with algae. 16 stony coral species were recorded. 39 species of reef fish were documented. The commercially important species Nassau grouper, Red snapper, and Spiny lobster were present.

- Soil quality assessment (as requested by DoE) was conducted. Overall, soil pH was generally alkaline (7.4-8.0), potassium and nitrogen levels were elevated (240-780 ppm and 54-300 ppm respectively), and phosphate was generally within or slightly higher than the normal range (8-29 pmm).

- The geotechnical assessment indicated that soil structure at the site is primarily comprised of sand and limestone of varying densities. Rock structure is generally poor resulting in the engineers from CEAS recommending that foundation piles be 8 m deep.

- Groundwater was recorded at 0.2-7.3 m below the surface.

- Water quality was conducted at 12 sites including wetland and marine locations. Temperature, turbidity, salinity, pH, nitrate, and phosphate levels were all within acceptable limits under the EPMA 2019. Fecal coliform and enterococci concentrations were higher than acceptable limits at 9 sites and enterococci concentrations higher at 3 sampling sites likely due to the prevalent livestock on the site. None of the other parameters exceeded threshold standard levels per the DoE standards.

- Noise levels at the Rosewood Barbuda Resort site currently range between 28 and 85 dBA but average between 31 and 54 dBA between 07:00 and 17:00. The primary sources of noise are the batch plant activities, traffic, and activity of trucks and vessels at the port.

Utilities: The developers intend for the project to be self-sufficient for all utilities. Electricity will be initially created by diesel generators and then liquid propane gas (LPG) will be used. Freshwater will be provided using a Reverse Osmosis (RO) system which will utilize deep injection wells to both obtain water and dispose of brine to avoid impact on any local aquifers and to minimize environmental impacts from brine disposal. The RO plant will be one of the first infrastructure units to be installed for use by a native plant nursery and the initial workforce. It is intended as a modular system that can be expanded as the development advances

The civil engineering components were assessed and designed by Harris Civil Engineers, and includes drainage and wastewater, sewage systems. The anticipated sanitary sewer flow for the project is approximately 215,000 lpd. The wastewater system will be based on a membrane bioreactor (MBR) plant. MBR technology uses membrane filtration to capture suspended solids and microorganisms to breakdown organic pollutants. The effectiveness of MBR systems is well-established and they are often favored for their compact design, scalability to adapt to varying capacity needs, and their outputs have been shown to exceed environmental regulatory requirements. To maximize water reuse and recycling, the project will use the Wastewater Treatment Plant (WWTP) effluent for irrigation on site. Wastewater will be collected from around the property via a gravity collection system.

Drainage and hydrology of the site will orient around the integrated constructed wetlands that are at the center of this development as a nature-based solution. Runoff from the surrounding land will provide water to maintain these wetlands, that will be eco-engineered for flood control and water management. An overflow pipe will facilitate water connection with the ocean.

The preliminary drainage assessment was prepared by Harris Civil Engineers. They established four watersheds both pre- and post-development and assessed water flow into the ponds in 2 year: 24 hour and in 50 year: 24 hour storm conditions. Based on the latter, the recommended building heights are 2.88 m above wetland water level.

The drainage assessment was based on the masterplan in the original G-application that contained an inland marina, and before the project had fully committed to a nature-forward solution that included wetland and mangrove enhancements. As a result, a more detailed hydrology and drainage plan, incorporating ecological design for mangrove and wetlands, and a masterplan/landscape plan that includes these elements is currently being prepared and will be provided to the DCA and DoE. (It is anticipated that this will be completed and submitted by the end of January 2025.)

Climate change poses a significant risk to Antigua and Barbuda. The risks from sea level rise and storm surge can be mitigated by several elements. These include the use of natural ecosystems coupled with climate resilient development and construction. An increased setback of 40-60 m from the line of permanent vegetation combined with construction of 4 m high sand dunes, planted with native vegetation was proposed. This was based on previous studies and discussions with the then master-planners and the DoE. The ecological team recommended that an updated and more comprehensive coastal vulnerability assessment be conducted that could better address FFE, erosion and setback options. This was completed by Moffatt & Nicol. The final hydrodynamic report was only recently provided (December 24, 2024) and has not yet been fully reviewed by our team. The findings will be incorporated into the final design and recommendations for FFE etc., and with a submission date to DCA/DoE of approximately the end of January 2025.

Socio-economic and cultural baseline: An archaeological assessment was completed in two phases by Dr. Reginald Murphy (Antigua) to determine historical use and identify any areas of historical and cultural significance. Various artifacts and evidence of a small, previously unknown building were found on the site, however, Dr. Murphy indicated that none of the findings were deemed to be of sufficient size, quality, and structural interest to justify it as an historical site of importance. However, the presence of an archaeologist during construction is recommended.

The Martello tower is an important cultural and historic site that is outside of this development. The Rosewood Barbuda development has offered to help restore this site as a tourist and educational facility and support the Barbuda Council and community in this effort. The restored site would remain under the ownership and control of the Council with support provided by the project.

The socio-economic assessment and stakeholder engagement report, conducted by Federico Scodelaro and Cristina Esteban, was structured around primary field work and secondary data collection from authoritative sources. Primary fieldwork played an essential role in grounding the analysis in the realities of the Barbuda community. Two field visits were conducted in Codrington and surrounding areas. These visits included site inspections, stakeholder interviews, and public consultations. Interviews were conducted with representatives from various sectors, including education, healthcare, construction, hospitality, fishing, and public services. Efforts to meet directly with the Barbuda Chairman and Council were unsuccessful as the Chair informed the team that he did not wish them to present to or engage with official

Council members. Observations of key community amenities and their usage patterns were also recorded.

The potential social impacts and risks of the project were evaluated. The key social impacts identified include: Road and traffic impacts; Occupational and community safety risks; Cultural heritage; Impacts on utilities; and Impacts on employment and economic activities. While the project is expected to generate new jobs, it may also disrupt existing economic activities, particularly in sectors like fishing and sand mining. A comprehensive Social Management Plan (SMP) can help to mitigate these factors and should include: Monitoring and compliance control; Occupational and community health and safety programs; Traffic and pedestrian management strategies; Community information and participation initiatives; Grievance redress mechanisms to address community concerns; Socio-environmental training for workers; Cultural heritage preservation and archaeological contingency plan; Gender equity and inclusion programs; and Fishermen's livelihood restoration plans.

The potential ecological impacts of the development identified can be significantly reduced if all proposed mitigation measures are correctly implemented. Incorporating nature-based solutions (NbS) will significantly reduce impacts, enhance resilience, and create opportunities for biodiversity and wildlife to be sustained and flourish. Wetland environmental conditions will also be enhanced by the planned integrated constructed wetlands and mangrove-based lagoons can offer a habitat for birdlife and other species. Coral reef education and protection, including for instance establishing Rosewood Barbuda coral gardens, will help to educate and protect reefs. Native plant nurseries to serve the dunes, lagoons and residences will increase native vegetation. A Barbuda warbler study and integrating protection and education programs on site will enhance awareness and conservation of this endemic species. These activities also offer job training and opportunities in new skill and environmental stewardship areas.

Natural hazards include hurricanes and less frequent risks from earthquakes and tsunamis. Climate change has altered the vulnerability and risks from some hazards such as hurricanes, storm surge. A disaster risk management plan is included and the project should work closely with the NODS (the government's natural disaster program) to align with their regulations, recommendations and training.

An Environmental Monitoring and Management Plan (EMMP) has been developed to ensure the proper procedures are in place for compliance with health and environmental standards and regulations. The EMMP outlines plans for biodiversity management, sewage treatment, stormwater runoff, socio-economic management, noise and air quality management, and disaster management.

Table 0.1: Summary of several main impacts and mitigation measures. These are detailed in Section 6.0.

Category	Description	Mitigation measures
Land environment	Soil pollution	Minimize runoff and leaching via pre-designed stormwater and discharge management plans.
	Light pollution	Construction predominantly during daylight hours and operational hotel will not have any bright spotlights on the beach or surrounding environs.
	Beach erosion	Mandated setbacks for construction are 40 m and 60 m; sand dunes will be increased to 4 m; stabilization through planting beach and dunes with native plants; ban on driving heavy machinery on beaches.
Air environment	Air quality	Dust suppression; haulage routes on sealed roads, cover truck loads; plant vegetation

Category	Description	Mitigation measures
Noise environment	Noise pollution	Construction restricted to daylight hours; regular noise monitoring (see EMMP).
Water and coastal environment	Climate change and sea level rise	Maintain healthy seagrass and coral reef ecosystems, and beach vegetation; protect and maintain beaches and beach sand. Apply climate-resilient setbacks (40-60 m), FFE, construction methods and site critical infrastructure in low-risk locations. The integration of constructed wetlands to reduce flooding, recharge groundwater and enhance wetland habitat.
	Water quality	Minimize runoff; dust suppression; safe disposal of waste materials; appropriate design of constructed wetlands to filter and circulate water; regular water quality testing (see EMMP).
Biological environment	Native vegetation	Primary native assemblages are present but much of the site is impacted by industrial activities and animal grazing. 3 invasive plant species are pervasive. Native tree and plant species protected under the EPMA (2019), including mangroves, are to be conserved and to be salvaged and replanted where necessary in a plant salvage plan. Landscaping and planting in the constructed wetlands will utilise native species as much as possible and will focus on mangrove enhancement and restoration. A native plant nursery will be established.
	Terrestrial wildlife	We recommend that the project institute a Barbuda warbler protection and education program. The integrated constructed wetlands, if properly designed ecologically, will create habitat for several bird species and are likely to be used by the magnificent frigatebird.
	Seagrass and coral reef ecosystems	Control sediment and nutrient runoff. Implement regular seagrass, coral reef and fish monitoring (see EMMP). Establish a coral reef garden to protect and educate.
	Sea turtles	Train workers to identify and report nesting sea turtles. Ensure minimal light pollution on beaches.
Socio-economic environment	Cultural	Restoration of the Martello Tower and preservation of the Strombus line will provide cultural and educational benefit. Provide locally guided cultural and educational tours for guests. These should also be available to non-local workers to educate them on the importance of local traditions. The project should actively engage with the community in a transparent manner to help integrate and protect the cultural traditions that are important to the Barbuda community. Regular meetings with community representatives about the project will improve communication and help to build trust and dialogue. Establish a community liaison officer position.

Category	Description	Mitigation measures
		Support community initiatives that have been identified by the community as ones that are important and relevant to community members.
	Human health	Enforce health and safety protocols for construction crews; limit dust and noise as much as possible; take precautions against mosquito breeding.
	Public beach access	Public beach access will be provided on the west side of the property and maintained at the port. The needs of fishermen and current users are to be addressed.
	Relocation of existing users	Includes batch plant industrial development, small non-permanent beach bars and vendors. Agreements to move will be confirmed prior to construction.
	Employment	Provide jobs and training preferentially to local community. Housing and support services will need to be provided.
	Public services	The development needs to provide resources to support an increased labor force and should provide support to minimize impacts on public services. The project should consider an onsite clinic, medical evacuation services, and other key services to support the workforce, their families and community.
Infrastructure, waste and pollution	Chemical spills	Ensure all chemicals are stored and handled correctly; treat chemical spills immediately; follow disaster response protocols.
	Electricity	All electricity will be created on site initially using diesel generators and then switching to LPG.
	Fresh water	All fresh water will be created on site using reverse osmosis systems. Deep water injection wells will be used to both obtain water and dispose of brine. Casing of pipes will eliminate impact to aquifers.
	Waste management	Implement effective waste management and recycling systems.
	Sewage and wastewater	Wastewater will be treated on site using a membrane bioreactor system. Clear water effluent will be stored on site and used for irrigation of green areas.
	Traffic and parking	Road relocation is planned (outside the scope of this ESIA). This and other developments will increase traffic and parking needs. Adequate planning that includes developers, Barbuda Council and relevant agencies is needed. During the construction phase, materials will be received at the dock immediately adjacent to the property which will reduce transport needs.



SECTION 1.0 INTRODUCTION

1.1 Introduction

1.1.1 Overview

The Murbee Resorts Inc. proposes to develop a high-end, luxury hotel and residences in Barbuda. The project will contribute to the high-end destination market that is envisioned for Barbuda while also focusing on providing local community and environmental benefits, job opportunities, and social programs to contribute to well-being of the island. The project incorporates integrating key elements of the development with the existing natural environment. This includes applying the nature-based benefits provided by dunes and mangroves.

1.1.2 Project profile

Murbee Resorts Inc. is identified as the entity holding the leases to 160.48 acres of land for the proposed development on Barbuda. The development will include a hotel and residences. The contact information and address for the representatives of the leaseholders are:

Name: Purcell Bird (Director/Partner)
Antigua BWI
Contact: 1-268-773-851
Name: Elizabeth Makhoul (Director)
Antigua BWI
Contact: 1-268-764-8634
Murbee Resorts Address: Christopher & Associates, Villa Nova court, Cnr, Dr. Rosa Lee Dr. & 4th Ave, St. Johns, Antigua and Barbuda

The owners/investors/partners have been provided as: Mr Purcell Bird (Barbudan), Mr. Kiril Domuschiev, Mr. Georgi Domuschiev, and Mr. Armand Arton.

The overall project management and day-to-day activities, including project development, implementation, and construction, is provided by CM&D New York (Mr. Geoff Ross). A Small World Group (Mr. Dario Bertucci) is the owners' primary representative.

The consultants engaged in the project to date have been identified in the introductory overview, and their CVs are provided in Annex 1.

The hotel will be a Rosewood Hotel property and, based on the design provided, will comprise 50 keys/suites, guest pools, an organic farm, restaurants, a spa and fitness facility, a kids club, sports courts, employee housing, and back-of-house area. The architecture is being designed by Elastic Architects. The area comprised by the project is 160.48 acres (64.94 hectares),

Murbee Resorts Inc. submitted Application G05-2024 to the Development Control Authority (DCA) for the project. Based on a review, site visit in May 2024, and recommendations by the Department of Environment (DoE), the DCA determined that the project could move forward to the next stage and for which an ESIA was necessary. DoE issued a Terms of Reference (ToR) for the ESIA. Murbee Resorts Inc. requested the assistance of Deborah Brosnan & Associates for several ecological, social and resilience assessments, and engaged additional consultants for necessary technical assessments (see overview section). This document responds to the ESIA requirements for the project and in accordance with the ToR.

During several ecological analyses and discussions, the developers agreed with recommendations to remove a proposed inland marina that had been included in the initial

design and submission. A revised master plan concept without the marina was submitted to the DCA in December 2024 (Figure 2.1). A larger mangrove wetland lagoon is proposed (other elements remained largely unchanged). This and other existing mangrove wetlands will form part of an extensive nature-based element for water management and resilience. The hydrological and other studies for this system have not yet been fully completed, along with details of the resulting final masterplan. The management team requested that the ESIA be submitted at this stage with their commitment to undertake and provide to DCA the necessary assessments to finalize any remaining details integrating the master plan, hydrology, nature-based solutions, and coastal resilience. At the time of writing, the authors confirm that these studies are being undertaken and where necessary these are referenced in the ESIA.

1.1.2.1 Purpose

Murbee Resorts Inc. proposes to develop a luxury hotel and residences on 160.48 acres of land along the southwestern coastline of Barbuda. The site extends from the pink sands beach on Palmetto Peninsula to the Barbuda port and ferry dock.

The 160.48 acres (64.94 hectares) of land will be used to develop a high-end luxury hotel and residences. The hotel will be a Rosewood property and will comprise 50 keys/suites, guest pools, an organic farm, restaurants, a spa and fitness facility, a kids club, sports courts, employee housing, and a house area. Different types of residences are planned for the development including 35 beachfront, 16 dune, and 64 lagoon residences planned for the site, including the following:

1	Beachfront Resident's Club
50	Hotel keys + Amenities
2	Beachfront Compounds
7	Beachfront Estates
4	Beachfront Villas
16	Dune Villas
10	East Lagoon Cottages
16	East Lagoon Flats – One Story
16	East Lagoon Flats – Two Story
2	Lagoon Bungalow
8	Lagoon Flats – One Story
8	Lagoon Flats – Two Story
2	Lagoon Villa

The development will provide numerous job opportunities for the local community and integrate social programs, including those identified in the community outreach part of the socio-economic analysis and based on feedback from the community. It will leverage the natural benefits of the existing environment and create harmony between the development and nature. Nature-based solutions utilizing primarily mangrove lagoons will be a prominent feature of the development.

1.1.2.2 Land description

The applicant, Murbee Resorts Inc., is the holder of several leases in Barbuda that together comprise the development area. The entire property is 160.48 acres, which has been leased out in sections of three different leases. The first lease encompasses a 70.02-acre parcel, the second lease a 76.55-acre parcel, and the third lease a 13.91-acre parcel. The total acreage is located on the southwestern coast of Barbuda, along the coastline between Palmetto Peninsula and the existing Barbuda port and ferry dock. The project also requires the diversion of an existing road to prevent non-development-related traffic from bisecting the site. A new road is proposed. However, the development team has identified the location of the new road as being outside of the property boundary and subject to a separate plan and permission. It will not be discussed further in this report.

Land Leases Barbuda: The project details, as provided to the ESIA team, identify that 160.48-acres are leased to the project. Mr. Purcell Bird and CM&D have confirmed that the leases have been secured, and necessary arrangements made for the sale or transfer of leases. This was confirmed in a statement by Mr. Bird and indicating that copies of the relevant leases have been filed with DCA (see statement by Mr. Bird in
Appendix 1). Additionally on some parcels of land currently occupied by other activities, notably a batch plant, these activities will be relocated. The ESIA team compiling this report has been advised by the development team that this transfer/relocation has been agreed upon by the current occupiers of the land. The ESIA is completed under the assumption that the above information is correct.

Provision for Access: Under the Antigua and Barbuda Physical Planning Act 2003 (Section 50), all beaches are public, and access must be provided. Public access to the beach must be maintained at intervals of 1 km (0.6 miles) or less (SIRMZP 2011). The Beach Control Act confirms the rights to beach access by recreational users and fishermen. Murbee Resorts Inc. recognizes these regulations and acknowledges the traditional use of the beaches enjoyed by the communities on Barbuda. The project includes a dedicated public access at the western end of the property. The current port access on the east side will not be impacted. At the time of writing, there was no defined pathway identified in the master plan available to the ESIA team. The development management team, CM&D, confirmed the inclusion of an access pathway on the western side of the boundary.

1.2 Environmental Legislation and Standards

A brief description of the main applicable local and national regulations and standards is provided below, along with applicable international treaties. The area is zoned primarily for industrial transport and tourism use, with the area west of the Martello tower within the Ramsar and CLNP designations. Zoning is described in greater detail in the following section.

1.2.1 Local And National Regulations And Standards

Physical Planning Act (2003) Rev 2024

Under the Physical Planning Act of 2003, the Development Control Authority (DCA) is given the authority to approve applications for development and to manage the Environmental Impact Assessment (EIA) procedure.

Sustainable Island Resource Management Zoning Plan (2011)

The SIRZMP provides guidance to sound socio-economic and physical development in Antigua and Barbuda and provides guidelines to current and proposed zoning management plans for future tourism projects.

Environmental Protection and Management Act (2019)

The EPMA provides for sustainable environmental protection and management of natural resources, to allocate administrative responsibility for the management of environmental matters; to give effect to Antigua and Barbuda's treaty obligations with respect to the environment and to provide the framework financial mechanism to satisfy the requirements of the Act and for other related matters.

Barbuda Local Government Act (1976)

This Act sets forth the establishment, composition, duties, authorities, and dissolution of the Barbuda Council, requirements for the membership of the Council, financing of the Council, offenses, and penalties. Barbuda Fisheries Regulations fall under this act and establish the coastal management advisory committee and several fisheries regulations.

Barbuda Fisheries Regulations (2014). Under the Barbuda Local Government Act

These regulations establish the coastal management advisory committee and several fisheries regulations governed by the Barbuda Council, among other conditions.

Barbuda (Coastal Zoning and Management) Regulations (2014). Under the Barbuda Local Government Act

These regulations declare marine sanctuaries, no-net zones, anchoring and mooring zones and shipping areas and empower the Barbuda Council to amend zones, create additional types, and restrict activities within these zones. Among other things, they require a management fee to be paid, provide for the protection of seagrass and/or coastal mangrove, and define offences and penalties.

Beach Protection Act (1957) and Amendment (1993)

The Minister of Public Works is authorized under the Beach Protection Act to issue permits before the removal of any sand, shingle, or gravel from beaches.

Beach Control Act (1959)

The Government of Antigua and Barbuda Cabinet is granted the right to make decisions in the public interest regarding the use of lands adjoining the foreshore for public recreational purposes. The Beach Control Act states that recreational users' and fishermen's rights to beach access cannot be withdrawn.

Disaster Management Act (2002)

An Act to provide for the effective organization of the preparedness, management, mitigation of, response to, and recovery from emergencies and disasters, natural and man-made, in Antigua and Barbuda. Implemented by the Director of Disaster Preparedness and Response.

Public Health Act, CAP 353 (1957)

The Central Board of Health, Public Health Act CAP 353, has the authority to regulate issues affecting public health, including the operation of hotels and restaurants, storage and disposal of refuse, and discharge of treated effluent into marine water bodies.

Public Utilities Act (1973)

The Antigua Public Utility Authority (APUA), under the Public Utilities Act, has the authority to install and operate sewage treatment plants on behalf of the government, and the administration of potable water for government/private purposes.

Pesticide Control Act (1973)

The Pesticide Control Board is given authority to control the importation and use of chemicals for agriculture and landscaping. This includes the storage of chemicals to protect workers as well as the application of chemicals for the interest of adjacent landowners.

Fisheries Act, CAP 173 (1984)

The Fisheries Division, under the Ministry of Agriculture and Fisheries, is responsible for the management of marine resources and commercial fisheries. This includes authority over established marine reserves to protect the ecological integrity of flora and fauna, promote scientific research, and preserve the natural beauty of marine areas.

Coastal Development Setback Guidelines in Antigua and Barbuda (1998)

Coastal setback guidelines for all construction in Antigua and Barbuda. This provides a standard framework to be applied by the planning authorities in Antigua and Barbuda with the aim of facilitating coastal development while reducing beach erosion.

Codrington Lagoon National Park (CLNP) (2004)

This was established in 2004 by the *National Parks Act of 1984* and although the development does not abut the lagoon, CLNP generally aligns with the Ramsar boundaries

1.2.2 International Conventions and Treaties

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1975)

An international agreement between governments with the aim to ensure that international trade in specimens of wild animals and plants does not threaten the survival of the species.

Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean (Escazú Agreement) (2018)

An international agreement among Latin American and Caribbean nations concerning the rights of access to information about the environment, public participation in environmental decision-making, environmental justice, and a healthy and sustainable environment for current and future generations.

RAMSAR Convention 1971

The area of land leased by the development to the west of Martello Tower is located with the area designated as a Wetland of International Importance under the IUCN Ramsar convention. The Ramsar site was designated in 2005. In addition, the same area falls inside the Codrington Lagoon National Park boundary, established in 2004.

The Cartagena Convention 1983

This is a legal agreement that aims to protect and develop the marine environment in the Wider Caribbean Region. It was adopted in 1983 and is the first and only regionally binding treaty of its kind.



SECTION 2.0 PROJECT DESCRIPTION

2.1 Project Details

Murbee Resorts Inc. proposes to develop a high-end luxury hotel and residences on 160.48 acres of land along the southwestern coastline of Barbuda. The site extends from the pink sands beach on Palmetto Peninsula to the boundary of the Barbuda port and ferry dock. Presently,144.78 acres (58.59 hectares) of the total 160.48 acres (64.94 hectares) of land planned for the Rosewood Barbuda Resort development is undeveloped. Parts of this land were previously cleared, apparently for potential agricultural use; however, there is no evidence of recent or ongoing agricultural activities. The remaining 15.7 acres (6.35 hectares) have been heavily developed for industrial and commercial use next to the port area, including areas for sand mining-related activity, cement batch plant operations, and small buildings for drink and food vendors. The beachfront close to the existing port is used for fishing boats and occasionally by swimmers.

The 160.48 acres (64.94 hectares) fall within five different zones as identified by the Sustainable Island Resource Management and Zoning Plan (SIRMZP) (adopted by Antigua and Barbuda in 2011) (Figure 2.5). These zones include industrial, tourism, transportation, settlement, and environmental protection. Approximately 55 acres (22.25 hectares) are in the environmental zone, including in the Ramsar and Codrington Lagoon National Park boundaries, and the remainder (105.48 acres/42.69 hectares) are in the first four zones.

The owners' representatives have indicated that they are committed to investing in implementing appropriate and recommended protocols and procedures to protect and enhance key features of the environment, with a view to also incorporating sustainable and nature-based designs and features into the development plans. The site has several mangrove wetlands, and these are being incorporated as a nature-based solution to manage water and provide wildlife habitat. The goal is to enhance the existing wetland habitats that occur naturally on-site. Recommended opportunities are discussed in subsequent sections. Similarly, the existing dunes that are being maintained and protected offer opportunities for planting with native vegetation that can also serve to encourage sea turtle nesting

2.1.1 The Hotel and Residences

The 160.48 acres (64.94 hectares) of land will be used to develop a high-end luxury hotel and residences. The hotel will be a Rosewood property and will comprise 50 keys/suites, guest pools, an organic farm, restaurants, a spa and fitness facility, a kids club, sports courts, employee housing, and a back-of-house area. Beachfront, dune, and lagoon residences are planned for the development.

Public access: The project includes a dedicated public access at the western end of the property. The current access at the port on the east side will not be impacted. At the time of writing there was no defined pathway identified in the master plan available to the ESIA team. The development management team (CM&D) confirmed the inclusion of an access pathway on the western side of the boundary.



Figure 2.1: (a) Master plan for the development, and (b) Phases of development of the master plan.

2.1.2 Implementation Schedule

The owners wish to commence construction in mid to late 2025, and the construction phase is anticipated to last approximately 3 years. The completion date of Phase I will be Q4 2027, and the subsequent phases will be developed according to sales and market absorption. The project will be developed in the following four (4) phases:

Phase 1 Beachfront Resident's Club
Hotel – 38 Keys + Amenities
3 Lagoon Flats – One Story
3 Lagoon Flats – Two Story
4 Beachfront Villas
5 Beachfront Estates

Phase 2	1 Lagoon Bungalow
	1 Lagoon Villa
	16 East Lagoon Flats – Two Story
	2 Beachfront Marina Estate
	2 Lagoon Flats – One Story
	2 Lagoon Flats – Two Story
	8 Dune Villas
	9 Beachfront Marina Cottages
Phase 3	1 Lagoon Bungalow
	1 Lagoon Villa
	16 East Lagoon Flats – One Story
	2 Beachfront Compounds
	2 Beachfront Estates
	3 Lagoon Flats – One Story
	3 Lagoon Flats – Two Story
	8 Dune Villas
Phase 4	10 East Lagoon Cottages

Costs of the project: The total cost is predicted to be US $360,125,195, of which $120,086,215 is allocated to Phase 1, $56,753,138 is allocated to Phase II, $56,273,738 is allocated to Phase III, and $127,012,104 is allocated to Phase VI.

Type of Project: The project is a new project

2.1.3 Current Land Use and Main Features

Details of the geology and historical use are provided in the landscape description. The project development site (160.48 acres) is largely undeveloped, with the exception of an industrial batch plant. However, especially on the eastern side of the property, there is notable industry, including a commercial ferry dock, sand-mining-related infrastructure, heavy machinery, and several paved and dirt/sand roads. There is also extensive grazing activity across the site. The main road along the southern end of the island and connecting the eastern side of Coco Point to Codrington Village currently runs through the property. A relocation of this road is planned, and the new road is to be situated outside the Rosewood Barbuda property. The owners have met with the Barbuda Council and others to discuss the road relocation.

A historic Martello tower is currently nested in the overall development site. However, it is not included in the lease nor part of the development. The Murbee Resorts Inc. owners have indicated their wish to support the restoration of the Martello tower for the Barbuda Council and community as a historic and tourist site. The Strombus line runs across part of the property (Section 5.6.2), and preservation plans are included for this feature.

The batch plant (included in the third lease of approximately 13.3 acres) is currently used by another entity and is to be relocated. The authors are informed that the third party is aware of the relocation and that there will be an agreement in place regarding relocation and timing. At the time of writing, no additional information is available. Demolition, dismantling, and site

clean-up will be required. This will need assessment and approval from DCA and DoE. As the agreement between the parties and the relocation effort is pending, and any action is in the future, no further assessment of the batch plant relocation can be included in this document.

For project implementation, a mass grading plan will be required, and fill material will be necessary to raise parts of the development, especially to account for coastal resilience and climate change. As the master plan is still being finalized, we provide the following considerations. Based on the existing master plan for the development and to ensure coastal resilience, additional fill will be needed. To achieve the necessary amount, the development will also likely use mangrove lagoon creation on the eastern side of the property as a source of fill while also establishing a new wetland habitat. During the initial master planning, setbacks were discussed with the DoE so that the project could take a risk management approach to the setbacks. Based on previous hydrodynamic studies, input from the then master planners, and discussions with DoE, the following setbacks were initially confirmed for planning purposes: On the western portion of the site within the dune-scape, the development has implemented a 197 ft (60 m) setback from the line of permanent vegetation, preserving the dune systems and habitats that provide shoreline protection. On the eastern portion of the property, where the landscape transitions from dune to protected nearshore areas with native coastal vegetation, the setbacks for the development are 131 ft (40 m). The ecological/coastal resilience team recommended a more current and comprehensive hydrodynamic assessment, which the developers agreed was necessary and important to maintain coastal integrity and resilience for the project and the Island community. The hydrodynamic assessment completed (Moffett & Nicol) will allow for a more precise assessment of coastal vulnerability and risks, including for FFE and setbacks. The report was just completed and is included in the appendix. But due to the short time-frame it has not yet been fully discussed and incorporated into final plans. It will form a basis for the final FFE, and resilience planning.

2.1.4 Nature Based Solutions

Nature-based solutions (NbS) are practices that use natural processes and features to address environmental, climate change, and social risks. They leverage the services provided by nature, such as flood control, storm surge protection, water filtration, carbon sequestration etc. to enhance project resilience and provide multiple benefits. The ecological/biological members of the ESIA team at Deborah Brosnan & Associates have pioneered nature-based solutions for the past 20 years and are recognized as a leading entity in this field, combining science-based and practical solutions. The team identified the mangrove wetlands – which contain protected species and the coastal dunes as the two most prominent ecosystems for nature-based solutions. Mangroves are legally protected, and the wetlands offer habitat to many species and provide flood control, water filtration, and carbon sequestration.

The development will make nature-based solutions a prominent feature of the design. The development is designed around existing and constructed wetlands. The design of these wetlands requires an understanding of hydrology and identification of the types of species to plant and in which locations. The design must also be integrated into the development plan, including e.g. fill and grading requirements. The final design will be informed by the hydrology, drainage and ecological studies in order to create resilient and sustainable systems with minimal risks of flooding and drying out and will be integrated with the final masterplan and landscaping plan. These details are currently in the planning phase and several initial discussions among the teams have taken plance.

2.1.5 Infrastructure

There is little infrastructure at the location and the development will need to build and install its own, including water, waste-water treatment, and energy. Earthworks, filling, and mass grading of the project area will be required to prepare the land.

2.1.5.1 Energy Demand and Supply: Electrical and telecommunications systems

Ingenuity Engineers Inc. provided the electrical and telecommunications systems assessment. Their study identified the energy requirements, estimated energy consumption and the overall electrical engineering plan for providing power production and distribution to the Rosewood Barbuda project. The engineers also provided expected methods for delivering telecommunications systems and connections for the project.

The project will require electrical power with an average expected usage of 3.5 to 5 Megawatts when fully operational. Power will be produced on-site via an internal micro-grid power plant complete with prime-rated generators fuelled with LNG and diesel-type fuels. A solar Photovoltaic (PV) system and battery storage system will integrate into the production of power to maximize the use of renewable energy on site. The power generation equipment can be produced at 13.2Kv or 480v with step-up type transformers. All these systems will be operated in harmony with each other and will be automatically controlled via an integrated grid controller system.

Back of House

The Back of House (BOH) area will be constructed to include many of the infrastructure processes and facilities as described below.

- Potable water treatment plant,
- Storage,
- Well pumping stations,
- Operations building,
- Fire Pump
- High Service Pumps
- Wastewater treatment plant,
- Reuse storage facilities and a reuse pumping station,
- Refuse storage and transportation area,
- Transportation staging area,
- Materials storage area,
- Electrical generation infrastructure.
- Fuel Energy Storage and transfer facility
- Employee housing and toilet facilities
- Employee cafeteria facilities
- Security facilities
- IT Telecommunications Bunker
- Medical facilities
- Contractor offices and laydown areas.
- Major Sewage lift stations
- Minor Sewage lift stations
- Irrigation Pumping Station
- Other owner described programming elements.

Energy utilities for residential, commercial hotel, and amenity support

The energy plan for the Rosewood Barbuda project will be required to provide power to support the following Commercial and Residential facilities.

- Hotel and Amenity areas
- Single Family Residences
- Restaurant
- Spa
- Sports courts
- Other owner described programming elements.

Electrical Demand Loads

Based on the existing master plan, the electrical design demands loads (Appendix B) are projected for each of the various project uses. These estimated average electrical demands are intended to be a comprehensive peak demand load similar to loads that the utility would utilize for the design of the system infrastructure and for the Micro-grid power plant design basis. The project demand loading is inclusive of all Back of House (BOH), Residential, Commercial, Hotel, and Amenity Support electrical consumption.

Electrical Systems Basis of Design

Electrical Generation

The Project site will require a significant amount of prime rated self-generating micro-grid electrical power. The average expected electrical usage is estimated at a total of +/- 2.8 Megawatts to +/- 3.5 Megawatts at project completion.

The current power utility on Barbuda is Antiqua Power Utility Authority (APUA), and the required amount of power production is not available by APUA to serve the Rosewood Barbuda project. This facilitates the need for a self-generating prime rated, micro-grid power production plant. Other similar and large projects in Barbuda have also elected to produce their own on-site power via micro-grid power plant installations.

The electrical power for the Rosewood Barbuda project will be produced via an on-site internal micro-grid power plant complete with prime rated generators fuelled with LNG and diesel type fuels. This will be scaled as the project progresses. There will also be an integration of approx. 1.20 Megawatts of Photovoltaic (PV) solar production system. The PV system will be coupled with battery storage that will directly integrate into the power production plant in order to provide an environmentally conscientious, reliable, and smooth power production solution.

The power plant control and integration of LNG and Diesel generators, PV, and battery systems will be controlled via an internal master grid controller. This grid controller will automatically add, subtract, combine, and turn off /on the power plant generation equipment for a seamless, cost-effective, and efficient use of all power generation assets.

The infrastructure plan includes locating all LNG and diesel generation assets within a hurricane-rated building/structure in order to protect the power generation equipment and control the switchgear from the harsh environment and storm potential. This is an important feature, as the loss of power-generating infrastructure during storms and hurricanes can severely impact the resilience and ongoing operations of resorts and hotels in the Caribbean.

Electrical Switchgear

The power production equipment will connect directly to an internally and centrally located distribution switchgear assembly. The cables will connect from the production equipment to the switchgear via UG duct banks. This switchgear will provide the required overcurrent and ground fault protective circuit breaker devices as required for each power production input and distribution output source. The switchboard circuit breakers will also include the required grid controller system, protective relays, and all communications and reporting controls.

The power generation equipment will produce a voltage of 13.2Kv 3 phase; therefore, the switchgear will be provided at a medium voltage as required up to a level of 15Kv.

Electrical Distribution System

The micro-grid electrical distribution switchgear system will provide an output medium voltage of 13.2Kv 3 phase. This medium voltage will be distributed from the switchgear and segregated into properly sized “reliability loops” as required to serve power to the specific areas around the site by the use of UG medium voltage duct banks. There are (2) UG medium voltage loops planned for this project. There will be a system of directly buried manholes and handholes located at critical junctures within the UG duct bank system and located at distances as dictated by local regulations and required engineering practice. These manholes and handholes will provide access and maintenance to the UG medium voltage cable system in order to serve the remote electrical loads. There will be step down utility grade transformers connected to the 13.2Kv primary medium voltage loop. These utility grade transformers will be located at each group of buildings or residences in order to accommodate a usable and manageable secondary facility voltage and KVA of 120/208v 3 phase 4 wire. The largest consumers users of electrical power energy will be the BOH water and sewer equipment, the hotel restaurant and pool marina power systems.

Meeting energy requirements while this system is being built out will involve setting up an initial generator system. The generators will be modular and more will be added to the system as site demand increases.

Telecommunications

The project will require a significant number of telecommunications services. The current method of communications for the island is accomplished by the use of an antenna mounted microwave antenna, which communicates to an existing transceiver station located on Antiqua. This system provides an internet signal with allows for Voice over IP (VoIP). All services currently emanate from this signal. Starlink may be available within the area within the next 2 years. The project is evaluating the use of an UG fibreoptic network which would provide a local signal to each residence of the facility as required. However, this is not yet confirmed.

Table 2.1: Infrastructure Energy Requirements (Harris Civil Engineers). These calculations were made when the inland marina was included in the master plan. As a result, the total VAD will be lower because the marina elements identified here are no longer in the project.

Phase 0.1 Nursery

Description	Quantity	Square Footage	Electrical Demand Unit		Total VAD
Irrigation System	1	lot		50,000	50,000
Lighting and Misc	1	lot		10,000	10,000
Control Room	1	750	5	VA/Sq. ft	3,750
Small water plant	1	lot		75,000	75,000
			Total Connected Load (VAD)		**138,750**

Phase 0.2

Description	Quantity	Square Footage	Electrical Demand Unit		Total VAD
Hotel					
Hotel Five Bay Suite	1	4,050	3	VA/Sq. ft	12,150
Hotel Three Bay Suite	2	2,430	3	VA/Sq. ft	14,580
Hotel Two Bay Suite	9	1,620	2	VA/Sq. ft	29,160
Hotel One Bay Suite	11	1,215	2	VA/Sq. ft	26,730
Hotel Junior Suite Detached	27	810	2	VA/Sq. ft	43,740
Hotel Arrival	1	1,500	2	VA/Sq. ft	3,000
Spa	1	6,500	5	va	32,500
Fitness	1	4,500	5	va	22,500
Residents Club	1	3,000	4	va	12,000
Kids Club and Sports Courts	1	2,000	4	va	8,000
Destination Bar	1	1,500	7	va	10,500
Bistro	1	2,500	12	va	36,000
Pool Area	2	each	45	Kva	90,000
Beach Bar	1	1,500	7	va	10,500
Farm to Table Restaurant	1	5,000	12	va	60,000
Beachfront Residences					
Beachfront Villas	4	6,243	5	va	124,860
Lagoon Residences					
Lagoon Estates	1	8,611	6	va	51,666
Lagoon Villas	4	6,458	5	va	129,160
Lagoon Bungalows	3	5,382	5	va	80,730
Lagoon Flats One story	8	2,024	3	va	48,576
Lagoon Flats Two story	8	2,917	3	va	70,008
Marina					
5 @ 200a Boat slips	lot				60,000

Future Phase F

Description	Quantity	Square Footage	Electrical Demand Unit	Total VAD
Beachfront Compounds	2	10,818	8 va	173,088
Beachfront Estates	7	8,988	6 va	377,496
Dune Villas - Two Story	8	5,059	5 va	202,360
Dune Villas - Two Story	8	4,144	4 va	132,608
Lagoon Estates	2	8,611	6 va	103,332
Lagoon Villas	3	6,458	5 va	96,870
Lagoon Bungalows	3	5,382	5 va	80,730
Marina Flats - One Story	16	2,024	3 va	97,152
Marina Flats - Two Story	16	2,917	3 va	140,016
Marina Cottages	10	4,036	4 va	161,440

Total Connected Load (VAD) **1,565,092**

Phase 0.1 Nursery

Total VAD	**138,750**

Phase 0.2

Total VAD	**2,124,541**

Phase F

Total VAD	**1,565,092**

Overall Total Connected Demand Load (VAD) **3,828,383 (This represents peak load after full build out)**

2.1.5.2 Water

Potable water will be required for the development of the commercial and residential buildings, restaurants, pools, BOH areas, resort and spa, other amenities, and fire suppression systems.

Harris Civil Engineers (HCE) prepared the potable water use estimates and infrastructure design in the Basis of Design Narrative.

Introduction

Potable water systems typically contain, at a minimum, the following elements:

- Water Source and Production
- Water Storage
- Pumping Systems (High Service and Fire Flow)
- Water Distribution Systems

Demands

Based on the Master Plan provided to the team, the design demands were projected for each of the different Project uses. These estimated average demands represent a comprehensive flow for the entire Project and are inclusive of all projected potable water users, such as:

- Commercial and Residential Buildings

- Restaurants
- Pool Water Make-up
- BOH Areas
- Resort and Spa
- Other Amenities

The potable water system will be designed to provide appropriate pressure and storage volume for fire water. The fire water system will consist of fire hydrants around the site and sprinkler systems internal to the buildings. Each building will connect to the proposed potable water system through a separate line.

The anticipated average design daily demand for potable water for the project is approximately 260,000 lpd.

Water and production

An existing water source is not available to meet the demands of the development. Therefore, a reverse osmosis water treatment plant (RO) will be installed in the BOH to service the project. At the time of writing, an RO plant that will draw water from deep wells and discharge bring into deep wells is the most likely option. As adjacent developments are using this technology and have conducted necessary geological and engineering studies to determine the suitability of the landscape for this technology, it is likely that this will be the water source/discharge method. The typical depth of a residential well ranges from 100 feet to 800 feet deep. The deeper a well is, generally, the better the water quality. The casing of the pipes ensures that the aquifer water is not affected. As this is part of the construction phase, the design will require appropriate studies to select the option most suitable locations and to reduce negative impacts on the function and health of the ecosystem.

The following key criteria will be necessary to incorporate in the design of the raw water (i.e. the saltwater sourced for creating freshwater) intake and disposal systems to be conducted by the developer:

Considerations And Assessment for Deep Water Wells

If (as anticipated) raw water will be supplied by a series of deep wells, a study of the hydrogeology characteristics of the proposed location of the raw water wells and discharge sites should be undertaken to determine their viability. The engineering design parameters for wells should include the following standard considerations:

For source:

- There should be a minimum of two (2) wells, each capable of supplying a raw water feed greater than the projected maximum daily demands for redundancy.
- The well and its vertical piping should be able to produce enough water such that the product water is equal to or greater than 40% of the raw water (i.e. the raw water flow rate should be greater than 2.5 times (1/0.4) the needed product water volume). An efficiency of 40% is quite common and conservative for saltwater RO systems.
- The piping material for the raw water supply should be AWWA C-900 PVC or pressure rated HDPE. Metallic piping is not appropriate for this application.

For discharge:

- There should be two (2) wells minimum, each capable of injecting the required amount of brine (for redundancy).
- The well and its vertical piping should be able to transmit and inject enough brine so that the product water is equal to or greater than 60% of the produced product water (i.e., the brine water flow rate should be greater than 1.5 times the needed product water volume).
- The piping for the raw water supply should be AWWA C-900 PVC or pressure rated HDPE. Metallic piping is not appropriate for this application.

The distance between the intake and discharge wells is essential to ensure no cross-contamination (e.g. to ensure that the intake well does not draw from the brine discharge site). The distance is typically several hundred feet, but the exact distance is determined by the local geology and, in some places, by regulation. In the (currently unlikely) event that a seawater source and discharge must be considered, several critical studies will be required, such as benthic analysis of the marine life and ecosystems, sea floor, wave patterns, currents, water quality, and topography, vessel traffic, and potential brine contamination.

Reverse Osmosis Water Treatment Plant

Reverse osmosis (RO) plants are used widely in Antigua and Barbuda and throughout the Caribbean, where salt water is in plentiful supply. A typical RO water treatment plant includes pre-treatment facilities, the RO train(s) itself, and post-treatment facilities to ensure water quality standards and avoid adverse impacts. RO regulations and considerations in Antigua and Barbuda have typically focused on proper location to avoid groundwater contamination, ensuring water quality standards, and managing wastewater discharge from the plants, particularly near coastal areas. The development team has been in discussion with an Antigua-based entity that has installed RO plants previously in Barbuda and Antigua to identify the range of plant options and associated infrastructure installation.

The RO plant will be one of the first infrastructure activities (with a generator set) that will occur on site. It will be a small system to start with, with provision to run the nursery and the on-site needs of a construction crew. The RO plant will also be modular and augmented as the project grows.

Water storage

The project will require sufficient potable water storage to support the project's maximum daily demands, plus additional day(s) storage. The Harris engineering team have noted that storage can include above-ground glass fused to steel tanks, which are typically less expensive than concrete tanks but do not have the same life spans; specifically in salty environments, steel tanks are more prone to damage during a storm event. In general, the potable water storage tank(s) should be sized for at least three full days' worth of maximum daily demand. The fire water tank(s) must contain water dedicated to fire demands of two (2) hours at 7,580 lpm. Multiple tanks designed to work together could be used. At the time of writing, water storage options have not yet been determined.

High service and fire flow pumping station

The project will have a high service pumping station and a fire flow pumping station. The high service pumping station should include two (one for redundancy) pumps, each capable of providing the peak flow rate to the buildings at an appropriate pressure. The fire flow pumping station should also include redundant pumps for the delivery of fire demands to the furthest building at a pressure as determined by the project Fire Protection Engineer.

Water distribution systems

The potable water and fire water distribution systems will consist of piping and valving that are responsible for getting water from the storage tank(s) and/or pumps to the end usages. The following are the design criteria that should be considered for this system:

- The piping should be either American Water Works Association (AWWA) C-900 polyvinyl chloride (PVC) pipe or pressure rated high-density polyethylene (HDPE) pipe.
- Piping should have a minimum pressure rating of 10 bar.
- Valves should be located at all piping intersections and at 300-meter intervals on continuous runs.
- At each location where there is a tee, three valves should be installed, one on each pipe.
- Piping under waterways should be placed in sleeves so that the piping can be removed in case of failure.
- Civil points of connection to the buildings should be designed to be 1.5 meters outside of the building where the plumbing contractors will pick it up.
- Backflow preventers and meters should be required at strategic locations as required by the design.
- Fire hydrants should be provided at every 150 meters as a truck drives.
- The mains should be sized based on the larger of high service and fire pump design flow rates.
- Where possible, looping should be utilized in design to minimize stagnation concerns.
- The mains should have a cover depth of 1 meter minimum.

2.1.5.3 Wastewater

The development will build a wastewater treatment plant to manage sewage and grey water and will use membrane bioreactor (MBR) technology.

Membrane Bioreactor (MBR) Overview

A membrane bioreactor (MBR) plant is a wastewater treatment system that combines biological treatment with membrane filtration to remove suspended solids. They use microorganisms to degrade organic pollutants and advanced membranes to reject suspended solids. MBR plants are used in many sectors, including municipal wastewater treatment plants, industrial facilities, and decentralized treatment systems. They are a popular choice because they offer several advantages over traditional wastewater treatment systems, including efficiency, often exceeding environmental regulations, compact design, scalability to adapt to varying capacity needs, and ease of installation. MBR can accomplish secondary to tertiary water treatment and, when used with domestic wastewater, can produce effluent of high enough quality for discharge into oceans, deep injection wells, brackish water bodies, or irrigation waterways.

To maximize water reuse and recycling, the project will use the Wastewater Treatment Plant (WWTP) effluent for irrigation on site. Potable water will be added to supplement the volume when and where necessary. Additionally, rainwater captured in cisterns can be used to supplement irrigation needs as well.

The sewage estimates and infrastructure design have been prepared by Harris Civil Engineers (HCE), and their main findings are reported here.

The sanitary sewer collection systems for the project will include a combination of gravity and pumped systems which include laterals, manholes, main piping, lift stations, and force mains. In addition to a wastewater treatment plant (WWTP) it will include a reuse tank for effluent storage.

Flow: The anticipated sanitary sewer flow for the Project is approximately 215,000 lpd.

Site collection systems

Gravity System and Manholes

To the greatest extent possible, wastewater sources will be collected and routed via a gravity collection system. “Minor” lift stations will be located around the Project in areas that cannot otherwise be serviced by gravity piping (i.e., basements, elevator pits, areas isolated by water bodies, and areas that are remote). These package units can also be installed at each individual residence where manifold force main from multiple users can combine and be routed to a major lift station. The major Lift Stations will be located at the downstream end of the gravity sewer systems. These “major” lift stations are also good locations to collect flows from the smaller package lift stations. The “major” lift station will pump through force mains that discharge into the proposed WWTP. The sanitary gravity system, lift station, and force mains will not be sized for full pool filter backwash cycles. A buffer tank at all filter locations will be needed to prevent overwhelming the sanitary system. The proposed sanitary grease waste collection systems should be required at all restaurant facilities. The sanitary laterals for grease should be heat traced for the length of the pipe run. The plumbing engineer is to provide the grease trap and piping design.

Operational management of the MBR

Design of an MBR system relates to three factors:

1. Configuration of the membrane – concerns the geometry of the membrane (hollow fibre, flat sheet or tubular) and the direction of water flow through it (in-to-out or out-to-in).
2. The membrane separation process – concerns membrane placement and whether it is inside or outside the tank.
3. The biotreatment process – this is commonly an aerobic suspended growth process, where the biotreatment leads to the production of CO_2 gas. The oxygen required for this process is introduced through a bubbler in the filtration tank.

Appropriate training for all operators is essential as MBR systems can be operationally complex. Challenges associated with an MBR system are generally associated with the filtration membrane, including fouling and clogging of the screens or aerators. Aerators must be easy to clean as their blockage can lead to rapid fouling.

Regularly scheduled maintenance is essential to maintain the efficacy of the MBR system. The membranes need to be chemically cleaned, which requires specific chemicals to be stored on site. Staff need to be trained in the appropriate and safe use of these chemicals.

The key contaminants that need to be removed from wastewater are suspended solids, organic matter, ammonia, nitrates, phosphate, pathogenic bacteria and micropollutants. Removal or inactivation of pathogenic bacteria is required for either discharge to the environment or reuse as irrigation. MBRs provide a high level of disinfection and also clarify the water so as to increase the effectiveness of a downstream UV irradiation disinfection

process. The quality of the clearwater produced should be periodically tested for all these factors to ensure pollution of the environment is not occurring.

2.1.5.4 Water reuse and irrigation

The reuse and irrigation water systems components will consist of an irrigation storage tank, pumping station, and a distribution system which will include internal Project piping, backflow prevention devices, meters, valves, air release valves, flush valves, and blowoff valves. This Project will utilize reused water as its primary source, with potable water as the secondary supply for irrigation demand.

The site flora is estimated to use up to 50 mm per week after accounting for losses due to evaporation. Once the plant palette and density are defined, the landscape architect and irrigation consultants will be able to provide estimated irrigation volume and quality requirements. The ecological team recommends using native plants adapted to salt and drought environments as much as possible, as they require less watering.

While it is not currently possible to estimate how much reuse will be required for alternative uses, the following general criteria can be used.

- Toilet flushing – 400 liters per toilet per day (4 liters per flush at 10 flushes per hour over 10 hours)
- Washdown – 6.5 mm/day over the hardscape area.

The source of water for the project's irrigation systems will be the effluent water from the WWTP with potable water added to supplement the volume when necessary. Cisterns below buildings can be used to store rainwater runoff from roofs.

The civil engineers indicate that 'lagoons' could potentially be used as a source of irrigation water. However, this can create additional environmental stress on the wetland ecosystem and is not favored by the ecological team without in-depth assessment and a viable water use plan. Additionally, the groundwater, and thus lagoon water, may be of salinity levels that are too high should non-native ornamental plants be used in the development. However, they are likely to be at salinity levels more suitable for native species, which is the preferred plant palette. Groundwater should be tested for salinity levels and cross-referenced against the proposed planting palettes tolerances.

Reuse of WWTP for Irrigation: Storage requirements

The WWTP effluent can be used for site irrigation, which requires the plant's product water to be treated to a tertiary level. The treated effluent can be stored in tanks to be used as irrigation water for the site. The amount of storage required cannot currently be estimated. It depends on multiple factors such as the amount of vegetated area that will be irrigated with reuse water, if the reuse will be used for alternative uses (such as toilet flushing), how many days of supply is desired. The pumping station should be capable of providing the peak flow rate to the site at an appropriate pressure and should follow engineering guidelines.

The reuse piping system will be designed to the same criterion as the potable water system as described above.

2.1.5.5 Solid waste disposal

Solid waste collection will occur at predefined locations throughout the site. From those locations, the solid waste will be collected along the perimeter services road, and it will be transported to a storage area, where it will be collected and disposed of by a third-party vendor. The options for solid waste management and disposal are discussed further in Section 6.1.3.

Recycling

We recommend that the project adopt a recycling program during the construction and operations phase. This will need to be coordinated on site and a recycling plan for the materials collected will need to be developed as there is currently no island-wide plan.

2.1.5.6 Roadways and parking

The project consists of several roadways, as shown on the master plan. Harris Civil Engineers have provided the project roadway plan. The proposed roadways will provide vehicular access to the Back of House, hotel, residences, employee housing, restaurant, spa, sports courts, and the parking lots. The posted speed limit for the roadways will be determined. The following criteria are recommended:

- A 6-meter right-of-way width (o be coordinated with client desires).
- Longitudinal slope with a 1.0% minimum and a 4.0% maximum (where achievable).
- Cross slope of 2.0%.

All pavement materials will conform to and be placed in accordance with any local regulatory guidelines. The final finish surfaces of all roadways will be coordinated with the architects and engineers. Roadway materials being considered include:

- Asphalt
- Concrete
- Marl (Compacted Crushed Lime Rock)

The under-road utilities of all roadways will have a minimum of 1m of cover from the base of the roadways. The design and spacing requirements of the under-road utilities shall be determined according to local regulations.

The environmental review team stresses the importance of considering water flow in the design and placement of roads, so as not to impede water flow from the highlands and north. Failure to consider these effects can impact flooding risks, create localized droughts, and impact access roads. Such impacts are evidenced by previous road construction in the area. Water flow patterns and volumes do not appear to have been adequately considered or drainage planning conducted and integrated into the landscape, and where flooding during heavy rainfall is common.

2.2 Essential Maps

The essential maps for the Rosewood Barbuda project displayed below include:

1. Map of major constructions, including buildings, roads, and other facilities (Figure 2.2).

2. Map of the site's context showing the aerial distance to the waste dump in Barbuda, Cooks municipal waste disposal facility in Antigua, the nearest protected area. The Codrington Lagoon National Park encompasses approximately 58 acres of the development property (Figure 2.3).

3. Maps showing physical land features, specifically natural features and topography (Figure 2.4), resource management and zoning plan (Figure 2.5), land use and built forms (Figure 2.6), major tourism facilities (Figure 2.7), and drainage maps pre-development (Figure 2.8) and post-development (Figure 2.9).

Maps showing sea level rise and storm surge models have been generated as part of the hydrological and hydrodynamic study. This study was only received in mid-December 2024 and has not yet been incorporated into this assessment.



Figure 2.2: Master plan of the major constructions including buildings, roads, and other facilities overlaid on the aerial view of the site.

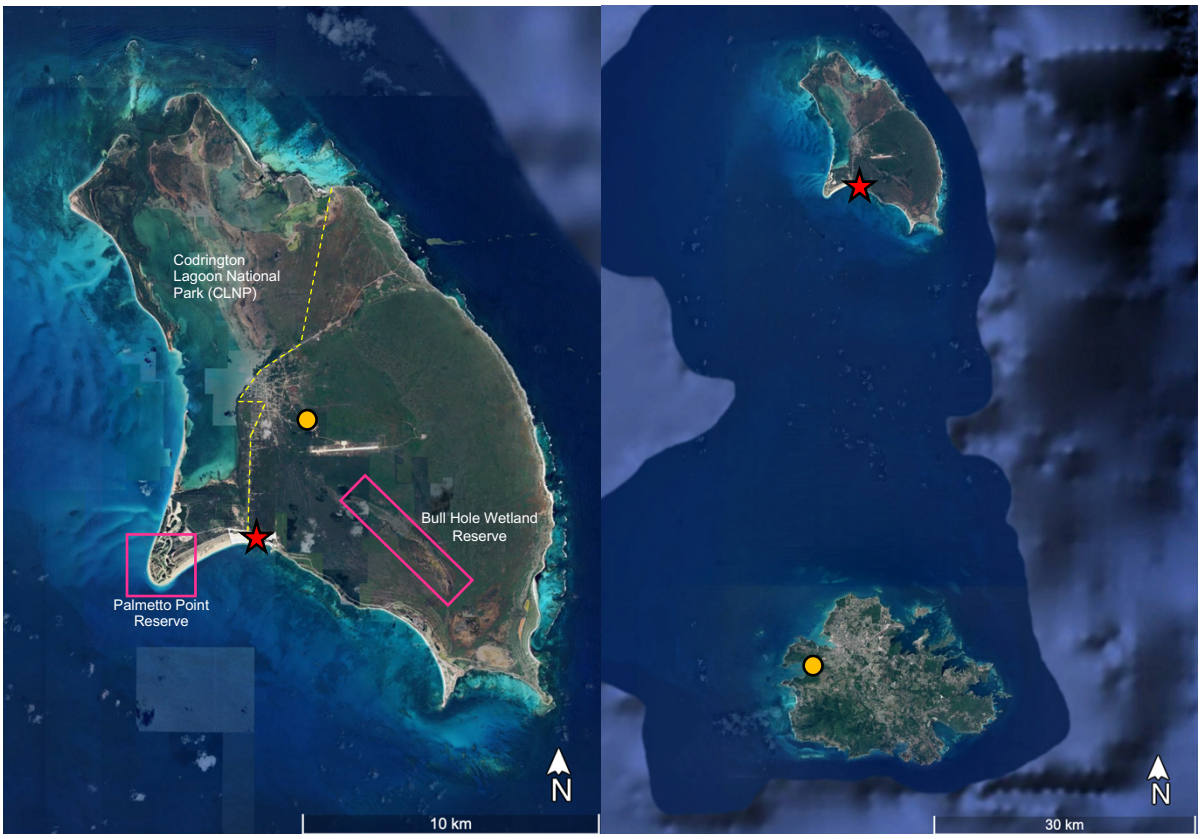


Figure 2.3: Maps of (a) Barbuda and (b) Antigua and Barbuda showing the location of the development (★), the waste dump in Barbuda and Cooks municipal waste facility in Antigua (●) and the nearest protected areas. The Codrington Lagoon National Park encompasses approximately 58 acres of the development property.

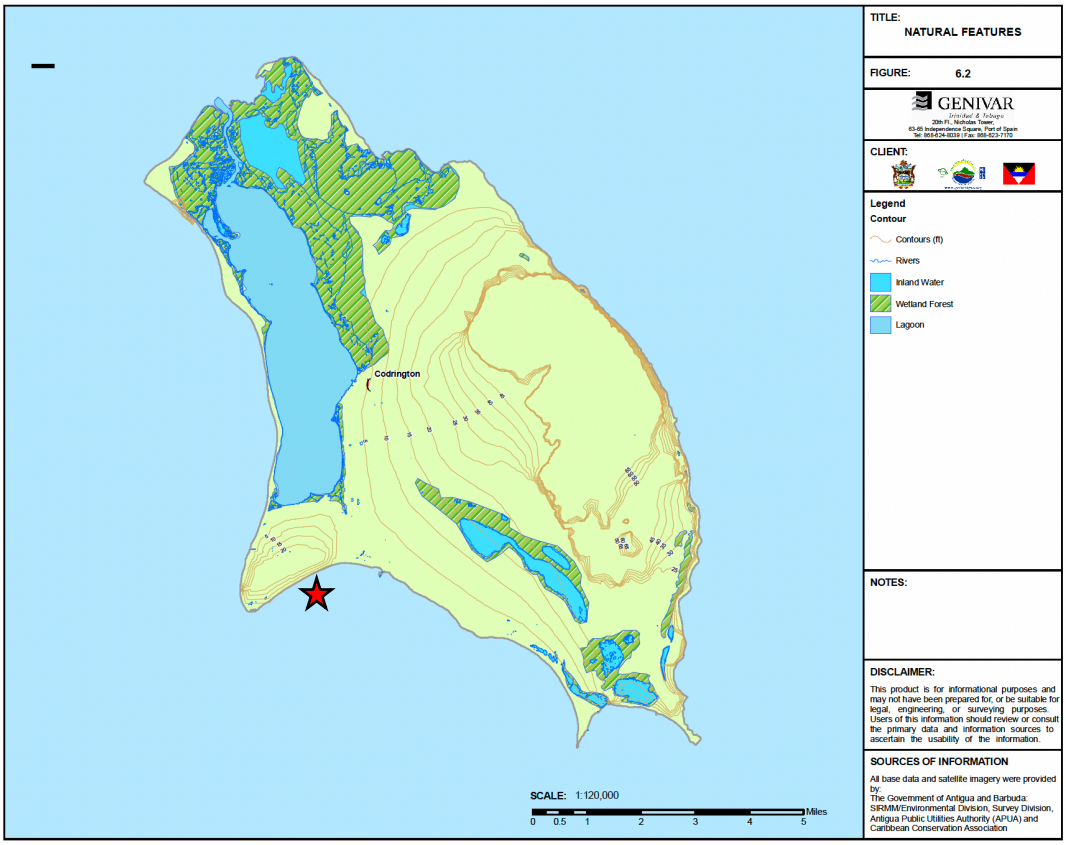


Figure 2.4: Natural features in Barbuda (SIRMZP, 2011) showing the location of the development (★)

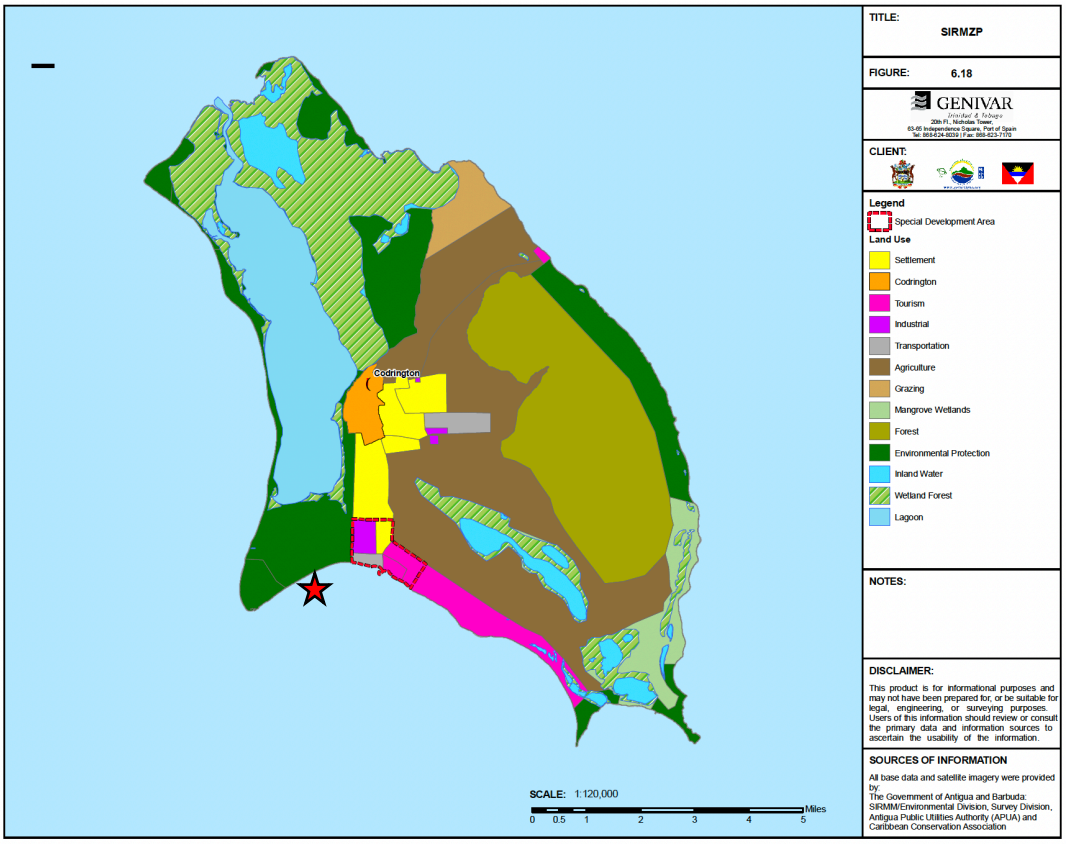


Figure 2.5: Sustainable Island resource management and zoning plan (SIRMZP, 2011) showing the location of the development (★)

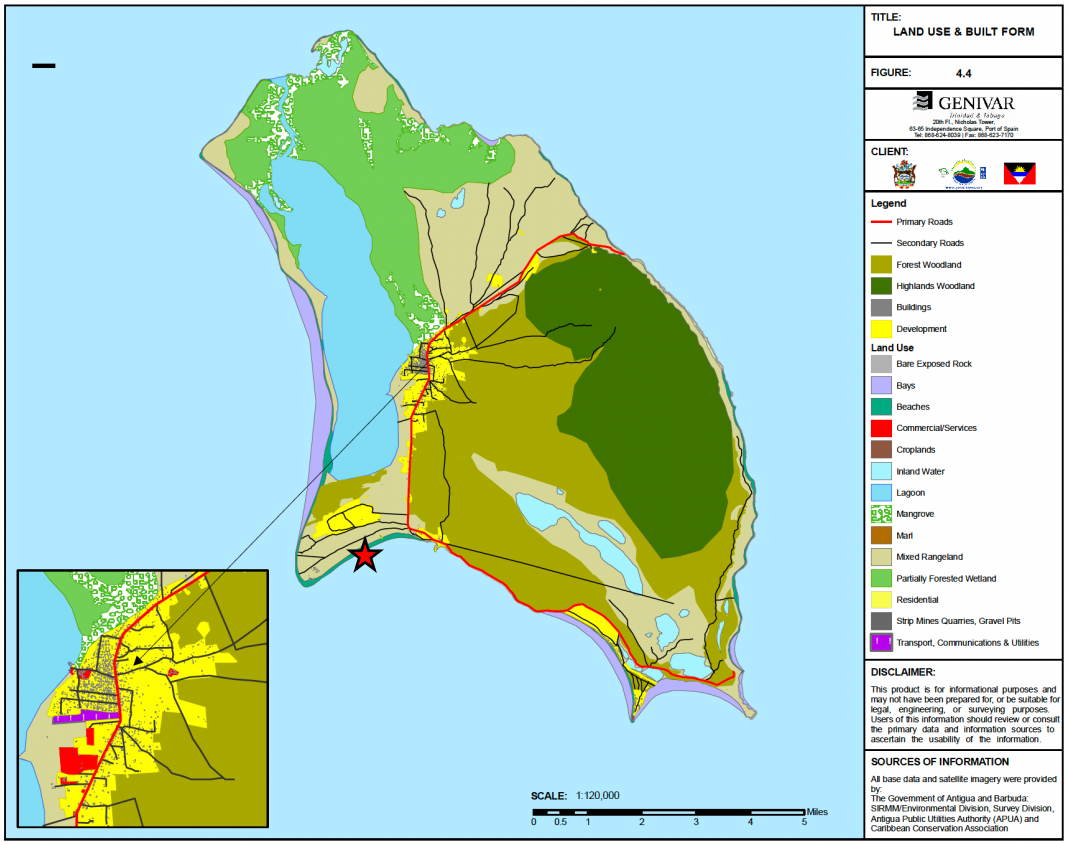


Figure 2.6: Land use and built forms in Barbuda (SIRMZP, 2011) showing the location of the development (★)

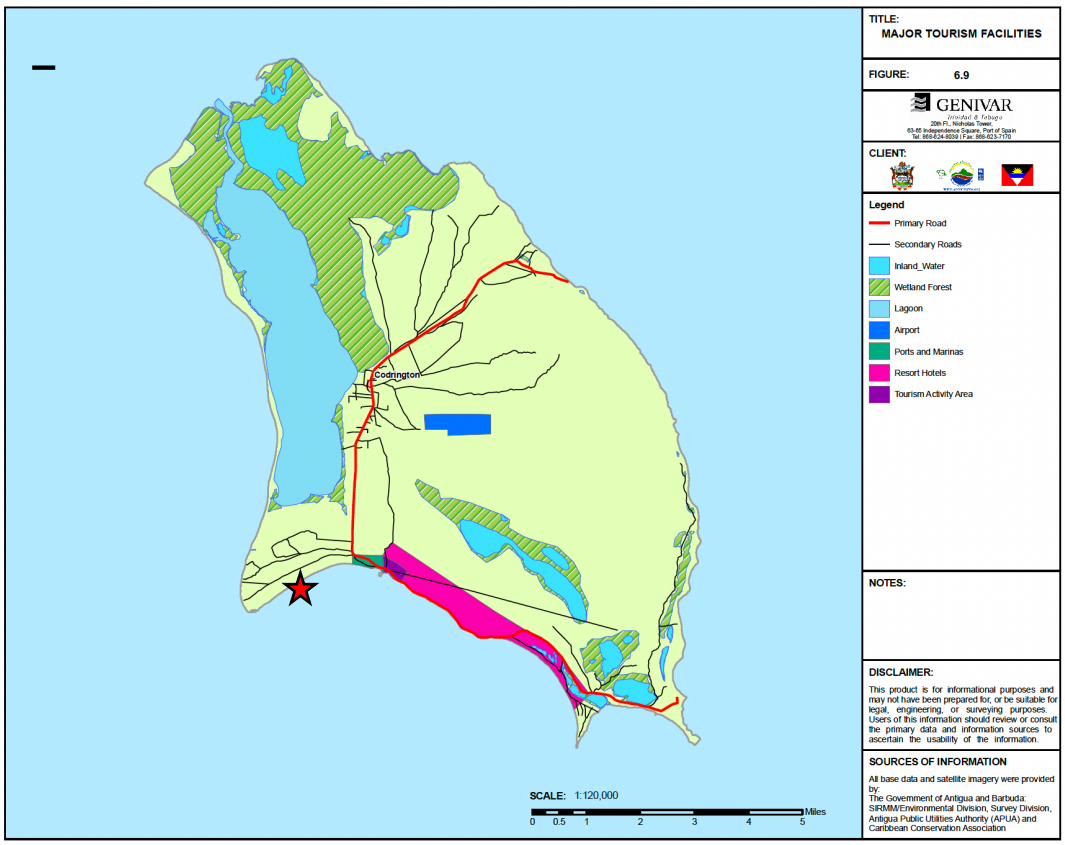


Figure 2.7: Major tourism facilities in Barbuda (SIRMZP, 2011) showing the location of the development (★)

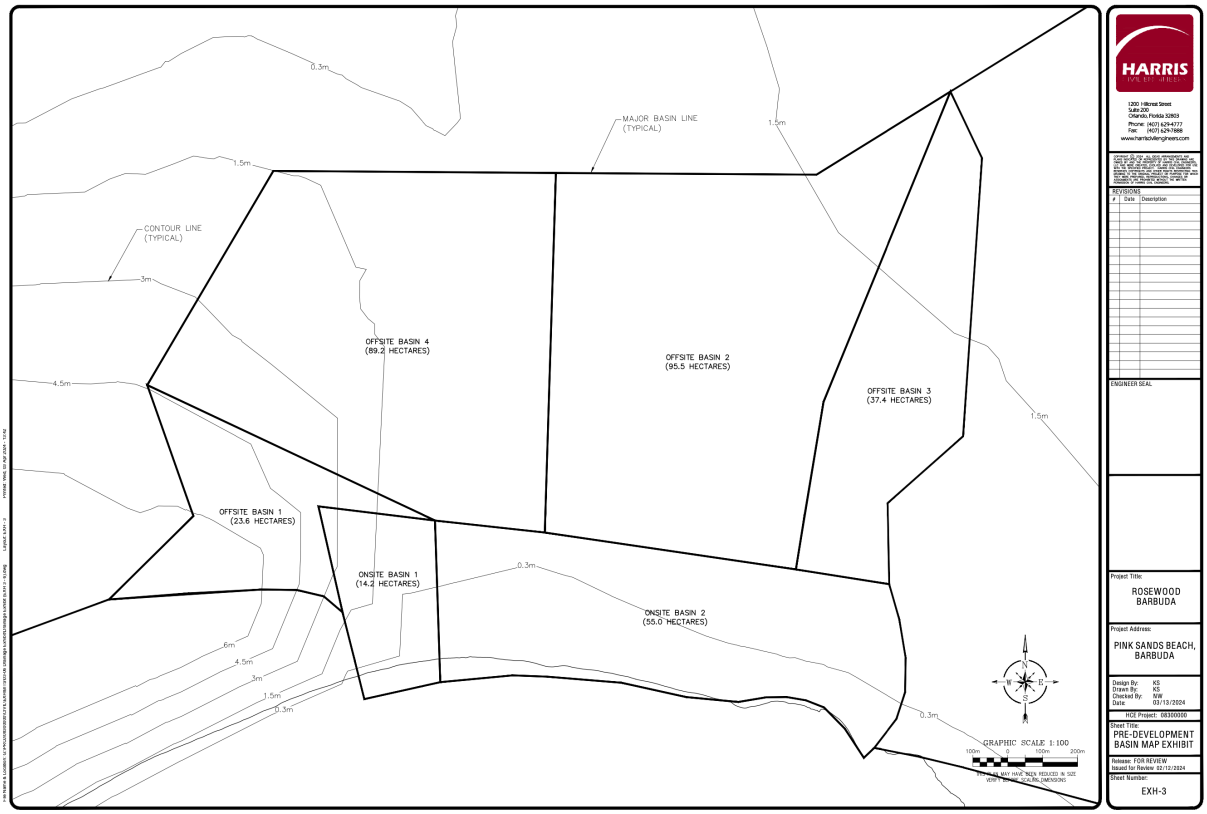


Figure 2.8: Pre-development drainage basin map (EXH-3 in Appendix 9)

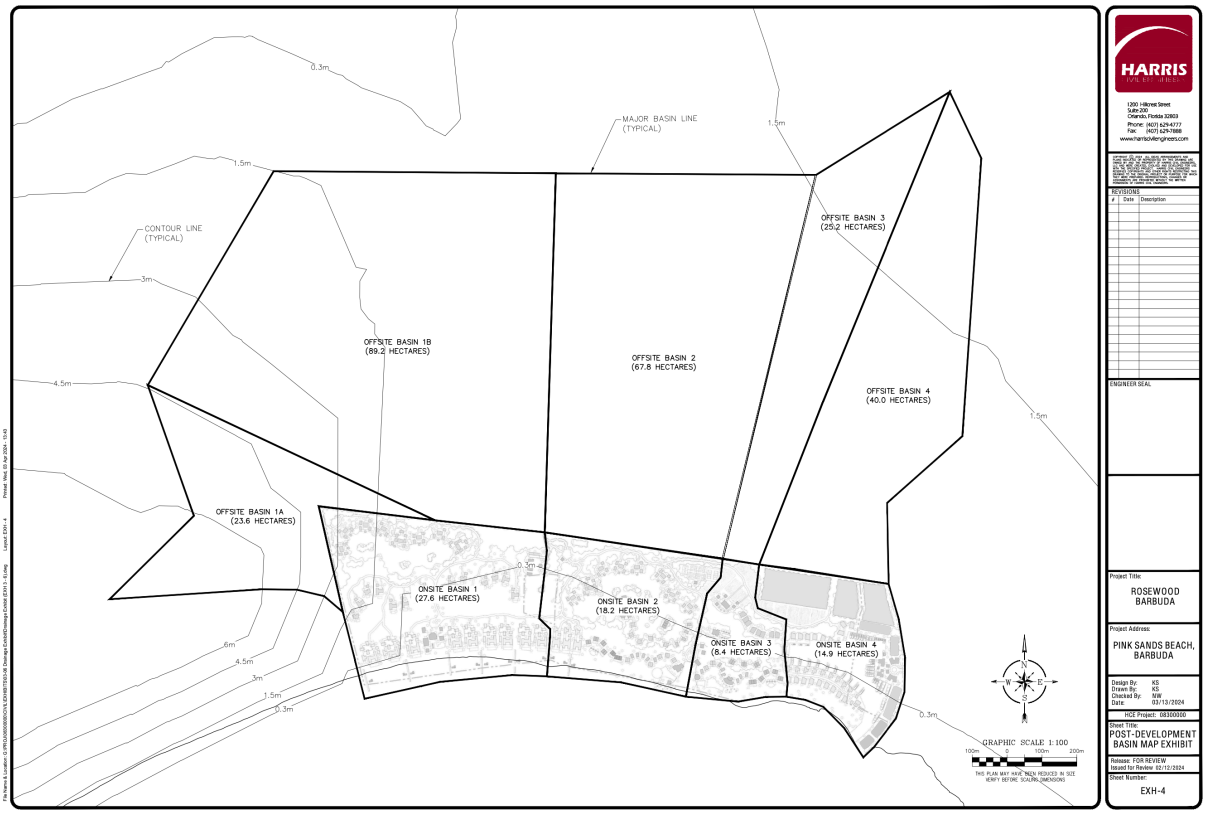


Figure 2.9: Post-development drainage basin map (EXH-4 in Appendix 9)

2.3 Project Benefits

The development aims to create a luxury development that showcases the use of nature-based solutions by protecting the established dune ecosystem, expanding mangrove lagoons, and integrating into the natural environment. The areas of the project currently used for industrial and heavy machinery will be remediated.

A portion of the property falls within the environmental zone. The owners are invested in implementing the appropriate and recommended protocols and procedures to protect and enhance key features of the environment. This includes incorporating sustainable and nature-based designs and features into the development plans. The proposed constructed wetlands that form the centerpiece of the development aim to enhance the naturally occurring wetlands on the site, providing a habitat for many local and migratory birds and animals. Setbacks to protect the dune habitats and associated vegetation that fall within the environmental zone have been used as design criteria in the master planning. No homes can be built outside the setbacks and no dunes can be cut down.

During the construction phases, the development plans to provide 200-250 jobs in Phase I and 50 jobs in each of the subsequent phases. Once all phases of the development are built, the resort aims to provide 1,752 direct jobs on site and more than 2,630 indirect jobs for local tour guides, food and beverage suppliers, transportation and logistics companies, laundry services, handicraft production, construction companies, and others. The project also plans to include several jobs in environmental stewardship, including monitoring and mitigation, native plant nursery, and managing the created ecosystems.

2.4 Analysis of Alternatives (Technology & Sites)

An alternative master plan was originally proposed for the site, that included an inland marina. Ecological and related concerns were raised and the inland marina was eliminated. Created wetlands have been enhanced.



SECTION 3.0 METHODOLOGY

Several assessments were used in the studies and preparation of the ESIA. These included desktop research and analysis of existing published and historical information that provided greater context for the project and data for specific analyses. Field assessments and mathematical modelling were also integral parts of the methodology used.

Ecological field studies were conducted on-site to identify and map marine and terrestrial habitats and assess vegetation, marine benthic composition, and fish species richness. Vegetation assemblages and plant diversity, including the identification of protected or sensitive plants, were recorded during *in situ* surveys. Native birds or wildlife present were also recorded at this time. Underwater transects were performed in the nearshore zone to determine the cover and species richness of benthic organisms, such as corals, seagrass, and fish species.

Baseline water quality was analyzed in May 2024. Water samples were collected from all wells and ponds on site, and from the marine environment to provide a baseline of existing water quality. Once collected, the samples were immediately transported to the Analytical Services Lab on Antigua for processing and analysis. The certified results from the lab and from the YSI probe are included in this report.

Baseline noise monitoring was completed between May 5-8, 2024, using standard noise monitoring methodologies based on established noise monitoring standards for development (The National Academy of Sciences, 1977) and recent noise monitoring studies (Golder Associates Ltd, 2018; Kerr et al., 2002; Ove Arup & Partners Hong Kong Ltd, 2001; Ramboll, 2018) as well as with direction and guidance from the DoE

The above desktop and field assessments were conducted by Dr. Holly Trew and Ms Alanna Waldman, M.S. of Deborah Brosnan & Associates.

Coastal vulnerability, climate change, and resilience including, nature-based solutions (NbS) were assessed by the team at Deborah Brosnan & Associates (DB&A) to establish the initial vulnerability and risk profile and opportunities for NbS. Their assessment included several on site studies and assessments from previously conducted erosion and coastal resilience analyses, including for dune height, setbacks, extreme events, and climate change impacts. This team recommended more in depth coastal and hydrodynamic assessments to inform the project and protect the Island and its coastal zone, and that were conducted- see below. This team also provided recommendations for incorporating mangrove wetlands to protect existing mangroves and to leverage NbS.

DB&A engaged Dr. Reginald Murphy, a globally renowned expert on Barbuda archaeology, to conduct the archaeological surveys The study was conducted in two phases. The first consisted of an onsite assessment to determine if any features of significant historical or archaeological importance were present. The second phase included the excavation of an area where 18th century ceramics and other artifacts were noted on the surface during phase 1, as well as a more in depth archival review of the history of the area, especially as it is associated with the Martello Tower or River Fort (the project has offered to assist in the restoration of the Martello Tower as an educational and tourism facility for the Barbuda Council and for the people of Barbuda).

Deborah Brosnan & Associates engaged Federico Scodelaro and Cristina Esteban to conduct socio-economic studies based on their extensive experience in such assessments and knowledge the application of relevant treaties (including Ecazu) and standards. The social impact assessment aligns with international regulatory frameworks, such as International Finance Corporation (IFC) Performance Standards. These standards are widely recognized as best practice guidelines for managing environmental and social risks in development projects.

The socio-economic analysis conducted for this ESIA was structured around primary fieldwork, involving two separate visits to Barbuda and interviews with government, organizations, and individuals, and secondary data collection. Secondary data were gathered from authoritative sources such as government statistics, reports from international organizations, including the World Bank and United Nations, and academic studies. This data provided a solid foundation for understanding key demographic trends, economic conditions, and social dynamics in Barbuda. It served as a backdrop to inform current localized insights gathered through fieldwork and interviews conducted on Barbuda.

Based on the assessments of project and island-risks, Deborah Brosnan & Associates recommended more in-depth sediment transport and hydrodynamic studies. The developers concurred with the need for these assessments. They were subsequently conducted by Moffatt & Nicol and their recent report is appended here.

Harris Civil Engineers provided an analysis of current drainage, infrastructure assessments, and recommendations through a narrative report. The preliminary results on drainage provided a report establishing on-site and off-site drainage basins and calculating the rainfall for these basins in a 2 year-24 hour rainfall event, and a 50 year-24 hour event (based on available data and models from Puerto Rico). Energy and water use needs, as well as road infrastructure, were assessed by Harris Civil Engineers. Their reports are discussed in the ESIA as well as appended to this document.

The geotechnical investigation of the site was performed by Civil Engineering & Associated Services Ltd (CEAS), Antigua. The assessment comprised two parts: physical Laboratory tests were carried out by a specialized Soils Mechanics Laboratory of the Government of Antigua & Barbuda in accordance with the testing schedule prepared by CEAS. Ltd. The geotechnical analyses and reporting were a collaborative effort of CEAS Ltd. and Geotech Associates Limited. The geotechnical work consisted of 20 boreholes spread over four main areas. For each drill hole, the following protocols were completed: Collection of soil samples; Standard Penetration Test (SPT) for N values; groundwater measurements, and rock cores. In the laboratory, tests were conducted for moisture contents on recovered soil samples, grain size analyses, unit weight on selected rock samples, and unconfined compressive strength and elastic modulus of rock.



SECTION 4.0 POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

This Environmental and Social Impact Assessment is required by the Physical Planning Act (PPA) (2003 rev. 2024).

The project is required to follow environmental regulations and guidelines, including those under the Environmental Management and Protection Act (EMPA) (2019) and the Sustainable Island Resources Zoning Management Plan (SIRZMP) (2011). These include specific regulations governing endangered species, protected wetlands and mangroves.

The applicable legal, regulatory and guidance instruments are listed below and outlined in more detail in Section 1.

Physical Planning Act (2003) Rev 2024
Sustainable Island Resource Management Zoning Plan (2011)
Environmental Protection and Management Act (2019)
Barbuda Local Government Act (1976)
Barbuda Fisheries Regulations (2014). Under the Barbuda Local Government Act
Beach Protection Act (1957) and Amendment (1993)
Beach Control Act (1959)
Disaster Management Act (2002)
Public Health Act, CAP 353 (1957)
Public Utilities Act (1973)
Pesticide Control Act (1973)
Fisheries Act, CAP 173 (1984)
Coastal Development Setback Guidelines in Antigua and Barbuda (1998)
Codrington Lagoon National Park, established in 2004

<u>International Conventions and Treaties</u>

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1975)
Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean (Escazú Agreement) (2018)
RAMSAR Convention 1971
The Cartagena Convention 1983



SECTION 5.0 ENVIRONMENTAL BASELINE

5.1 Land Environment

Barbuda lies approximately 40 km north-northwest of Antigua on the relatively shallow Barbuda Bank, which covers an area of about 1,390 sq. miles (3,600 km^2). Barbuda is 100 km east respectively of the centre of the volcanic activity associated with the Caribbean volcanic islands. The climate is tropical maritime, with a mean annual temperature of 26°C, ranging between 16.7 to 28.3°C (WorldBank, n.d.-b). Annual precipitation is 760-900 mm but is variable throughout the year. The main rainy season is between October and November annually. Ecologically, the island is predominantly covered by trees and shrubs on a rocky landscape with considerable mangrove wetlands. It is surrounded by scattered coral reef and seagrass ecosystems and a mostly sandy seabed.

5.1.1 Geomorphology

Barbuda first emerged between 15-20 million years ago. It is a flat limestone island located on the eastern side of the relatively shallow Barbuda Bank. The island is approximately 3600 km^2 (62 sq. miles) and is composed of a tilted success of Oligocene volcanic rocks capped by fossil-rich volcanic tuff and marine limestone.

The geology of the development area falls on the edge of the Codrington Limestone and Palmetto Point Formations (Brasier & Mather, 1975). The Codrington Formation is composed of limestones that abut the escarpment of the Highlands Limestone formation, topped by well-preserved fossiliferous sediments. The Palmetto Point formation overlays the Codrington formation. It is composed of cemented post-Pleistocene accumulations of sand and includes most of the extension of the beach ridge system of Palmetto Point. Martin-Kaye (1959) describes the Pleistocene Codrington Formation Limestones using four characteristics: (1) calcareous coral-shell sands of various ages, (2) soft rubbly shelly limestone, (3) moderately hard shelly limestone, massive, surface calcreted, and (4) jointed, semi-crystalline limestone.

5.1.1.1 Topography

Barbuda's topography is relatively uniform, where most of the island is low-lying. Areas on the west coast, especially the sand spit, are noted as being approximately 3 m (10 ft) above sea level. The Highlands, located centrally on the island and to the east, reach up to 38 m (124 ft) (Figure 5.2). There is an abrupt escarpment on the eastern side of the highlands, which border the east coast of the island. Moving westward from the highlands, the land gradually slopes downward towards the west and southwest portions of the island, where the development site is located. The development site itself is flat, with elevation ranges from 1.0 to 2.5 m throughout the site (Figure 5.1). The elevation of the sand dunes on the western side of the property was calculated as being approximately 3 m.

There are several areas on the development site where groundwater naturally rises to the surface (Figure 5.2 inset). These form natural wetlands and mangrove areas (2) and springs (2). The water quality of these naturally occurring springs was tested as part of the environmental baseline assessment of the site, and the results are presented in Section 5.2.3.

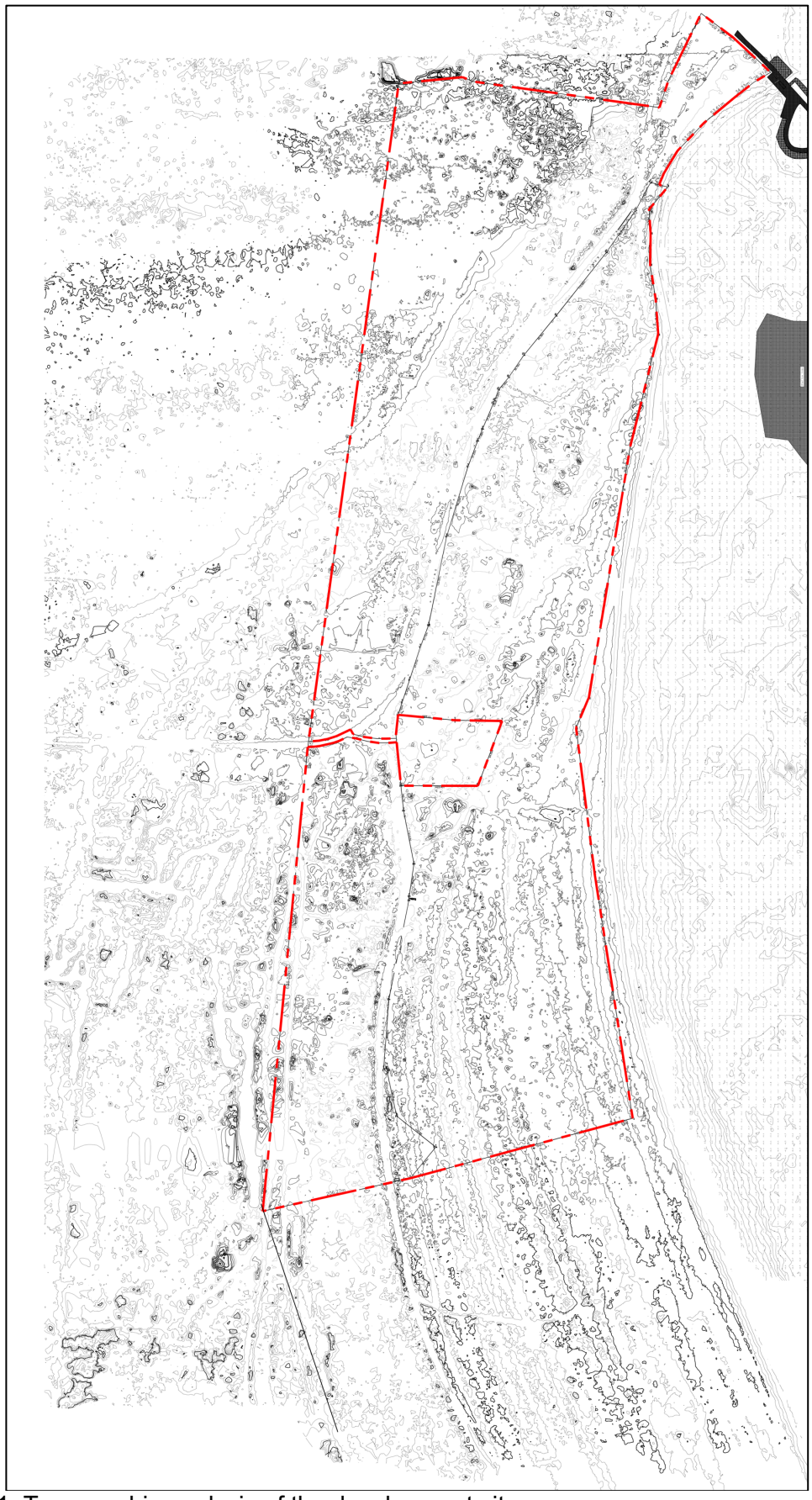


Figure 5.1: Topographic analysis of the development site

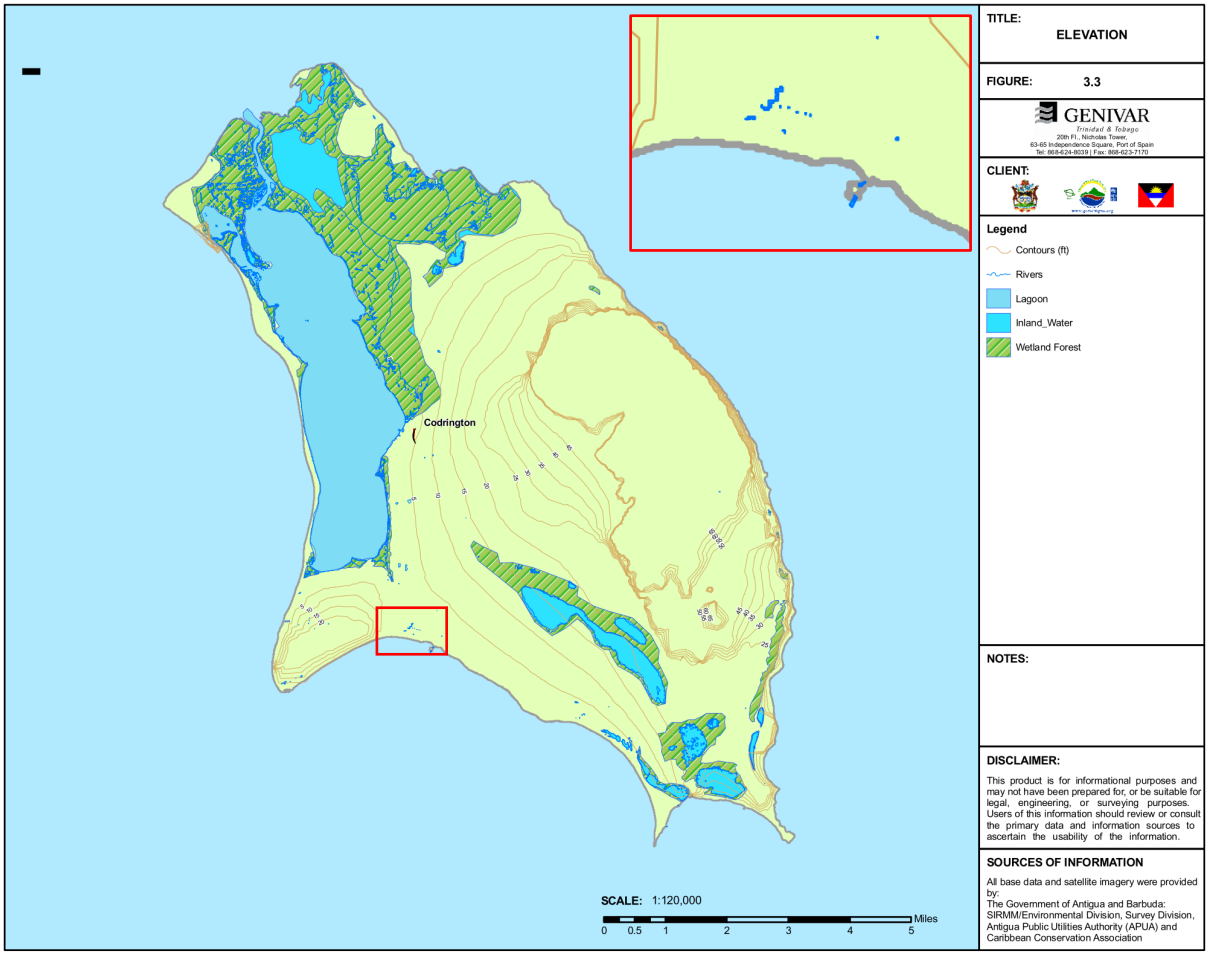


Figure 5.2: Topographic map of Barbuda showing inset of the development site (highlighted in red).

5.1.1.2 Soils

Comprehensive studies of soils in Barbuda were carried out by Martin-Kaye (1956), Hill (1966), and Ahmad (1984). These studies showed that Barbuda's soils are mostly homogenous, with soil derived from limestone covering approximately 78% of the island. The limestone-derived soil is predominantly comprised of small particles of bio-genic origin, such as from shells, corals, and coralline algae. Overall, the soils are porous and drain quickly.

According to an assessment of natural resources in Barbuda in 1992, soil quality was poor overall in Barbuda. Soils were classified from Class I as the most suitable for agriculture to Class VII as completely unsuitable for agriculture. 18% (6,640 acres (2,687 ha) are assessed as Class III, and 33% (12,048 acres (4,486 ha)) are assessed as Class IV. The remaining 49% of lands are in categories V or VI. The beach and sand dune areas are included in these higher classes unsuitable for agriculture.

Some areas within the northeastern corner of the site were reportedly farmed until recently, but presently, there is no evidence of land within the development site being used for cultivation. However, large areas have been used for grazing livestock.

The project will not establish any agricultural work in the beach and dune habitats although it does intend to build organic farms. The organic farms are planned for the northeastern corner of the site near the planned Back of House.

The predominant soil types associated with the site are:

- Beach sand,
- Loose and beach sands,
- Dense to very dense calcareous coral-shell sands (Codrington Formation),
- Soft rubbly shelly limestone (Codrington Formation),
- Moderately hard shelly limestone, massive, surface calcreted (Codrington Formation),
- Hard, jointed, semi-crystalline limestone (Codrington Formation),
- Mangrove swamp formations

Soil type and composition were further analyzed by taking soil samples and through geotechnical analysis of deeper soils using boreholes as part of the geotechnical analysis (see below)

Soil type and composition

The DoE requested that one set of soil quality samples be included in the ESIA to establish baseline site soil quality. Soil samples were collected on August 19, 2024, from nine sites (Figure 5.3). Analyses were conducted by the Analytical Services Laboratory (ASL) in Antigua and for the following components (per DoE request). Soil samples were tested for nitrate-nitrogen, phosphate, pH, and potassium to align with the capabilities of the laboratory and the parameters agreed upon with DoE. The DoE standards require that phosphate and nitrate results be reported in mg/mL, and since the ASL reports these metrics in ppm, the results were converted from ppm to mg/mL. The ASL-certified data are reported in Table 5.1 and Appendix 4.

Soil pH was found to range between 7.4 and 8.0, which is considered alkaline and characteristic of arid environments. Plants adapted to this habitat will thrive, but other plants that prefer more neutral or acidic soils may struggle to uptake iron. This has implications for the development's landscaping.

Potassium is a vital plant nutrient that helps with growth and reproduction. Insufficient potassium results in weak, slow-growing plants that are less resistant to disease. Conversely, excessive potassium (>160 ppm) in the soil inhibits the uptake of calcium and magnesium in the plants, as well as manganese, boron, and zinc. Additionally, it will cause clay particles to disperse and clog needed pore space, causing water to stand on top instead of infiltrating the soil as it would under normal circumstances. All samples here are considered to have excessive potassium, ranging between 240-780 ppm, so they should be consciously excluded from any fertilizers applied to the site.

Phosphorus is a vital macronutrient for plant growth and development and plays a key role in maintaining soil fertility and nutrient availability. Normal phosphate levels are between 10 and 20 ppm. Here, phosphate levels ranged between 8 and 29 ppm. Three sites had elevated phosphate levels: Wetland soil, Farmland soil, and Batch plant soil. Elevated levels can increase the risk of runoff, leading to eutrophication in coastal waters.

Finally, nitrate is a key macronutrient that plants require for growth and development. Normal nitrate levels range between 10-20 ppm. Elevated nitrate levels can lead to groundwater pollution due to leaching, especially if soils are sandy, as is the case here, and eutrophication in coastal waters. Here, extremely high nitrates were detected at all nine sites, ranging between 54 and 300 ppm. This indicates that nitrogen-rich fertilizers are to be avoided in landscaping. This nitrogen nitrate can be fixed in a form usable by plants by plants in the genus Fabaceae (or Leguminosae).

The high nutrient levels in the soil indicate a potential risk to the marine environment should the development fail to manage runoff adequately. The tropical marine waters are nutrient poor, and the survival and growth of corals require low nutrient levels.



Figure 5.3: Soil sampling sites were collected on August 19, 2024, from 9 locations.

Table 5.1: Soil sampling results

Description	pH	Potassium (ppm)	Nitrogen-Nitrate (ppm)	Phosphate (ppm)
Northwest Corner Soil	7.7	600	82	12
New Road Soil	7.4	780	117	15
Dune Soil	7.8	240	54	16
Ferry Dock Soil	7.6	260	70	15
Wetland Soil	8.0	660	210	29
Open canopy Soil	8.0	600	300	13
Farmland Soil	8.3	360	106	26
Batch plant Soil	7.5	380	67	26
North center Soil	7.8	560	56	8

5.1.1.3 Geotechnical report

The geotechnical analysis was conducted by Civil Engineering & Associated Services (CEAS) Antigua Ltd. to identify the soil conditions, groundwater, seismic risks, and other parameters at the site. This report provides important baseline environmental data, but much of the findings are subsequently applied to construction guidelines. The full report is provided in Appendix 4, including guidelines for construction, and a summary of the main environmental findings is included here

Twenty 20 boreholes were successfully drilled between July and October 2024 to investigate four (4) main areas of the proposed development (Figure 5.4).:

1. Area 1 – This area consisted of a total of seven (7) boreholes (B01 – B07)
2. Area 2 - This consisted of a total of eleven (11) boreholes (BH1 – BH11)
3. Area 3 – In this area, two (2) special grab samples were taken (BS01 & BS02) along the shoreline, and the boreholes were advanced until the rock was encountered.
4. Area 4 – This consisted of one (1) borehole (DS01) which was advanced in the sea along a proposed access channel, located near the existing passenger ferry dock.

For each drill hole, the following protocols were completed:

1. Sampling: Soil samples were taken at intervals of 0.75 m for the first 3.0 m.
2. Standard Penetration Test (SPT) to determine N value
3. Groundwater Measurement: was observed in the boreholes while sampling, before and after casing removal, and 24 hours after borehole completion.
4. Rock Cores: For the rock core runs, the rock quality designation (RQD) measurements were taken in accordance with ASTM D6032M-17.

The following additional tests were conducted in the laboratory:

1. Natural moisture contents on recovered soil samples (ASTM D2216-19),
2. Grain size analyses on selected disturbed soil samples (ASTM D422-63 (2007)),
3. Unit weight on selected rock samples (ASTM D 7012-04), and
4. Unconfined compressive strength and elastic modulus of rock (ASTM D7012-04).

Key Findings

Five distinct soil units were identified in the report

1. Loose sand
2. Dense to very dense calcareous coral-shell sands (Codrington Formation),
3. Soft rubbly shelly limestone (Codrington Formation),
4. Moderately hard shelly limestone, massive, surface calcreted (Codrington Formation), and
5. Hard, jointed, semi-crystalline limestone (Codrington Formation).

Soil strength and density was reported by N values. The N values express the strength of the ground. They are derived from the Standard Penetration Test (SPT) N-value", which represents the number of hammer blows required to drive a split-spoon sampler a specific distance (typically 6 inches) into the soil. A higher N value means that the ground is firmer and stronger. On the other hand, a low N value indicates weaker and softer soil. N values generally vary between 0 and 100.

N values are typically interpreted as follows
Low N value (0-4): Very loose soil
Medium N value (4-10): Loose to medium dense soil

High N value (10-30 and above): Dense to very dense soil

N values are essential to estimate soil bearing capacity, settlement potential, and other geotechnical properties when designing foundations.

The N values recorded were highly variable across the site and ranged between 5 to 100.

Rock Quality Designation (RDQ) was also recorded. This is a measure of the quality of a rock mass. It is typically based on the percentage of intact core pieces retrieved from a borehole that is longer than a specific length (usually 100 mm/4 inches). A higher RQD value (c 75% and above) signifies a more solid and less fractured rock mass, while a low value (C.50% and below) indicates a more fractured and weaker rock mass.

Table 5.2: Summary of classification of rock quality (after ASTM D6032M-17) (Table 5.1 in Appendix 5)

RQD (%)	Classification of rock quality
0-25	Very poor
25-50	Poor
50-75	Fair
70-90	Good
90-100	Excellent

Overall, rock structure was poor to very poor (<50% RQD), except in soil unit 5 (57-84% RQD).

Groundwater was recorded at 0.2 to 7.3 m below the surface.

Antigua and Barbuda lie in a seismically active zone. Based on the data collected, the geotechnical report indicated that the area is taken as a seismic Site Class D. Seismic Design Category D is a classification for buildings and structures that are expected to experience severe ground shaking but are not close to a major fault. Sites with poor soil are a common example of a location that would be assigned to Seismic Design Category D. However, the engineers recommended that the shear wave velocity profile be determined to confirm the seismic Site Class.

The above analyses were used to identify key construction needs, including determining the angle of internal shearing resistance, friction factors between concrete and sand, spectral acceleration, and coefficients for dynamic design. The engineers indicated that allowable bearing capacity may be taken as 250 kPa for an isolated pad footing, and recommended pile length 8 m based on fixity and worst-case soil conditions. However, a test pipe program should be implemented to verify the adequacy of this recommendation. The report also provides minimum pavement specifications for base course, sub-base course, and select fill material. These are provided in the full report in the Appendix.

During construction, measures need to be put in place for pumping water within excavation, including sumps and pumps, and/or trenches, to dewater the foundation bases. The subgrade must be cleared and grubbed to a maximum depth of about 0.15 m to remove any vegetation and other deleterious material. Any soft spots that are identified via “proof-rolling” must be removed and replaced with sub-base material.

A summary of the report is presented below, and the complete report and borehole data are presented in Appendix 5.

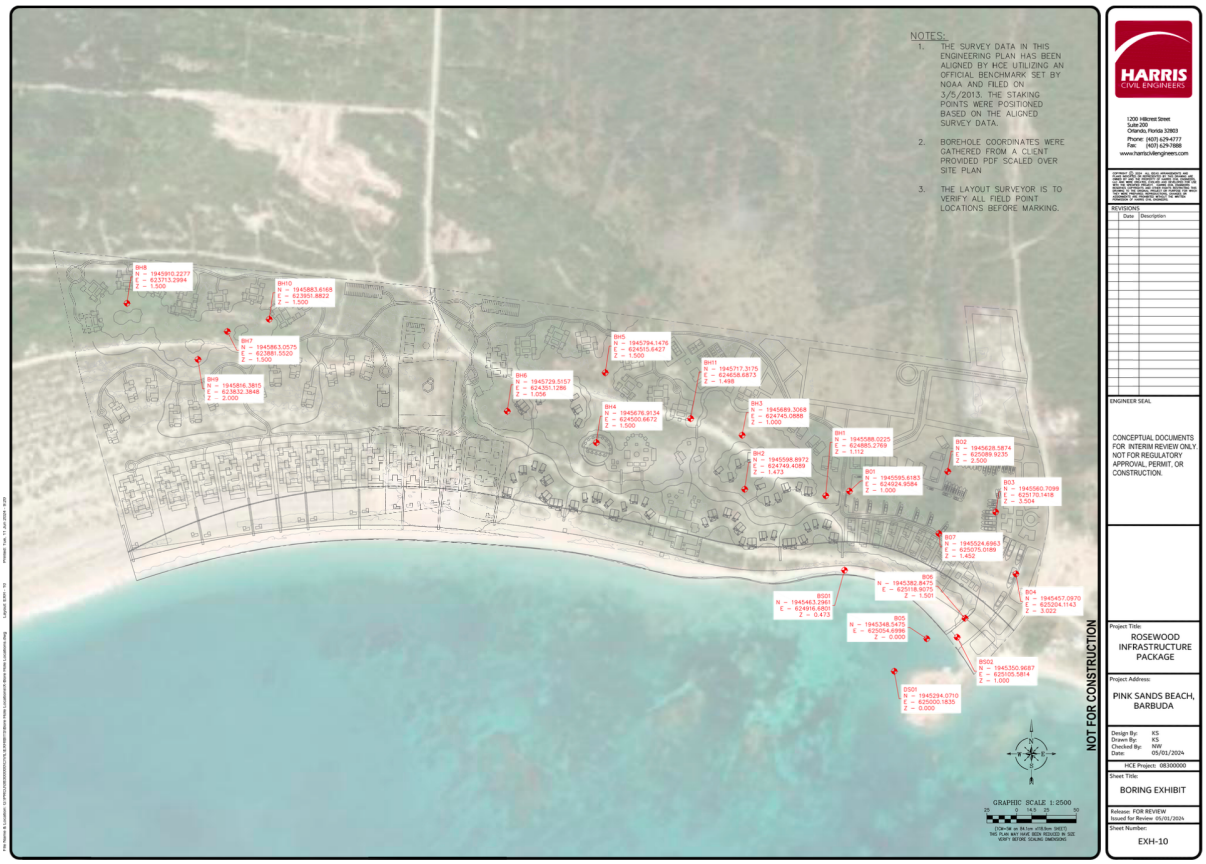


Figure 5.4: Map of borehole locations (Enclosure 1, Appendix 5)

Guidelines for site fill

It is expected that the site's elevation may be raised via filling. The following guidelines are presented here and should be adhered to provide structural fill with good load-bearing capabilities:

a) All loose, organic, or otherwise deleterious materials should be removed from the site as far as practicable,
b) The area should be brought up to grade using fill material which can achieve a soaked CBR of at least 10%, and
c) The fill material should have a liquid limit of no greater than 45% and a plasticity index (PI) no greater than 15%.

The fill material should be compacted in lifts not exceeding 150 mm and to a dry density of at least 97% of the modified Proctor compaction maximum dry density, excluding the first 300 mm.

5.1.1.4 Ground and surface water

Barbuda is divided into ten watersheds that surround the Highlands, the only area on the island with any appreciable slope (Mather, 1971). Runoff is generally limited but may become significant in flood conditions (see Drainage Report in Appendix 9). Historically, runoff percolated through the limestone surface rock into groundwater aquifers, where the freshwater sits in lenses above saltwater that permeates from the ocean. The freshwater has been traditionally accessed via several wells across the island (Figure 5.5). However, the water in

these wells is increasingly brackish, and some reports indicate that it may be polluted since sufficient freshwater is not replenished, and saltwater rises towards the surface.

Water resources are critical for sustaining Barbuda's domestic and agricultural endeavors. The island is on the edge of a semi-arid climate subject to periods of drought. This is evident in the ecology. For instance, plants that survive and thrive are predominantly highly drought-resistant. Today, the island is predominantly dependent on desalination to meet its water needs and supplemented with water from groundwater wells, where most of the community, especially in Codrington have their own wells. Ground and surface water are essential to the Island. However, population growth and development have pushed water demands far beyond the capacity of ground and surface water sources. These resources require protection against overuse and pollution.

Water management and avoiding groundwater extraction and pollution is a key focus of the development. A key focus is the retention of rainwater runoff in integrated and constructed wetlands and the facilitation of partial reabsorption of the water into groundwater aquifers.

Throughout the development site, there are several natural upwellings of fresh and brackish water in the form of relatively small natural wells and larger ponds that sustain a few mangroves and small wetland ecosystems. Groundwater is found 0.2 to1.8 m below the ground (see geotechnical report). At the western side of the property, surface water is present in low-lying sandy areas that have been excavated by previous sand mining activities over the past c.60 years (which were carried out by external entities, not the owners of this development). The development will expand and restore these naturally existing wetlands and use them to create a stronger connection between them, the constructed wetlands, and the groundwater to support healthy mangrove habitats as well as replenish and recharge the groundwater systems. The wetlands are part of a nature-based solution to development that can help sustain and enhance ecosystem services and provide habitats for multiple species.

Scarce water availability on-site and throughout the island requires that freshwater needs for drinking, washing, laundry, etc., be fulfilled by a reverse osmosis desalination plant. It is estimated that the average design daily demand for potable water will be c. 312,000 gal/day. Irrigation requirements will be fulfilled using grey water from the sewage processing plant. Details of this have been discussed in the previous section in Section 2.1.5.2.

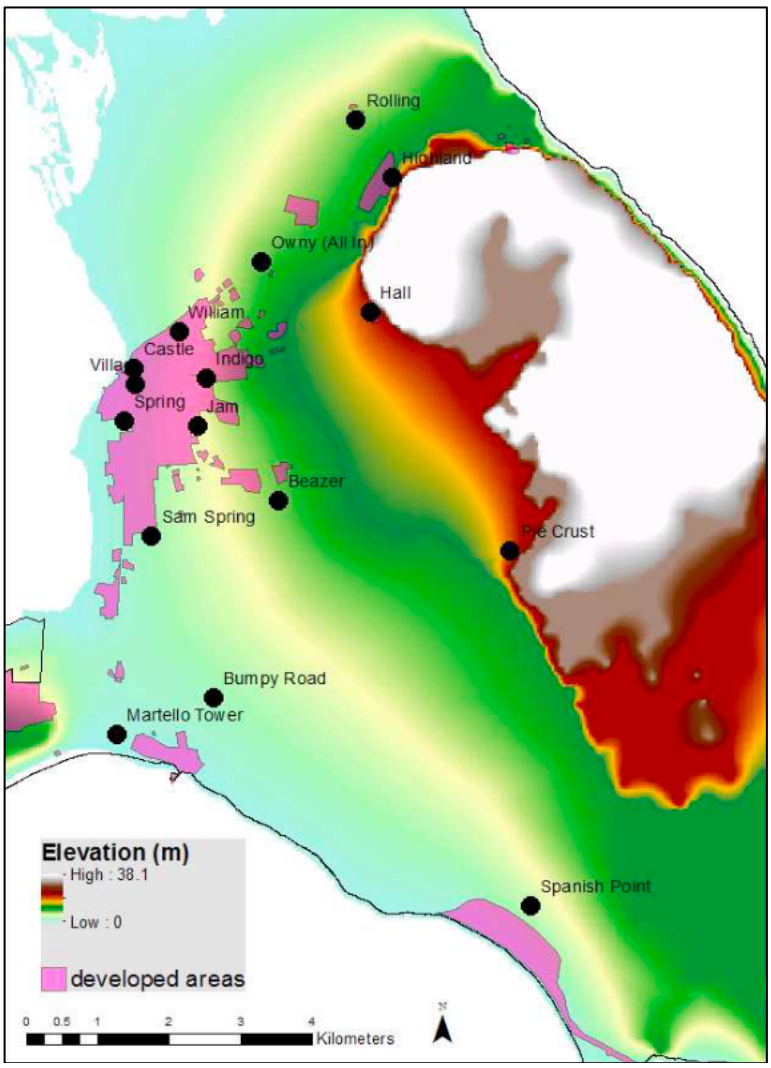


Figure 5.5: Locations of Barbuda's historic wells (Boger et al., 2014).

5.2 Air Environment

5.2.1 Meteorology

Barbuda has a tropical climate that is hot year-round. The climate is influenced by the steady north-easterly trade winds and has a marked dry and wet season. Average daily temperature in Antigua and Barbuda averaged 26.41°C from 1901 until 2021, reaching an all-time high of 27.5°C in 2010 and a record low of 25.2°C in 1913. (WorldBank, n.d.-b).The prevailing winds are from the east with average wind speeds of 20 km/h.

5.2.1.1 Rainfall

Precipitation in Antigua and Barbuda averaged 1,048.83 mm from 1901 until 2021, reaching an all-time high of 1,361.70 mm in 2008 and a record low of 666.20 mm in 2015 (WorldBank, n.d.-a). Although Barbuda is considered one of the driest islands in the Caribbean and typically receives between 760-990 mm precipitation per year, it experiences episodic heavy rainfall from passing storms and hurricanes, which causes flooding events on the island. For instance, in November 2022, feeder bands from Hurricane Nicole caused over 6 inches (150 mm) of

rainfall in Barbuda over a 24-hour period, leading to flooding on various low elevation parts of the island. Rainfall data between June 2011 and December 2017 were obtained from the NOAA National Centres for Environmental Information Centre for Weather and Climate at meteorological data from station 998441-99999 in Barbuda at 17.591N, -61.821W. These data showed that rainfall has been relatively consistent throughout this period. The wet season is officially between June and November annually, although this may vary inter-annually.

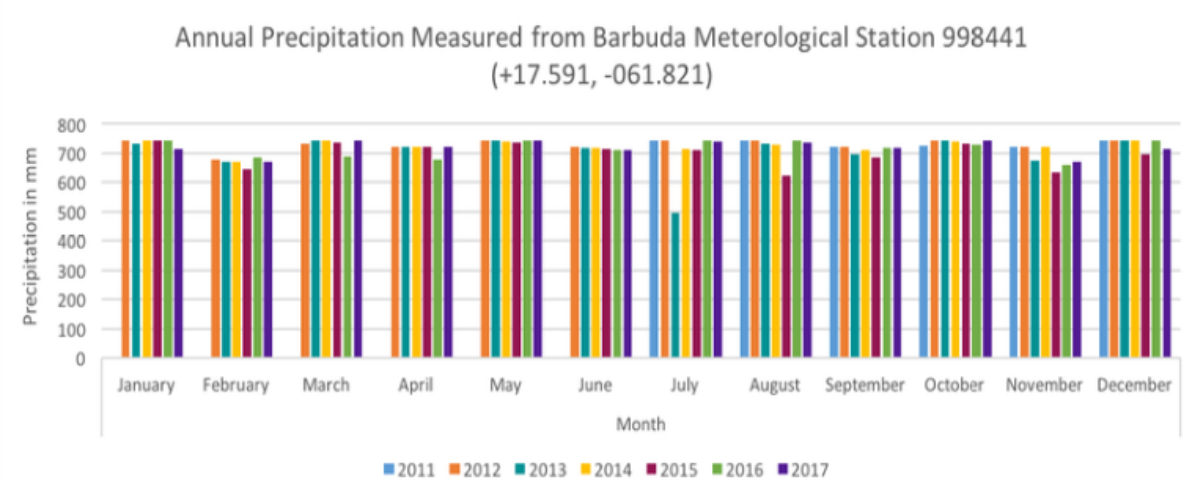


Figure 5.6: Monthly rainfall data for Barbuda from NOAA meteorological station 998441.

Drought periods are common in Antigua and Barbuda's climate and have important repercussions because of their small size. The country was subject to prolonged drought between 1964 to 1968 and 1983 to 1984, as well as additional years in 1966, 1967, 1968, 1971, 1977, 1983, 1990, and 1991 (Ivor Jackson & Associates, 2001). More recent drought years include 2015, 2018, and 2021 (Figure 5.7). Barbuda has very limited surface and groundwater reservoirs that rely on rainwater to be recharged. As a result, there has been an increasing reliance on desalination as a source of freshwater.

Antigua and Barbuda receive ample amounts of sunlight during the year, including during the wet season, averaging 200-250 hours of sun per month. The islands infrequently experience dense cloud cover, not including scattered cloud conditions (Dense cloud occurs <6 months/yr.) (Figure 5.8) (Ivor Jackson & Associates, 2001).

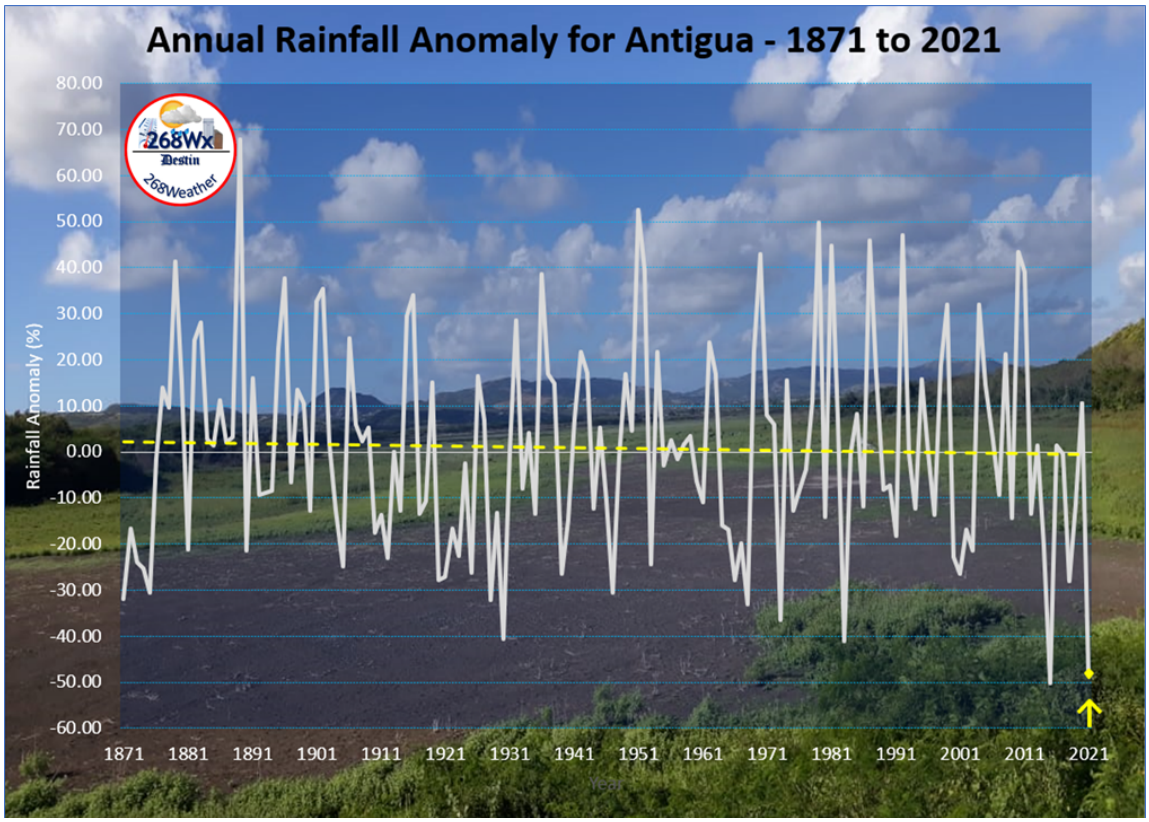


Figure 5.7: Annual rainfall anomalies from the mean (yellow broken line), where wet (positive) and dry (negative) anomalies (Source: 268weather).

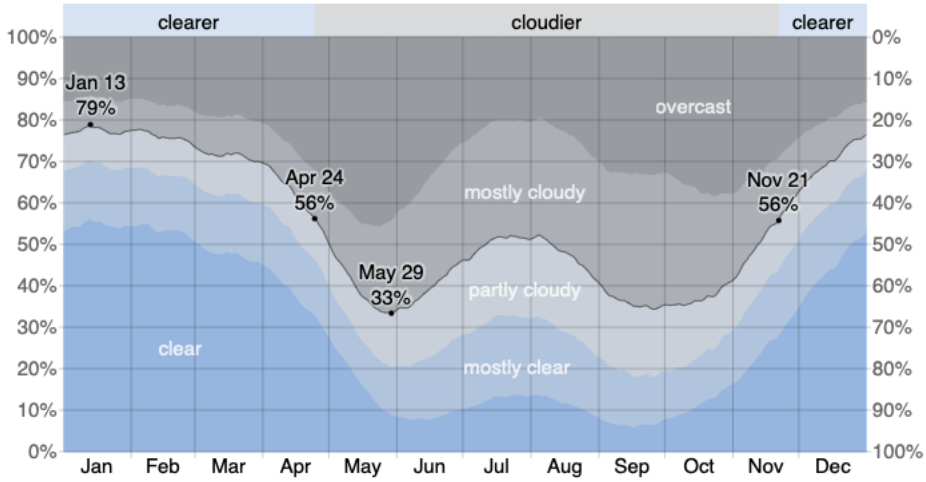


Figure 5.8: Average annual cloud cover at VC Bird International Airport (Source: WeatherSpark.com)

5.2.1.2 Wind

Barbuda is predominantly affected by the easterly Trade Winds, which blow consistently throughout the year. These winds have a large effect on the island, bringing Sahara dust and influencing hurricanes. The nearest, comprehensive weather station is at VC Bird International Airport in Antigua. Average wind direction is from the east, with some variation to ENE and to

ESE during the summer. Highest average windspeeds are generally in July and December, and lowest in April and October (Figure 5.9).

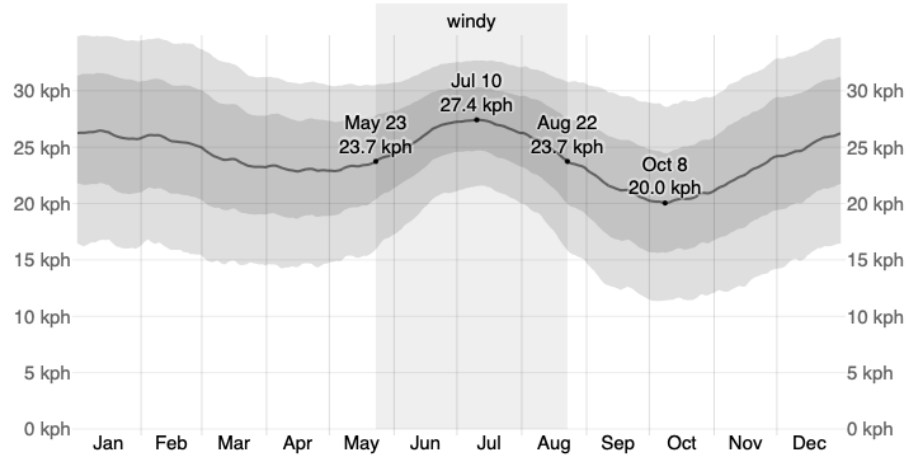


Figure 5.9: Average windspeed at VC Bird International Airport (Source: WeatherSpark.com)

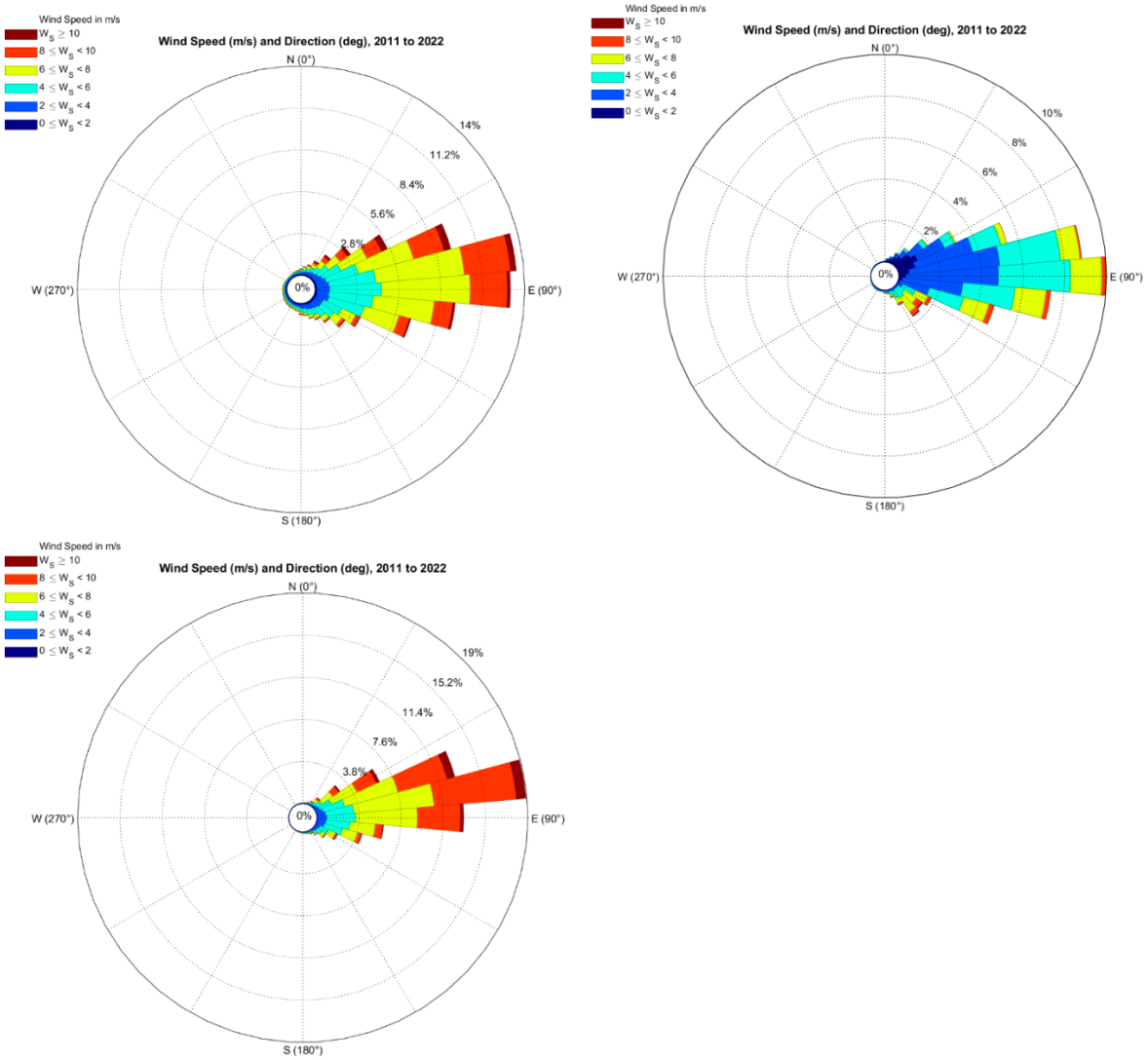


Figure 5.10: Wind roses for the period 2011-2022, where data is from (a) Station 41044 located 330 nautical miles north east of the project site in the open Atlantic Ocean, (b) Station 42060 situated in the Caribbean Sea southwest of the development site, and (c) Data from Station BARA 9 on Barbuda.

5.2.1.3 Air quality

Based on data collected by UNEP (2015), Barbuda has been recorded as having good air quality. The UNEP 2015 Air Policy Report for Antigua and Barbuda indicates that the Island has low overall air pollution (UNEP, 2015). The World Health Organization 2014 Ambient Air Pollution Index indicates that Antigua and Barbuda have an annual mean concentration of particulate matter, fine suspended particles of less than 2.5 microns in diameter, of 13 $\mu g/m^3$. This is within the US EPA's National Ambient Air Quality Standard range of 12.0 $\mu g/m^3$ to 15.0 $\mu g/m^3$, ranking Antigua and Barbuda in one of the lowest categories for mean particulate matter concentration across the globe. However, when the Sahara dust blows across the Caribbean, air quality decreases and there are occasional air quality warnings issued by the Meteorological service during these times (the most recent being Dec 24-26 2024 https://x.com/268weather?lang=en).

However, in recent years, it is likely that the local mean concentration of particulate matter and fine suspended particles has increased. This is due to the increase in construction activity on the island, with the density of large machinery and trucks transporting materials across the island having increased since the reports were published. This rise in large vehicular traffic causes the dust, sand, and dirt from the roads, which are largely unpaved, to be suspended in the air. In situ observations of large trucks and machinery suspending particulate matter and creating dust plumes have been frequently noted by the science team during its time on the island. While there have not been recent ambient air pollution studies conducted in Antigua and Barbuda, trucks on unpaved roads have been shown to be responsible for an estimated 47% of particulate matter (of 10 microns) emissions (Giunta et al., 2019). These fine particles, which can range from respirable dust to coarse particulate matter, can pose respiratory hazards to nearby communities and workers. Road dust particles have also been linked to other health effects, particularly on the cardiovascular and respiratory systems. Therefore, it is recommended that the development strive to implement strategies to avoid dust plumes. This is further discussed in SECTION 6.0.

5.2.2 Sea currents and general hydrology

Barbuda is located on the north-eastern side of the Barbuda Bank, which is characterized by waters shallower than 30 m. On the eastern side of the island, the bank rapidly slopes away to more than 500 m depth. Located on the south-west of the island, the development site is characterized by the shallow waters and flat bottom of the top of the Bank.

The Caribbean Sea, including Barbuda, has a micro-tidal range, which mostly varies between 10 and 20 cm. The tide is primarily mixed semidiurnal or mixed diurnal.

The bathymetry of the nearshore coastal habitat near the development is characterized by flat bottom extending from the beach to a depth of approximately 5 m at 500 m offshore (Figure 5.12). These flat areas a primarily comprised of sand and seagrass habitat with small reef patches, which are described in greater detail in Section 5.4.6.1. There are four main shallow reef patches that sit just below the surface and are a navigational hazard for boat traffic.

Additional information on the coastal hydrodynamics and process are provided in the coastal vulnerability and hydrodynamic assessment findings (Section 6.1.1 and Appendix 12).

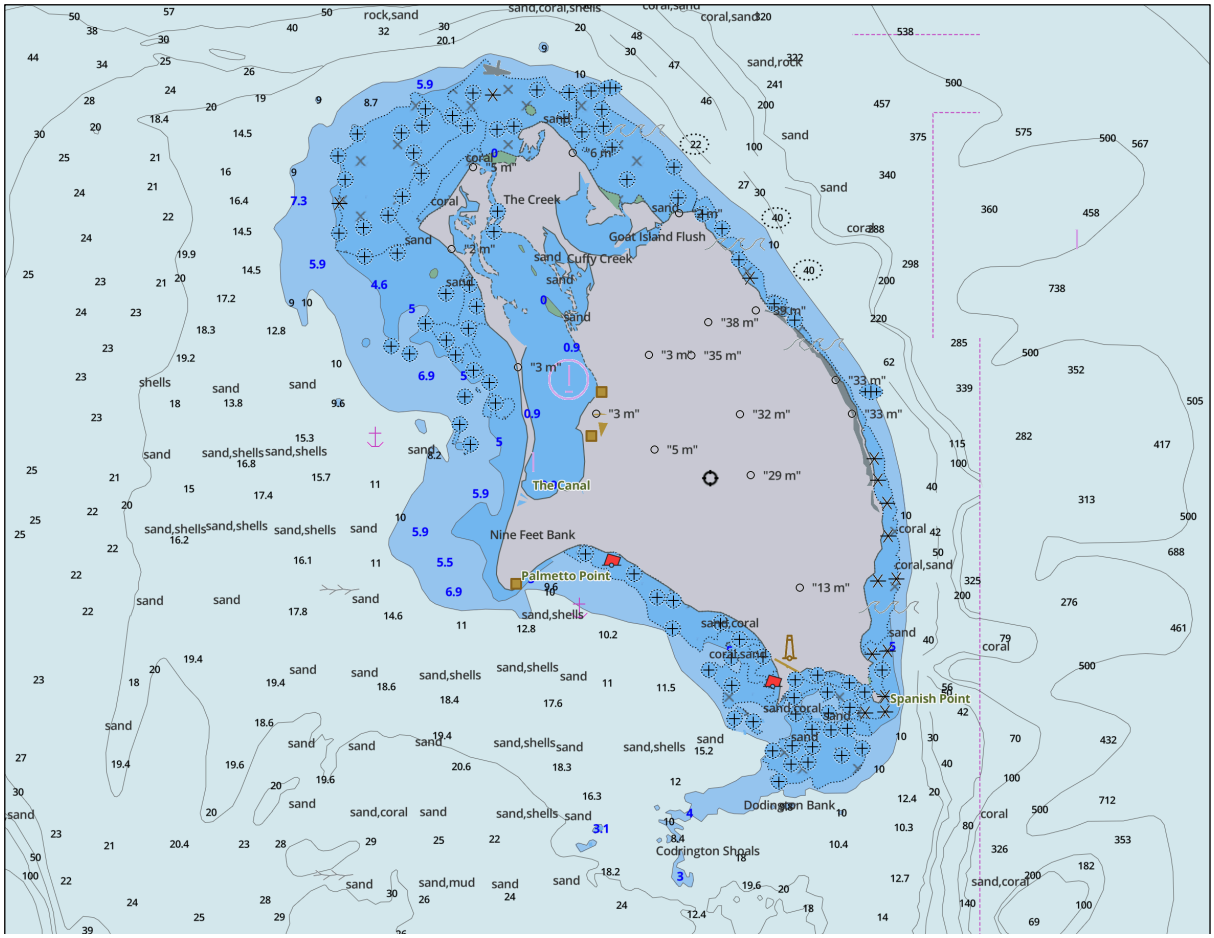


Figure 5.11: Bathymetric map of Barbuda's waters (https://fishing-app.gpsnauticalcharts.com)



Figure 5.12: Bathymetric analysis of the nearshore habitat adjacent to the development site showing the border of the site (red) and four shallow reef patches (black).

5.2.3 Surface freshwater and marine water quality

Changes in island hydrology, pollution, or contamination of groundwater and near-shore marine resources, or the introduction of pathogens and nutrients can pose serious and irreversible environmental impacts.

Water quality analyses of freshwater and the marine environment were conducted by the Analytical Services Laboratory (ASL), in Antigua and as per the request of DoE. Water samples were collected on May 8, 2024, from 12 sites, including 5 marine locations. Samples were put on ice and transported and delivered to the ASL lab on the same day where they were tested for nitrate, phosphate, salinity, pH, turbidity, Enterococci, and fecal coliform. These parameters align with the capabilities of the laboratory and were agreed upon by DoE for the ESIA. Temperature and dissolved oxygen were also measured *in situ* with a YSI probe by the science team. The required water measurement reporting and standards were provided by the DoE. These standards require that phosphates and nitrate results be reported in mg/mL, and since the ASL reports these metrics in ppm, the results were converted from ppm to mg/mL.

Both ASL-certified data and *in situ* raw data are reported in Appendix 3, and a summary of both sets of results and the converted values are presented in Table 5.3.

Water quality at only 3 out of 12 sites samples met good quality standards for all of the parameters measured based on the analysis conducted by ASL and the *in situ* measurements made by the science team. Temperature, turbidity, salinity, pH, nitrate and phosphate levels were all within acceptable limits under the EPMA 2019. Faecal coliform and enterococci concentrations were higher than acceptable limits at 9 and 3 sites respectively, but none of the other parameters exceeded threshold standard levels per the DoE standards.

On May 8, 2024, nutrient concentrations (phosphate and nitrate) at all 12 sites sampled were within the acceptable threshold standards provided by DoE. Phosphate concentrations were within acceptable threshold limits (<0.025 mg/mL) and the nitrate concentrations were within acceptable threshold limits (<0.4 mg/mL) per the DoE standards at all sites for this sampling event. Water temperature ranged between 25.2 and 29.0°C.

Enterococci concentrations were within acceptable EPMA (2019) threshold limits for 9 of the 12 sites (threshold <60 cfu/100 mL for a single sample), but the levels at the other 3 sites, East, West and South Wetlands, were dramatically higher (240-990 cfu/100mL). Fecal coliform concentrations were higher than the acceptable limits under the EPMA (2019) at 9 of the 12 sites for the sampling event (the threshold standard is <400/100 mL for a single sample and <200/ 100mL for repeated sampling). Both *Enterococci* and fecal coliform levels are indicators for fecal contamination in water. *Enterococci* are generally hardier and are a better indicator of pervasive contamination and a more reliable indicator for marine waters. Here, the results indicate that East, West, and South Wetlands all have high fecal contamination. This is likely from animals, including donkeys and bird life, as they are small active wetlands in a predominantly dry area. There is no major development hydrologically upstream (to the northeast) of the site, so it is unlikely that the source is offsite. The development of the site will incorporate much larger wetland areas with higher water flow and nutrient cycling, which will aim to mitigate for this. The high fecal coliform levels throughout the site will need to be combined with results from future sampling events to assess any patterns.

We report DO standards based on those provided in the EPMA. These thresholds apply to marine coastal and fresh waters. Lagoonal or coastal wetland water quality thresholds have yet to be legally defined, but the EPMA values are useful as a benchmark to assess fluctuations and trends and can help to identify concerns. Dissolved oxygen (DO) levels were

>5.0mg/L (the EMPA (2019) threshold for recreational coastal waters) for 4 of the 5 marine sites (Table 5.3). Ferry Dock 2 was below this threshold, and it is likely that this is due to low water flow and stagnation observed on the nearshore side of the ferry dock. The remaining 7 sampling sites were inland water bodies that contained either fresh or brackish water. Of these, 5 had DO levels above the threshold for Class 2 freshwater bodies (>4.5 mg/L), while East and West wetlands had DO of 0.55 and 2.83 mg/L, respectively. This is likely due to a lack of circulation in these small and shallow water bodies.

The pH of the 9 sites sampled fell within the EPMA (2019) range for marine/coastal waters of 7.7-8.5. Turbidity was low at all coastal samples except the West Coast location, at the western end of the property, where there is higher wave action and suspended sediment in the water (Table 5.3). There was a range of turbidity across all freshwater and brackish sites, from 10.2-94.0 NTU.

The planned integrated constructed wetlands form two bodies of water at the heart of the development. A healthy and diverse wetland can filter out pollutants and process inorganic compounds via microbial digestion.

Coastal tropical marine ecosystems that are primarily based on low-nutrient dynamics, such as coral reefs, are particularly vulnerable to nutrient phase shifts. The habitat closest to shore is seagrass, which transitions to contain coral reef patches. The quality of water entering the marine environment is critical for the persistence of these ecosystems and must be monitored and maintained throughout the construction of the development.

In summary, good water quality management is essential for the health of aquatic environments throughout this development. Ongoing assessment and quick mitigation of any issues will help avoid any further contamination. Water quality should be monitored on an ongoing basis and at least every 3 months during the construction phase of the development to ensure early detection and rapid response if there are any development-related impacts to the coastal and ground waters. There is no anticipated any cumulative impact from water discharge into coastal waters.

Table 5.3: Water quality results from the 12 sampling locations sampled on May 8, 2024.

Sample ID	Description	Water Type	ODO (mg/L)	Temp (°C)	Enterococci (CFU/100 ml)	Faecal coliform (CFU/100 ml)	Turbidity (NTU)	pH	Salinity (g/L)	Nitrate (mg/mL)	Phosphate (mg/mL)
BP	Batch Plant	Brackish/fresh	7.14	26.9	ND	>200	10.2	8.03	1.4	0.0021	0.0066
FD1	Ferry Dock 1	Marine	7.04	27.8	2	ND	0.2	8.31	36.4	0.0000	0.0041
ED	End of Dock	Marine	5.75	28.9	5	>200	2.1	8.31	36.3	0.0000	0.0019
FD2	Ferry Dock 2	Marine	4.47	29.0	12	>200	0.3	8.28	36.4	0.0000	0.0034
MC	Middle coast	Marine	6.72	28.0	7	ND	36.7	8.30	36.1	0.0000	0.0047
OF	Outflow	Brackish	6.65	25.8	ND	>200	43.8	8.33	11.3	0.0004	0.0002
WS	Well sample	Fresh	2.71	26.0	ND	>200	33.1	8.03	0.8	0.0000	0.0002
EW	East wetland	Fresh	0.55	26.3	570	>200	94.0	8.14	2.6	0.0000	0.0002
WW	West wetland	Brackish	2.83	25.7	240	>200	63.1	7.94	10.3	0.0000	0.0002
WC	West coast	Marine	7.58	27.9	27	>200	54.0	8.25	3.9	0.0000	0.0020
NW	North wetland	Brackish/fresh	2.25	25.9	8	ND	0.6	8.27	36.4	0.0000	0.0012
SW	South wetland	Brackish	7.04	25.2	990	>200	16.9	8.45	3.5	0.0000	0.0004

5.3 Noise Environment

The proposed development area is currently subject to noise impacts from ferries, sand mining activities, and a batch plant. The baseline noise levels across the development site were assessed in a baseline study in May 2024. Noise quality impacts from the development itself are expected to be largely temporary and mostly during the construction phase. There are no immediate neighbors to the site that will be directly impacted. There are no ongoing noise risks.

Noise levels are measured in decibels (dB), which are described using an adjustment for human hearing and are called decibels A (dBA). Normal ambient noise levels fall within the 50-65 dBA range, up to 70 dBA, without causing damage after exposure over long periods. Construction noises may be up to 120 dBA from, for example, hammer drills, and much construction activity is around 80-90 dBA. According to the U.S. Occupational Safety and Health Act (OSHA), average noise exposure should not be more than 90 dBA over an 8-hour period, and workers should not be exposed to levels of more than 115 dBA for more than 15 minutes (Table 5.4). Therefore, construction noise exposure should be limited, and hearing protection devices should be provided to workers when needed.

Table 5.4: U.S. Occupational Safety and Health Act of 1970 (OSHA) standards & OSHA Hearing Conservation Program Amendment (Occupational noise exposure - 1910.95)

Duration per day (hours)	< ¼	1	1 ½	2	3	4	6	8	16	32
Sound level (dBA) Slow Response	115	110	105	102	97	95	92	90	85	80

During the construction phase of this development, daily activities will take place during daylight hours. When the development is operational, high noise levels are not anticipated.

Baseline noise monitoring was completed between May 5-8, 2024, using standard noise monitoring methodologies based on established noise monitoring standards for development (The National Academy of Sciences, 1977) and recent noise monitoring studies (Golder Associates Ltd, 2018; Kerr et al., 2002; Ove Arup & Partners Hong Kong Ltd, 2001; Ramboll, 2018) as well as with direction and guidance from the DoE. Depending on their purpose, varying sampling intervals, total sampling time, and microphone sensitivity were used. For this assessment, sampling was completed between 07:00-17:00, with a high sampling interval (2 seconds) to capture a thorough understanding of noise on the site, including short, high-level noises.

Baseline noise data were collected using an R8070SD Data Logging Sound Level Meter (REED Instruments) using a wind diffuser ball. Prior to use, the sound level meter was calibrated using the R8090 Sound Level Calibrator. Measurements were taken at 9 locations as described in Table 5.5 and shown in Figure 5.13. Each location was selected to represent a different location and ecological habitat of the development site, in an open area more than 1.5 m away from hard surfaces, in accordance with recommended noise monitoring protocols and data logger specifications. The deployed noise meters are pictured in Figure 5.14.

At each of the 9 sampling sites, continuous recording at 2 second intervals was completed for 1 hour in the morning (07:00-12:00) and afternoon (12:00-17:00). This resulted in 2 hours of data and 3,600 data points for each site. The afternoon sampling period for the Ferry Dock was only 25 minutes long due to heavy rain.

Table 5.5: Noise sampling sites with coordinates in decimal degrees

Site No.	Name	Latitude	Longitude
1	New Road 1	17.602933	-61.828900
2	New Road 2	17.603033	-61.819917
3	Dune	17.593000	-61.831700
4	Open Canopy Wetland	17.595033	-61.826600
5	Wetland	17.593233	-61.825883
6	Open Canopy	17.595683	-61.822583
7	Batch Plant	17.594306	-61.819939
8	Cleared Farmland	17.593333	-61.822048
9	Ferry Dock	17.591350	-61.820817

The data collected was used to calculate the equivalent noise level over each 1-hour sampling period (Leq, 1 hour), the maximum and minimum noise levels recorded in each sampling period (Lmax, Lmin), and the 10th and 90th percentiles of noise level readings (L90 and L10). L10 is the noise level exceeded 10% of the sampling time and includes noise peaks probably due to sporadic or intermittent events, such as traffic or construction noise. L90 is the level exceeded for 90% of the sampling time and is considered to represent the ambient noise level of an environment. It is used to quantify the background noise level.

The results of this study indicated that noise levels around the Rosewood Barbuda Resort site currently range between 28 and 85 dBA but averaged between 31 and 54 dBA between 07:00 and 17:00 ($L_{eq,\ 1\ hour}$ in Table 5.6). The data collected at each sampling site for each time period are displayed in Figure 5.16. The data and *in situ* observations indicate that the noise data were affected as follows:

- New Road 1 and Open Canopy Wetland are both near the main road, and the data peaks, up to 78 and 83 dBA respectively, resulted from high traffic noise.
- New Road 2 is located in the middle of the bush, subject to low-level noise ~35 dBA. Two data peaks of 68 and 84 dBA were caused by heavy machinery from the Batch Plant driving along this existing track.
- Wetland is characterized by generally low-level noise with some impact from traffic on the main road.
- The batch Plant is characterized by high noise, averaging 53 dBA. In the afternoon sample, the noise increases from 28 minutes onwards, resulting from consistent activity from the batch plant. The morning sample was characterized by periodic activity, including loading trucks and moving machinery around.
- Open Canopy was also strongly impacted by the batch plant activity. The afternoon sample occurred on a Sunday afternoon when the batch plant was not active, while the morning sample captured the batch plant activity. This activity results in a noise difference of approximately 20 dBA at this site.
- Cleared Farmland was slightly impacted by noise from the batch plant at both sampling times. This site was close to both the road and the batch plant, but the noise from both of these sources was buffered by tall hedges, resulting in average noise levels of 46 and 48 dBA.
- At Dune, the afternoon sample between 0-15 minutes was impacted by the departure of the ferry. The ferry arrival was audible from this location. The morning sample was impacted by the loading of sand on the construction dock, as well as perhaps by slightly stronger wind.
- At the Ferry Dock, both morning and afternoon samples were strongly impacted by many trucks loading sand on the dock and sand mining activity nearby.

These data will serve as a baseline for the site when comparing to the operational phase of the project.



Figure 5.13: Map of the sites where noise monitoring was collected

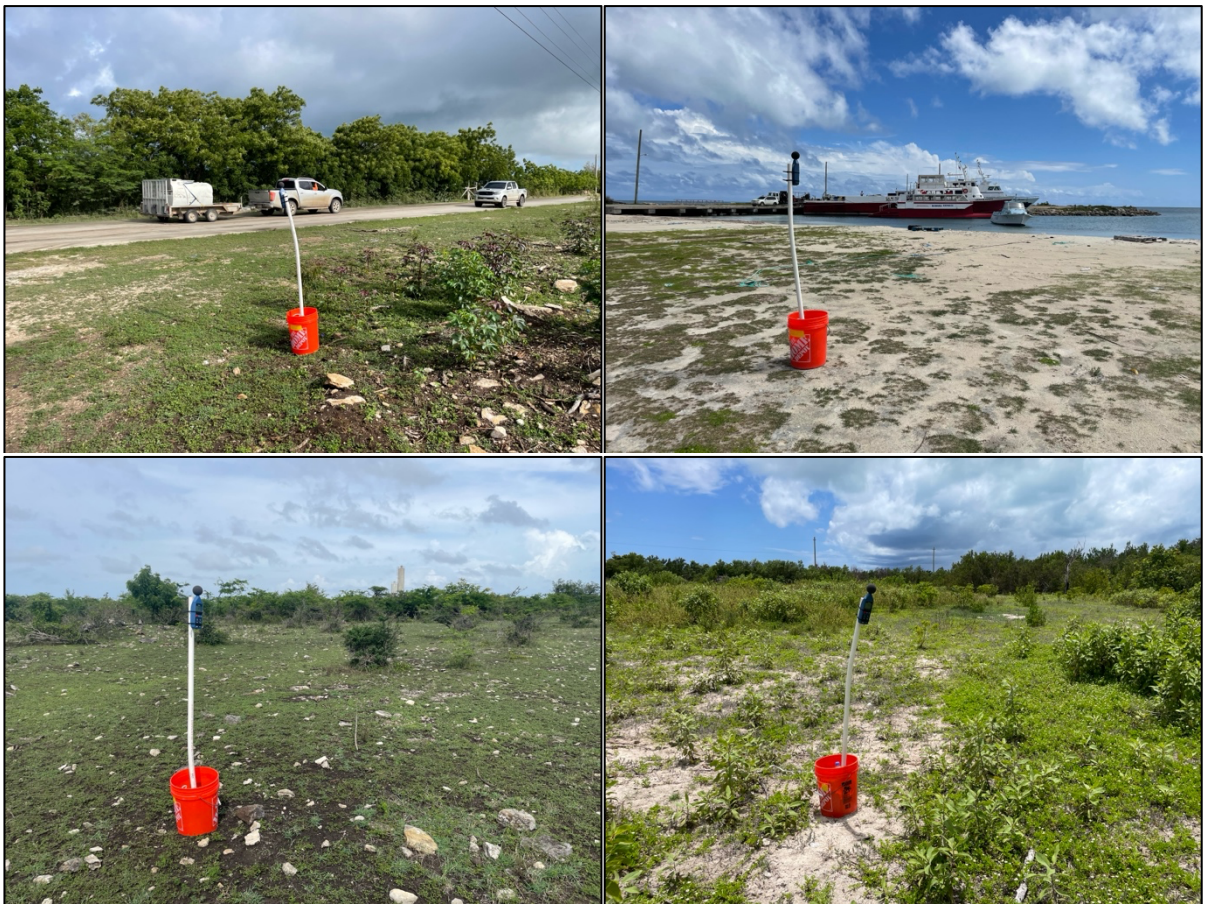


Figure 5.14: Sound level meter deployed at (a) New Road 1, (b) Ferry Dock, (c) Open Canopy, and (d) Cleared Farmland.

Table 5.6: Noise level monitoring summary statistics in dBA for each of the 9 sampling sites for the morning (07:00-12:00) and afternoon (12:00-17:00) sampling times.

		New Road 1	New Road 2	Dune	Open Canopy Wetland	Wetland	Open Canopy	Batch Plant	Cleared Farmland	Ferry Dock
Morning	$L_{eq,\ 1\ hour}$	46	34	46	43	42	48	53	46	48
	L_{max}	82	67	71	85	67	69	66	65	67
	L_{min}	31	28	35	31	35	37	44	40	40
	L_{10}	37	29	40	35	37	44	50	43	42
	L_{50}	44	32	46	41	41	48	53	45	47
	L_{90}	60	40	54	55	48	52	58	51	55
Afternoon	$L_{eq,\ 1\ hour}$	43	31	46	38	38	31	54	48	54
	L_{max}	78	84	61	83	73	74	70	67	72
	L_{min}	29	26	31	29	31	27	50	43	49
	L_{10}	31	27	35	32	33	29	52	46	52
	L_{50}	37	29	39	38	37	32	60	49	54
	L_{90}	55	41	46	54	47	42	64	52	60

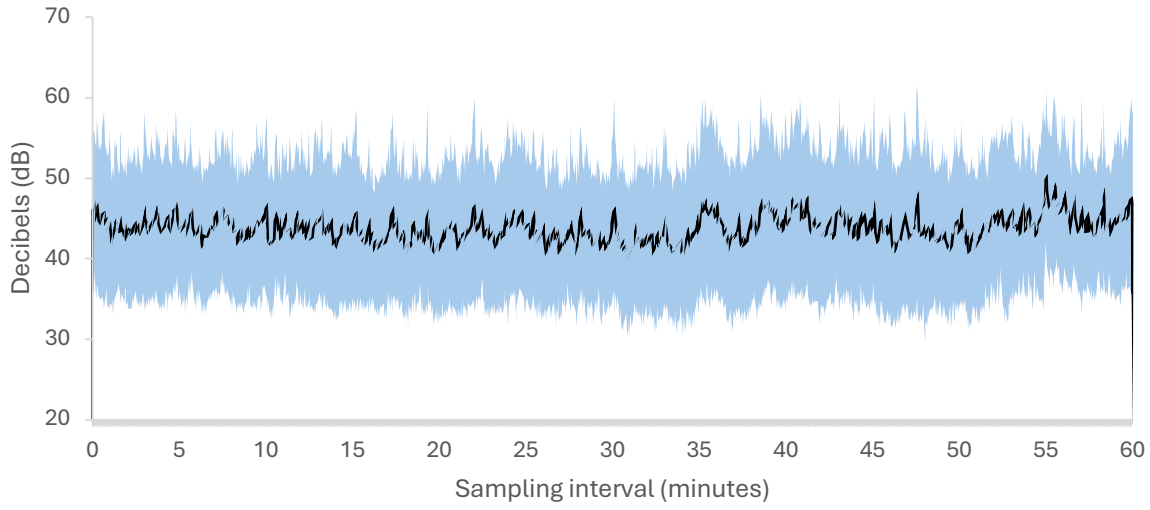


Figure 5.15: Average noise data across all 18 sampling periods (morning and afternoon at 9 sites) and standard deviation.

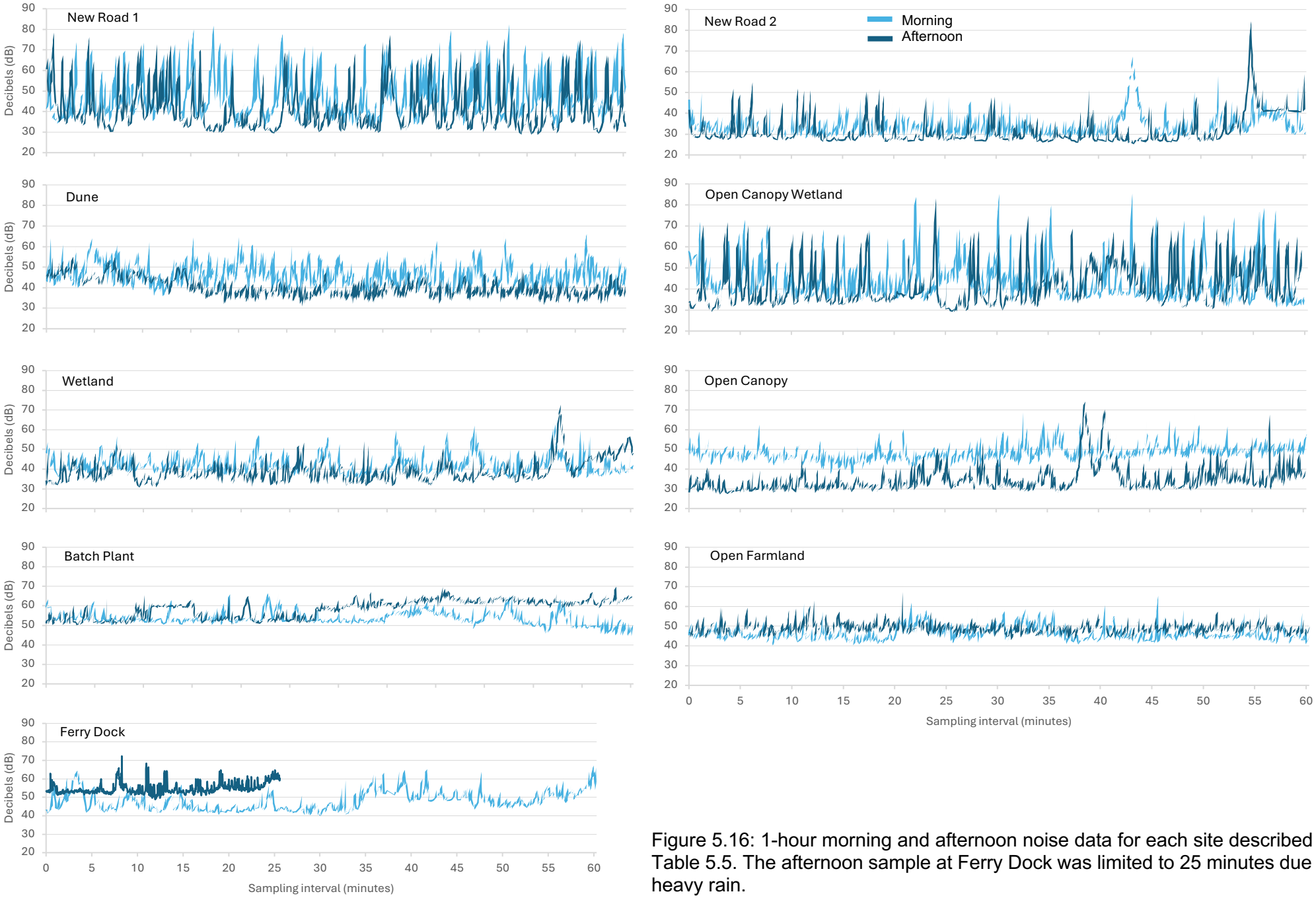


Figure 5.16: 1-hour morning and afternoon noise data for each site described in Table 5.5. The afternoon sample at Ferry Dock was limited to 25 minutes due to heavy rain.

5.4 Biological Environment

All ecosystems in Barbuda are critical reservoirs for genetic material and biological diversity for the island. Critical ecosystems include forests, wetlands, mangroves, seagrass and coral reefs. To conserve and protect these ecosystems, a better understanding of species abundance, location and habitat requirements is needed. Thus, thorough baseline and ongoing assessments of the plants, birds, mammals and other wildlife in development areas are required to determine how development will affect and is affecting the community. Overall, Barbuda is home to 14 species of mammals, 12 species of reptiles, and 74 species of birds.

5.4.1 Terrestrial vegetation and fauna

The distribution of plant assemblages on Barbuda has been previously described in Beard (1949), Harris (1960), and Lindsay and Horwith (1997) and in several recent studies by Deborah Brosnan & Associates. In 2008, Barbuda's vegetation types were comprehensively classified and found to contain 311 plant species. The three broad ecosystem communities in the development area are

1. Dwarf Shrubland Communities – consists of stunted trees and shrubs that grow on sand dunes and sandy soils, parasitic vines;
2. Grassland Communities – comprising of grasses and forbs with scattered trees and shrubs, produced by the grazing of livestock. Tends to flood after heavy rains; and
3. Mixed Evergreen Drought Resistant Deciduous Communities – found mainly surrounding Codrington Village, adjacent mangroves on thin and saline soils and characterized by stunted vegetation and bare patches of earth interspersed with flashes.

Assessments of the vegetation throughout the study site were conducted in May 2024 with the intent to identify the plant species present, wildlife use of the habitat and current land use. The site was surveyed on foot and a list of all species observed was created based on 13 zones, displayed in Figure 5.17. The species lists are presented in Table 5.7.

During the survey, 58 plant species in 38 families were recorded within the site and ranged from scattered ground cover and shrub plants to large trees. The former low ground cover was typically found in disturbed areas. The most common species, found in 8 or more of the 13 zones, were the regionally endemic Torchwood (*Amyris elemifera*) and White cedar (*Tabebuia heterophylla*), Buttonwood (*Conocarpus erectus*), which is protected under the EPMA (2019), as well as Seagrape (*Coccoloba uvifera*), Hop bush (*Dodonaea viscosa*), and the invasive shrub species Alabamba (*Acacia macracantha*).

Including Torchwood and White cedar, a total of 12 regionally endemic species were recorded. These were broom (*Chamaecrista glandulosa*), Bread and cheese (*Mimosa ceratona*), Loblolly (*Pisonia subcordata*), Boxwood (*Sideroxylon obovatum*), and Dolly tomato (*Solanum racemosum*), Yam bush (*Gundlachia corymbosa*), which is vulnerable in Antigua and Barbuda. Sea lavender (*Argusia gnaphalodes*) and Royen's tree cactus (*Pilocereus royeni*) are both regionally endemic and included on the IUCN Red List as Least Concern, while Palmetto palm (*Coccothrinax barbadensis*) and Mangrove berry (*Psiduim longipes* var. *orbiculare*) are similarly categorized with a status of 'Near Threatened'.

A further 2 groups and 3 species recorded are protected under the EPMA 2019, specifically, palms, Bromeliads, Buttonwood (*Conocarpus erectus*), Ironwood (*Krugiodendron ferreum*)

and red mangrove (*Rhizophora mangle*). Yellow sandalwood (*Zanthoxylum flavam*) is listed as 'Vulnerable' by the IUCN and is common throughout Zone 6.

The individual plants of these species should be preserved *in situ* or salvaged to a nursery environment and replanted for use in the development. More detailed surveys will be required to record the locations of large trees for preservation, and training for on-site workers will be required for the identification of smaller shrubs so they can be removed and preserved in a nursery.

Three invasive species were also recorded across the site, Alabamba (*Acacia macracantha*), Neem (*Azadirachta indica*), and Logwood (*Haematoxylum campechianum*), in 12, 3, and 5 zones, respectively. Consistent grazing pressure, in Zone 8 especially, and general land disturbance have facilitated the establishment of these invasive species, and at the expense of native species. Two native pest species, Love Vine (*Cassytha filiformis*) and Sandbur (*Cenchrus spinifex*), were also recorded in Zones 1 and 12, which are common in areas highly disturbed by human activity from sand mining and activities around the port, respectively.

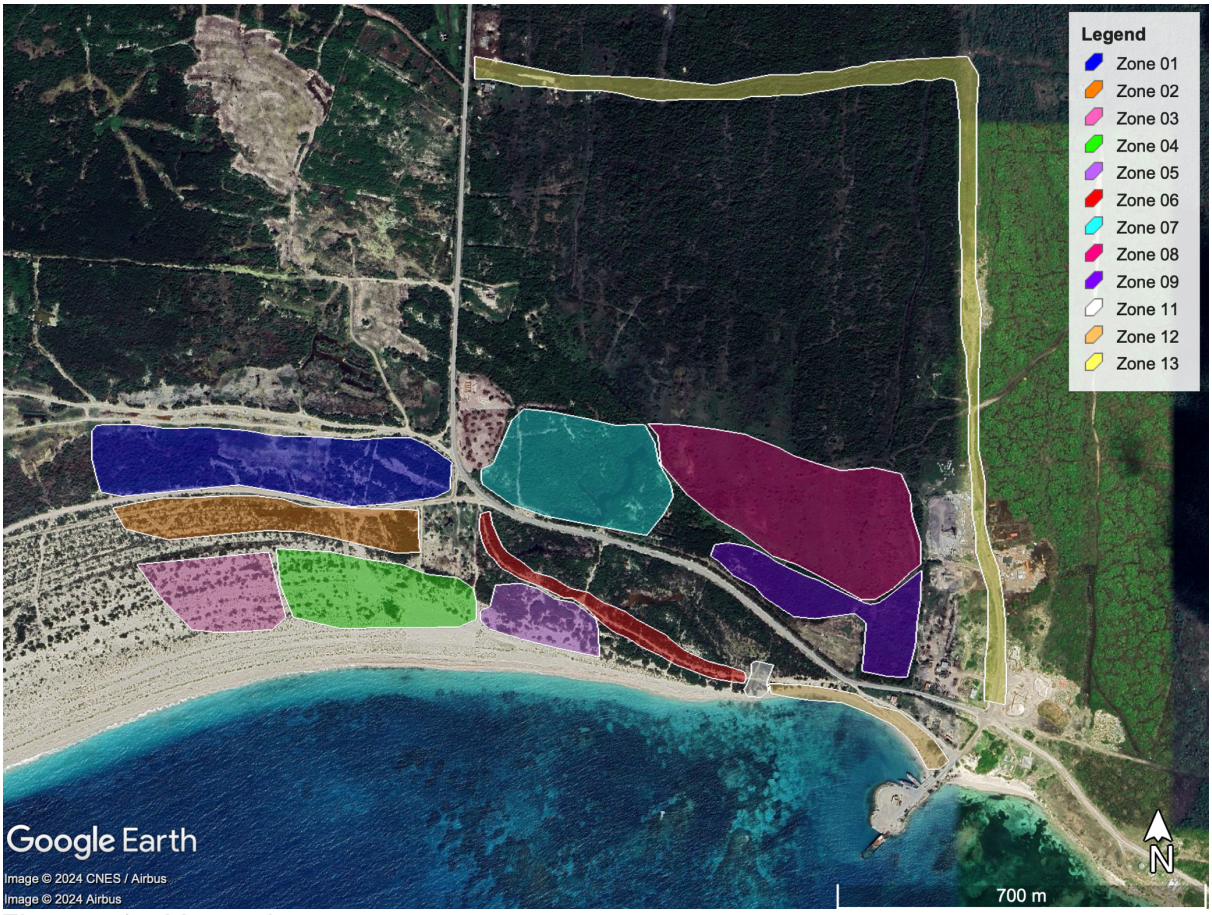


Figure 5.17: Vegetation survey zones.

Table 5.7: Plant species recorded in each survey zone (Figure 5.17) throughout the development site and their conservation status.

Zone	Common name	Botanical name	Family	Life form	Native to Barbuda and/or Endemic (RE) and/or IUCN Red Listed and Level
01	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
01	Love vine	*Cassytha filiformis*	Lauraceae	Vine	Yes / pest
01	Sandbur	*Cenchrus spinifex*	Poaceae	Shrub	Yes / pest
01	Broom	*Chamaecrista glandulosa*	Leguminosae-Caesalpinia	Shrub	Yes / RE
01	Coco plum	*Chrysobalanus icaco*	Chrysobalanaceae	Tree	Yes
01	Seagrape	*Coccoloba uvifera*	Polygonaceae	Tree	Yes
01	Palmetto palm	*Coccothrinax barbadensis*	Palmae	Tree	Yes / RE / Vulnerable in A&B, Protected under the EPMA 2019 / IUCN Red List - Least Concern
01	Buttonwood	*Conocarpus erectus*	Combretaceae	Tree	Yes / Protected under the EPMA 2019
01	Nail polish bush	*Croton flavens*	Euphorbiaceae	Shrub	Yes
01	Hop bush	*Dodonaea viscosa*	Sapindeceae	Shrub	Yes
01	Wild pomegramma	*Ernodea littoralis*	Rubiaceae	Shrub	Yes
01	Yam bush	*Gundlachia corymbosa*	Asteraceae	Shrub	Yes / RE / Vulnerable in A&B
01	Sage	*Lantana camara*	Verbenaceae	Shrub	Yes
01	Bread and cheese	*Mimosa ceratona*	Leguminosae-Mimosoideae	Tree	Yes / RE
01	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE
02	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
02	Torchwood	*Amyris elemifera*	Rutaceae	Tree	Yes / RE
02	Neem	*Azadirachta indica*	Malvaceae	Tree	No, invasive
02	Coco plum	*Chrysobalanus icaco*	Chrysobalanaceae	Tree	Yes
02	Seagrape	*Coccoloba uvifera*	Polygonaceae	Tree	Yes
02	Palmetto palm	*Coccothrinax barbadensis*	Palmae	Tree	Yes / RE / Vulnerable in A&B, Protected under the EPMA 2019 / IUCN Red List - Least Concern
02	Hop bush	*Dodonaea viscosa*	Sapindeceae	Shrub	Yes
02	Bread and cheese	*Mimosa ceratona*	Leguminosae-Mimosoideae	Tree	Yes / RE
02	Billbush	*Phyllanthus epiphyllanthus*	Euphorbiaceae	Shrub	Yes
02	Royen's tree cactus	*Pilocereus royeni*	Cactaceae	Cactus	Yes / RE / IUCN Red List - Least Concern
02	Ciliment	*Pimenta racemosa*	Myrtaceae	Tree	Yes
02	Loblolly	*Pisonia subcordata*	Nyctaginaceae	Tree	Yes / RE
02	Mangrove berry	*Psiduim longipes* var. *orbiculare*	Myrtaceae	Shrub	Yes / RE / Vulnerable in A&B, Protected under the EPMA 2019 / IUCN Red List - Near Threatened
02	Boxwood	*Sideroxylon obovatum*	Sapotaceae	Tree	Yes / RE
02	Dolly tomato	*Solanum racemosum*	Solaneceae	Shrub	Yes / RE

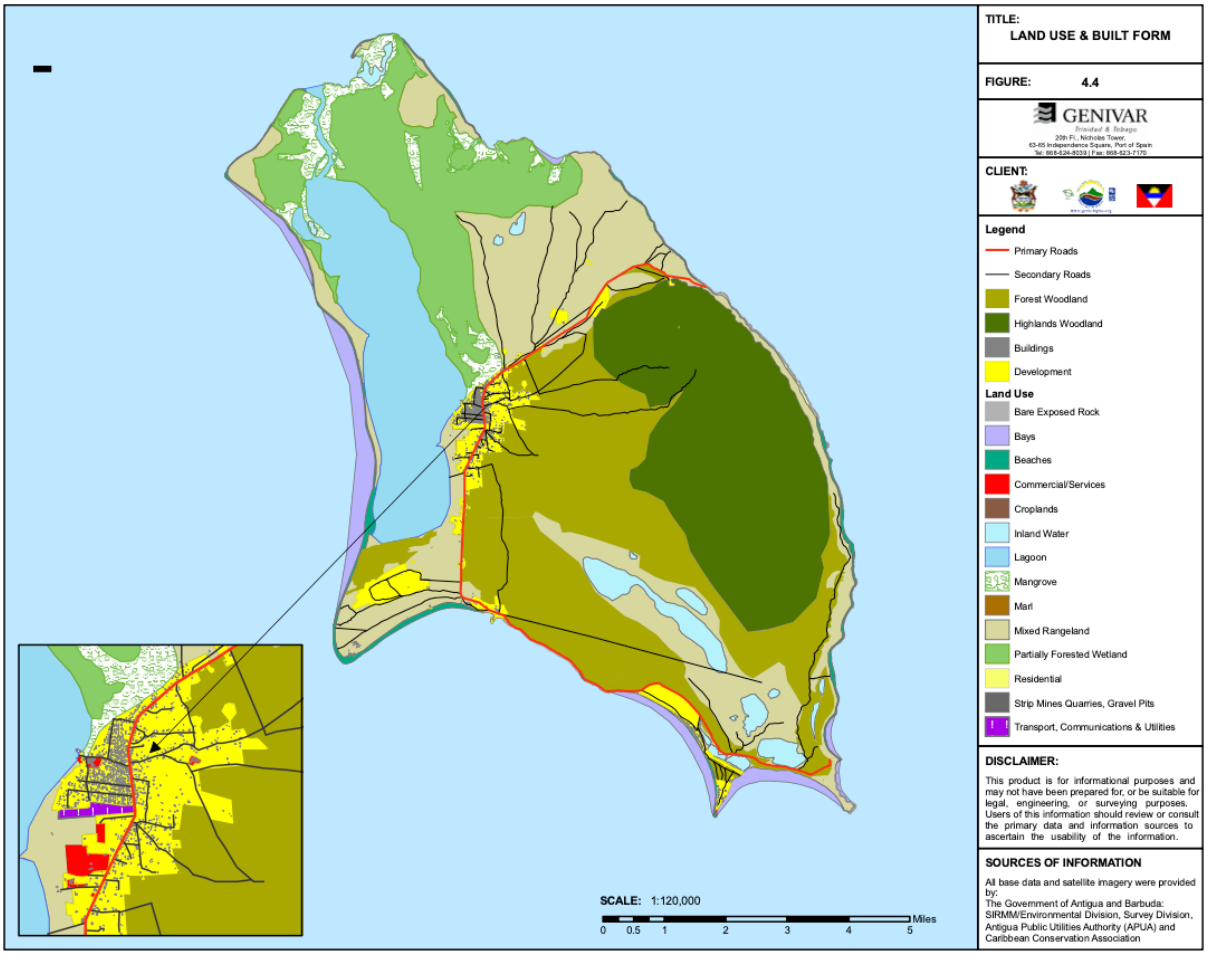
Zone	Common name	Botanical name	Family	Life form	Native to Barbuda and/or Endemic (RE) and/or IUCN Red Listed and Level
02	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE
03	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
03	Sea lavender	*Argusia gnaphalodes*	Boraginaceae	Shrub	Yes / RE / Vulnerable in A&B / IUCN Red List - Least Concern
03	Love vine	*Cassytha filiformis*	Lauraceae	Vine	Yes / pest
03	Coco plum	*Chrysobalanus icaco*	Chrysobalanaceae	Tree	Yes
03	Seagrape	*Coccoloba uvifera*	Polygonaceae	Tree	Yes
03	Buttonwood	*Conocarpus erectus*	Combretaceae	Tree	Yes / Protected under the EPMA 2019
03	Hop bush	*Dodonaea viscosa*	Sapindeceae	Shrub	Yes
03	Yam bush	*Gundlachia corymbosa*	Asteraceae	Shrub	Yes / RE / Vulnerable in A&B
03	Dune sunflower	*Helianthus debilis*	Asteraceae	Shrub	No
03	Cattle tongue	*Pluchea carolinensis*	Asteraceae	Shrub	Yes
03	Mangrove berry	*Psiduim longipes* var. *orbiculare*	Myrtaceae	Shrub	Yes / RE / Vulnerable in A&B, Protected under the EPMA 2019 / IUCN Red List - Near Threatened
03		*Scaevola* sp.	Goodeniaceae	Shrub	Yes
03	Bay cedar	*Suriana maritima*	Surianaceae	Shrub	No
03	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE
04			Palmae	Tree	Yes / Protected under the EPMA 2019
04	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
04	Torchwood	*Amyris elemifera*	Rutaceae	Tree	Yes / RE
04	Broom	*Chamaecrista glandulosa*	Leguminosae-Caesalpinia	Shrub	Yes / RE
04	Coco plum	*Chrysobalanus icaco*	Chrysobalanaceae	Tree	Yes
04	Seagrape	*Coccoloba uvifera*	Polygonaceae	Tree	Yes
04	Buttonwood	*Conocarpus erectus*	Combretaceae	Tree	Yes / Protected under the EPMA 2019
04	Maidenberry	*Crossopetalum rhacoma*	Celastraceae	Shrub	Yes
04	Hop bush	*Dodonaea viscosa*	Sapindeceae	Shrub	Yes
04	Candlewood	*Erithalis fruticosa*	Rubiaceae	Shrub	Yes
04	Wild pomegramma	*Ernodea littoralis*	Rubiaceae	Shrub	Yes
04	Yam bush	*Gundlachia corymbosa*	Asteraceae	Shrub	Yes / RE / Vulnerable in A&B
04	Sage	*Lantana camara*	Verbenaceae	Shrub	Yes
04	Bread and cheese	*Mimosa ceratona*	Leguminosae-Mimosoideae	Tree	Yes / RE
04	Mangrove berry	*Psiduim longipes* var. *orbiculare*	Myrtaceae	Shrub	Yes / RE / Vulnerable in A&B, Protected under the EPMA 2019 / IUCN Red List - Near Threatened
04		*Scaevola* sp.	Goodeniaceae	Shrub	Yes
04	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE
05	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
05	Coco plum	*Chrysobalanus icaco*	Chrysobalanaceae	Tree	Yes

Zone	Common name	Botanical name	Family	Life form	Native to Barbuda and/or Endemic (RE) and/or IUCN Red Listed and Level
05	Seagrape	*Coccoloba uvifera*	Polygonaceae	Tree	Yes
05	Buttonwood	*Conocarpus erectus*	Combretaceae	Tree	Yes / Protected under the EPMA 2019
05	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE
06	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
06	Torchwood	*Amyris elemifera*	Rutaceae	Tree	Yes / RE
06	Clam cherry	*Byrsonima lucida*	Malpighiaceae	Shrub	Yes
06	Broom	*Chamaecrista glandulosa*	Leguminosae-Caesalpinia	Shrub	Yes / RE
06	Soap bush	*Colubrina arborescens*	Rhamnaceae	Shrub	Yes
06	Maidenberry	*Crossopetalum rhacoma*	Celastraceae	Shrub	Yes
06	Nail polish bush	*Croton flavens*	Euphorbiaceae	Shrub	Yes
06	Hop bush	*Dodonaea viscosa*	Sapindeceae	Shrub	Yes
06	Yam bush	*Gundlachia corymbosa*	Asteraceae	Shrub	Yes / RE / Vulnerable in A&B
06	Sage	*Lantana camara*	Verbenaceae	Shrub	Yes
06	Billbush	*Phyllanthus epiphyllanthus*	Euphorbiaceae	Shrub	Yes
06	Ciliment	*Pimenta racemosa*	Myrtaceae	Tree	Yes
06	Mangrove berry	*Psiduim longipes* var. *orbiculare*	Myrtaceae	Shrub	Yes / RE / Vulnerable in A&B, Protected under the EPMA 2019 / IUCN Red List - Near Threatened
06	Boxwood	*Sideroxylon obovatum*	Sapotaceae	Tree	Yes / RE
06	Bay cedar	*Suriana maritima*	Surianaceae	Shrub	No
07	Bromeliads		Bromeliaceae	Herb	Yes / Protected under the EPMA 2019
07	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
07	Torchwood	*Amyris elemifera*	Rutaceae	Tree	Yes / RE
07	Neem	*Azadirachta indica*	Malvaceae	Tree	No, invasive
07	Clam cherry	*Byrsonima lucida*	Malpighiaceae	Shrub	Yes
07	Goat bush	*Castela erecta*	Simaroubaceae	Shrub	Yes
07	Butterfly pea	*Centrosema virginianum*	Leguminosae	Vine	Yes
07	Pigeon plum	*Coccoloba swartzii*	Polygonaceae	Tree	Yes
07	Seagrape	*Coccoloba uvifera*	Polygonaceae	Tree	Yes
07	Buttonwood	*Conocarpus erectus*	Combretaceae	Tree	Yes / Protected under the EPMA 2019
07	Nail polish bush	*Croton flavens*	Euphorbiaceae	Shrub	Yes
07	Wild pomegramma	*Ernodea littoralis*	Rubiaceae	Shrub	Yes
07		*Eugenia* sp.	Myrtaceae	Shrub	Yes
07	Logwood	*Haematoxylum campechianum*	Leguminosae	Tree	No, invasive
07	Sage	*Lantana camara*	Verbenaceae	Shrub	Yes
07	Bread and cheese	*Mimosa ceratona*	Leguminosae-Mimosoideae	Tree	Yes / RE
07	Billbush	*Phyllanthus epiphyllanthus*	Euphorbiaceae	Shrub	Yes

Zone	Common name	Botanical name	Family	Life form	Native to Barbuda and/or Endemic (RE) and/or IUCN Red Listed and Level
07	Royen's tree cactus	*Pilocereus royeni*	Cactaceae	Cactus	Yes / RE / IUCN Red List - Least Concern
07	Loblolly	*Pisonia subcordata*	Nyctaginaceae	Tree	Yes / RE
07	Cattle tongue	*Pluchea carolinensis*	Asteraceae	Shrub	Yes
07	Mangrove berry	*Psiduim longipes var. orbiculare*	Myrtaceae	Shrub	Yes / RE / Vulnerable in A&B, Protected under the EPMA 2019 / IUCN Red List - Near Threatened
07	Inkberry	*Randia aculeata*	Rubiaceae	Shrub	Yes
07	Castor oil plant	*Ricinus communis*	Euphorbiaceae	Shrub	Yes
07	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE
08	Nothing nut	*Cassine xylocarpa*	Celastracaeae	Tree	Yes
08	Manchioneel	*Hippomane mancinella*	Euphorbiaceae	Tree	Yes
08	Bellyache bush	*Jotropha gossipifolia*	Euphorbiaceae	Shrub	Yes
08	Slipper plant	*Pedilanthus tithymaloides*	Euphorbiaceae	Shrub	Yes
08	Yellow sandalwood	*Zanthoxylum flavam*	Rutaceae	Tree	Yes / IUCN Red List - Vulnerable
09	Bromeliads		Bromeliaceae	Herb	Yes / Protected under the EPMA 2019
09	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
09	Torchwood	*Amyris elemifera*	Rutaceae	Tree	Yes / RE
09	Goat bush	*Castela erecta*	Simaroubaceae	Shrub	Yes
09	Coco plum	*Chrysobalanus icaco*	Chrysobalanaceae	Tree	Yes
09	Pigeon plum	*Coccoloba swartzii*	Polygonaceae	Tree	Yes
09	Seagrape	*Coccoloba uvifera*	Polygonaceae	Tree	Yes
09	Buttonwood	*Conocarpus erectus*	Combretaceae	Tree	Yes / Protected under the EPMA 2019
09	Maidenberry	*Crossopetalum rhacoma*	Celastraceae	Shrub	Yes
09	Nail polish bush	*Croton flavens*	Euphorbiaceae	Shrub	Yes
09	Hop bush	*Dodonaea viscosa*	Sapindeceae	Shrub	Yes
09	Wild pomegramma	*Ernodea littoralis*	Rubiaceae	Shrub	Yes
09		*Eugenia* sp.	Myrtaceae	Shrub	Yes
09	Wild coffee	*Faramea occidentalis*	Rubiaceae	Shrub	Yes
09	Yam bush	*Gundlachia corymbosa*	Asteraceae	Shrub	Yes / RE / Vulnerable in A&B
09	Logwood	*Haematoxylum campechianum*	Leguminosae	Tree	No, invasive
09	Sage	*Lantana camara*	Verbenaceae	Shrub	Yes
09	Bread and cheese	*Mimosa ceratona*	Leguminosae-Mimosoideae	Tree	Yes / RE
09	Billbush	*Phyllanthus epiphyllanthus*	Euphorbiaceae	Shrub	Yes
09	Royen's tree cactus	*Pilocereus royeni*	Cactaceae	Cactus	Yes / RE / IUCN Red List - Least Concern
09	Loblolly	*Pisonia subcordata*	Nyctaginaceae	Tree	Yes / RE
09	Cattle tongue	*Pluchea carolinensis*	Asteraceae	Shrub	Yes
09	Boxwood	*Sideroxylon obovatum*	Sapotaceae	Tree	Yes / RE

Zone	Common name	Botanical name	Family	Life form	Native to Barbuda and/or Endemic (RE) and/or IUCN Red Listed and Level
09	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE
11	Buttonwood	*Conocarpus erectus*	Combretaceae	Tree	Yes / Protected under the EPMA 2019
11	White mangrove	*Laguncularia racemosa*	Combretaceae	Tree	No / Protected under the EPMA 2019
11	Red mangrove	*Rhizophora mangle*	Rhizophoraceae	Tree	Yes / Protected under the EPMA 2019
12	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
12	Torchwood	*Amyris elemifera*	Rutaceae	Tree	Yes / RE
12	Warri bush	*Casesalpinia bonduc*	Leguminosae-Caesalpinoideae	Shrub	Yes
12	Love vine	*Cassytha filiformis*	Lauraceae	Vine	Yes / pest
12	Sandbur	*Cenchrus spinifex*	Poaceae	Shrub	Yes / pest
12	Coco plum	*Chrysobalanus icaco*	Chrysobalanaceae	Tree	Yes
12	Seagrape	*Coccoloba uvifera*	Polygonaceae	Tree	Yes
12	Soap bush	*Colubrina arborescens*	Rhamnaceae	Shrub	Yes
12	Buttonwood	*Conocarpus erectus*	Combretaceae	Tree	Yes / Protected under the EPMA 2019
12	Maidenberry	*Crossopetalum rhacoma*	Celastraceae	Shrub	Yes
12	Wild pomegramma	*Ernodea littoralis*	Rubiaceae	Shrub	Yes
12	Yam bush	*Gundlachia corymbosa*	Asteraceae	Shrub	Yes / RE / Vulnerable in A&B
12	Dune sunflower	*Helianthus debilis*	Asteraceae	Shrub	No
12	Sage	*Lantana camara*	Verbenaceae	Shrub	Yes
12		*Scaevola sp.*	Goodeniaceae	Shrub	Yes
12	Dolly tomato	*Solanum racemosum*	Solaneceae	Shrub	Yes / RE
12	Bay cedar	*Suriana maritima*	Surianaceae	Shrub	No
12	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE
13	Bromeliads		Bromeliaceae	Herb	Yes / Protected under EPMA 2019
13	Alabamba	*Acacia macracantha*	Leguminosae	Tree	No, invasive
13	Torchwood	*Amyris elemifera*	Rutaceae	Tree	Yes / RE
13	Neem	*Azadirachta indica*	Malvaceae	Tree	No, invasive
13	Whitewood	*Bucida buceras*	Combretaceae	Tree	Yes
13	Clam cherry	*Byrsonima lucida*	Malpighiaceae	Shrub	Yes
13	Goat bush	*Castela erecta*	Simaroubaceae	Shrub	Yes
13	Broom	*Chamaecrista glandulosa*	Leguminosae-Caesalpinia	Shrub	Yes / RE
13	Wild grape	*Coccoloba krugii*	Polygonaceae	Tree	Yes
13	Pigeon plum	*Coccoloba swartzii*	Polygonaceae	Tree	Yes
13	Pick evil	*Comocladia dodenaea*	Anarcardiaceae	Shrub	Yes
13	Maidenberry	*Crossopetalum rhacoma*	Celastraceae	Shrub	Yes
13	Nail polish bush	*Croton flavens*	Euphorbiaceae	Shrub	Yes
13	Hop bush	*Dodonaea viscosa*	Sapindeceae	Shrub	Yes

Zone	Common name	Botanical name	Family	Life form	Native to Barbuda and/or Endemic (RE) and/or IUCN Red Listed and Level
13	Wild pomegramma	*Ernodea littoralis*	Rubiaceae	Shrub	Yes
13		*Eugenia* sp.	Myrtaceae	Shrub	Yes
13	Short leaf fig	*Ficus citrifolia*	Moraceae	Tree	Yes
13	Logwood	*Haematoxylum campechianum*	Leguminosae	Tree	No, invasive
13	Manchioneel	*Hippomane mancinella*	Euphorbiaceae	Tree	Yes
13		*Ipomea sp.*	Convolvulaceae	Vine	Yes
13	Ironwood	*Krugiodendron ferreum*	Portulaceceae	Shrub	Yes / Protected under EPMA 2019
13	Sage	*Lantana camara*	Verbenaceae	Shrub	Yes
13	Billbush	*Phyllanthus epiphyllanthus*	Euphorbiaceae	Shrub	Yes
13	Royen's tree cactus	*Pilocereus royeni*	Cactaceae	Cactus	Yes / RE / IUCN Red List - Least Concern
13	Ciliment	*Pimenta racemosa*	Myrtaceae	Tree	Yes
13	Loblolly	*Pisonia subcordata*	Nyctaginaceae	Tree	Yes / RE
13	Cattle tongue	*Pluchea carolinensis*	Asteraceae	Shrub	Yes
13	Mangrove berry	*Psiduim longipes* var. *orbiculare*	Myrtaceae	Shrub	Yes / RE / Vulnerable in A&B, Protected under the EPMA 2019 / IUCN Red List - Near Threatened
13	White cedar	*Tabebuia heterophylla*	Bignoniaceae	Tree	Yes / RE



5.4.2 Protected areas

Codrington Lagoon National Park (CLNP) was established in 2004 under the National Parks Act, 1984, (which was amended by the Barbuda Lands Act, 2007); with a total area of 25.8 sq. miles (66.8 km^2). The CLNP was added to the list of Wetlands of International Importance under the Ramsar Convention in 2005 with a surface area of 3,600 acres. The vegetation communities were mapped here by Putney in 2009 (Figure 5.19) and subsequently by Brosnan & Associates (L. Flynn et al 2018), who provided GIS-mapping, and to the Barbuda Council and GoAB. Areas of the Palmetto peninsula have been severely degraded by sand mining, dune cutting, and livestock trampling. Previous developments have occurred on Palmetto Point (Beach Club Resort) on the sand spit (Lighthouse Resort), and 100 acres of the peninsula (Oyster Pond), was due to be developed (with lots on the market). Since 2018, Palmetto peninsula has seen major development, including a coastal golf course.

The CLNP and Ramsar overlap with the western end of the proposed development site, to the west of Martello Tower. This encompasses approximately 58 acres (0.23 km^2) of the total 160 acres dedicated to this development. This area has already been subjected to human activity, including in the form of sand mining on the Palmetto peninsula. Vegetation surveys of this area were completed in Zones 1-4 (Figure 5.17, Section 5.4.1), and showed that plant communities were comprised of primary colonizers and fast-growing species consistent with a disturbed environment.

Under the Ramsar Convention, Antigua and Barbuda is obliged to promote the conservation of wetlands, formulate and implement their plans to promote their conservation, and notify the Ramsar Secretariat of any changes to the character of the wetland. The Rosewood Barbuda Resort development has committed to place wetland conservation as a central feature of their resort, preserving the existing wetlands. The planned constructed wetlands will enhance the naturally existing wetlands on the site, which are relatively small and can dry out during drought periods.

The Ramsar and CLNP also include the beach and sand dune areas highlighted in vegetation survey zones 3 and 4 (Figure 5.17). In the original master planning, dunes are being protected by the increased setbacks of 60 m from the line of permanent vegetation. It was recommended that the dune height be a height of 4 m to protect the stability of the beach and the property itself from storm surge. These dunes should be planted with native plant species. Additional hydrodynamic studies which have just been completed have not yet been incorporated into this assessment.

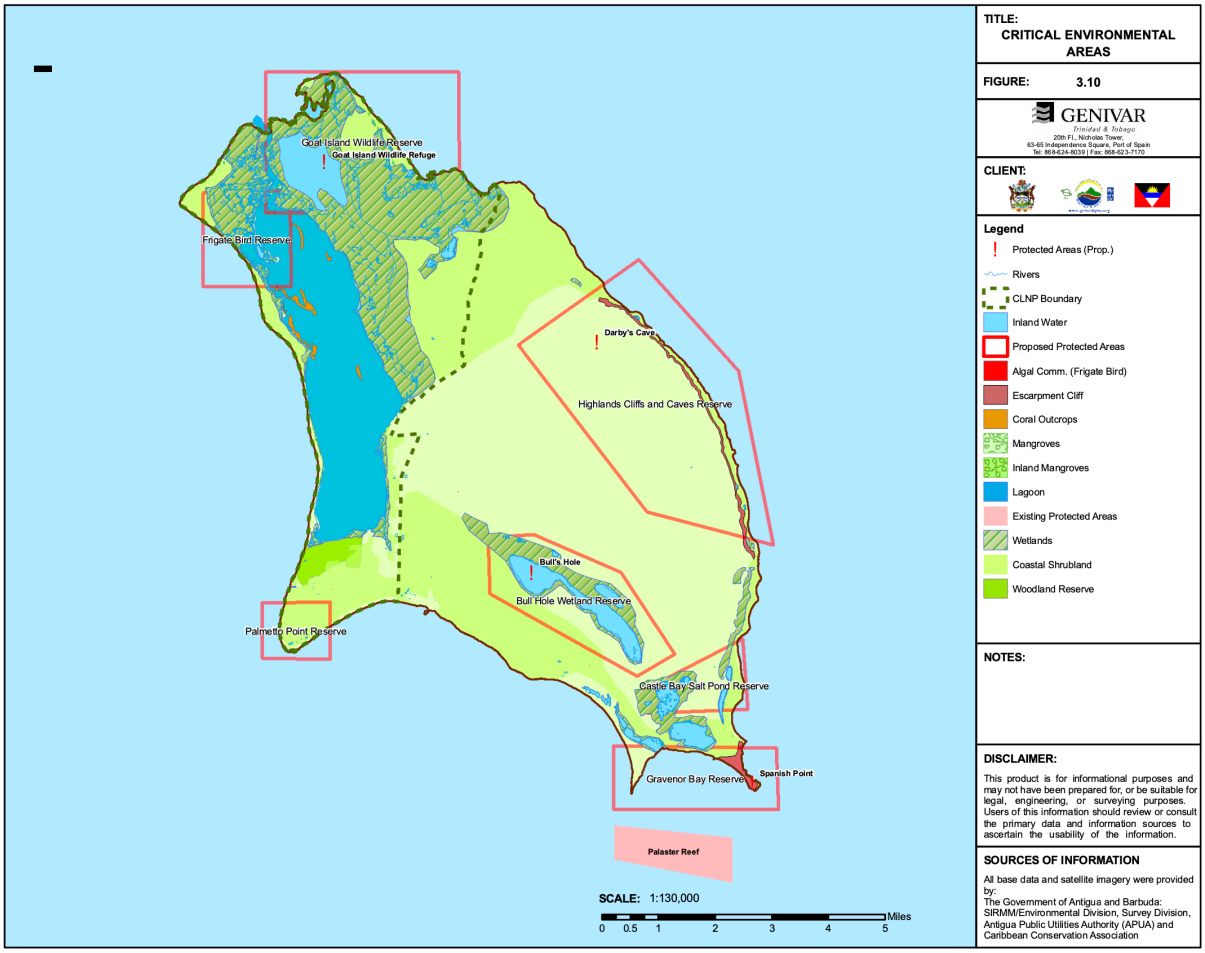


Figure 5.18: Critical environmental areas identified by the SIRMZP (2011)

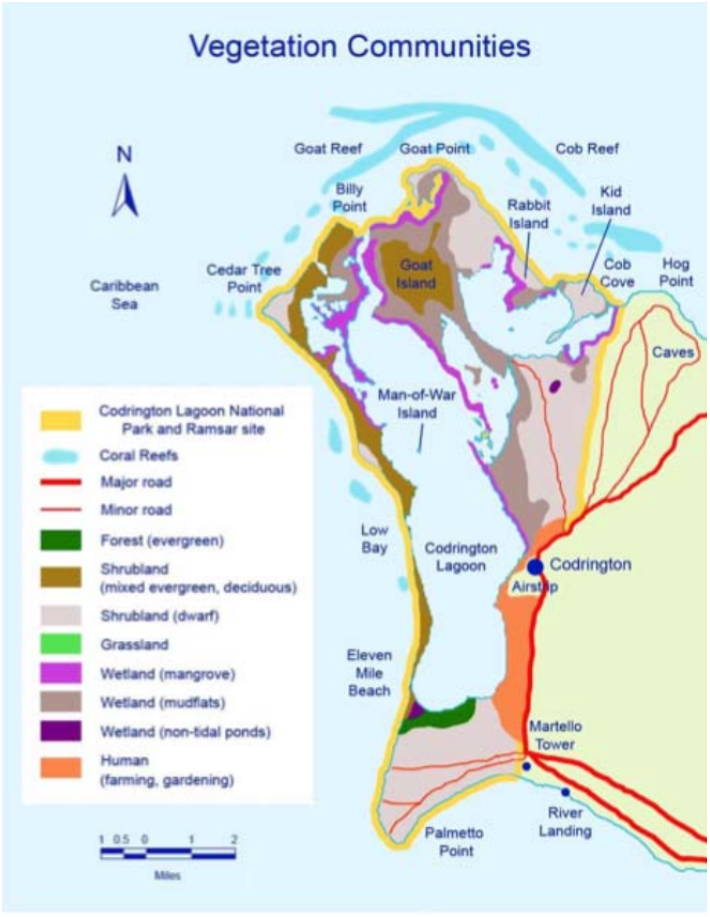


Figure 5.19: Diagram showing Vegetation Communities for Codrington Lagoon National Park

5.4.3 Integrated Constructed Wetlands and Mangroves

5.4.3.1 Role of integrated constructed wetlands

In wetland areas, water is the primary factor controlling the environment and the associated plant and animal life. The Ramsar definition of wetlands refers to “areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres”. Mangrove ecosystems are a specific type of tropical estuarine wetland. The hydrology of wetlands is generally represented by slow flows and either shallow waters or saturated substrates.

Wetlands provide several functions and values:

1. Water purification: physical, chemical, and biological processes combine to remove contaminants from wastewater as the water passes through the wetland system. This removal occurs via several processes. Aerobic and anaerobic microorganisms facilitate the decomposition of organic matter. The microbial nitrogen cycle releases nitrogen into the air as nitrogen gas. Phosphorous ions are combined with iron, aluminium and calcium compounds in the root bed substrate. Excess nutrients in runoff

are associated with algal blooms and eutrophication of coastal waters, which can negatively impact marine ecosystems.

- Nitrogen removal – primarily removed via anoxic metabolism deeper in the wetland.
- Phosphorous removal – predominantly takes place in the substrate.
- Suspended solids – these settle out of the water as the rate of flow slows down. This is important to prevent blockage of channels, but flow should be monitored to ensure it is maintained and the system does not stagnate.

2. Shoreline stabilization – wetlands along the shorelines of lakes, rivers and the ocean help protect shoreline soils and substrates from erosion by forces from waves and currents. Plants in wetlands act as a buffer by dissipating the water's energy and providing stability to the substrate via their root systems.

3. Groundwater recharge and runoff control – aquifers and groundwater are recharged by surface water or rainwater that seeps into the ground. Wetlands retain water and allow time for it to filter into aquifers, rather than water settling on impermeable surfaces (e.g. clays, roads) or running off into the sea.

4. Flood protection – Wetlands hold excess water after storms and then release it slowly, which reduces flooding in nearby areas. The size, shape, location, and soil type of the wetland determines its ability in this role. Wetlands slow the velocity of major runoff and reduce erosion from floods.

5. Fish and wildlife habitat – wetlands are a haven for many species of birds, fish, mammals, reptiles, and amphibians for breeding, foraging and shelter. Migratory birds rely on wetlands, and many endangered and threatened animal species utilize wetlands during their life cycles. Wetland plants, algae and insects are essential links in the base of the food chain, and their abundance can impact populations of larger, more distinctive animals and birds.

6. Economic benefits – the topics addressed in points 1-5 all contribute to the economic benefits associated with wetlands. For example, if other man-made methods of flood control or water treatment systems had to be built, the construction and maintenance costs often outweigh the costs of maintaining a healthy wetland. Additionally, wetlands play an important role as fish nurseries and habitats, which cannot be replaced by other methods and have important implications for fishing industries. Additionally, mangrove wetlands have high primary production and act as carbon sinks, sequestering up to 4 times more carbon than tropical rainforests. Layers of organic matter are stored within their substrates. Overall, there is no precise formula to determine the dollar value per acre of wetlands. The estimated recreational benefits of constructed wetlands have ranged between $580 to $9,160 USD per hectare.

5.4.3.2 Introduction to Integrated Constructed Wetlands

Constructed wetlands are comprised of an engineered series of water bodies designed to control storm water runoff and treat wastewater. They are managed systems that are designed to mimic the soil, flora, and microorganisms in natural wetlands. An integrated constructed wetland includes restoration and maintains a hydrological connection to water bodies other than the source (i.e. groundwater, the sea), connection to nearby ecosystems, and adaptive succession. The vegetation in natural and constructed wetlands provides a substrate for the growth of microorganisms, which then break down organic material. These microorganisms

are responsible for approximately 90% of the removal of pollutants and waste breakdown in the system via their natural chemical processes. The remaining 7-10% of pollutants are removed by the plants themselves and also act as a carbon source when they die and decay. Different species of wetland plants have different rates of pollutant uptake and species composition should be considered in the design of a constructed wetland.

The costs associated with constructed wetlands are considerably lower than those of conventional wastewater treatment systems as capital costs are generally lower, and they are self-sustaining over their lifetime. The main constraint is space, which may be restrictive when real estate costs are high.

Table 5.8: Primary functions of each type of constructed wetland

Constructed wetland type	Description	Primary pollution removal	Advantages	Disadvantages
Horizontal subsurface flow	Water level is below the surface. Water flows horizontally across the wetland pond	High reduction in BOD, suspended solids, and pathogens. Provides mainly denitrification.	Reduced smell, insect vectors due to subsurface water level.	Controlled point source of water; requires active pumping
Vertical subsurface flow	Water level is below the surface. Water flows vertically through the wetland pond. Can be enhanced using vertical baffles to force water into sinusoidal flow	High reduction in BOD, suspended solids, and pathogens. Provides mainly nitrification.	Reduced smell, insect vectors due to subsurface water level.	Controlled point source of water
Free water surface flow	Wetland systems where the water surface is exposed. Includes most natural wetlands.	High removals of suspended solids Moderate removal of pathogens, nutrients, and other pollutants such as heavy metals.	Effective treatment in a passive manner. Reliably remove BOD, Chemical Oxygen Demand (COD), and TSS.	Potential smell and insect vectors if not managed correctly. Larger land area than subsurface flow wetlands required. P and metals filtered by substrate may accumulate over time.
Hybrid / Inegrated constructed wetlands		Increased performance due to a combination of different methods (e.g. vertical flow to horizontal flow)	Combination of SSF and FWS	Combination of SSF and FWS

Constructed Wetland Type 1: Sub-Surface Flow

There are two broad types of constructed wetlands: surface flow and subsurface flow wetlands. In subsurface flow wetlands, the flow of wastewater occurs between the roots of plants and the water level is kept below gravel or other substrate so there is no exposed surface water. There are different types of subsurface flow designs that direct water in specific ways. These wetlands are relatively efficient and require 1.5 to 3 m^2 surface area per person in serviced areas, but also require active pumping of water through the treatment beds. The source of wastewater is generally one or more point sources from primary treatment plants. The water level should be maintained at least 2.5 cm below the planting layer to facilitate efficient oxygen transfer for aerobic chemical processes.

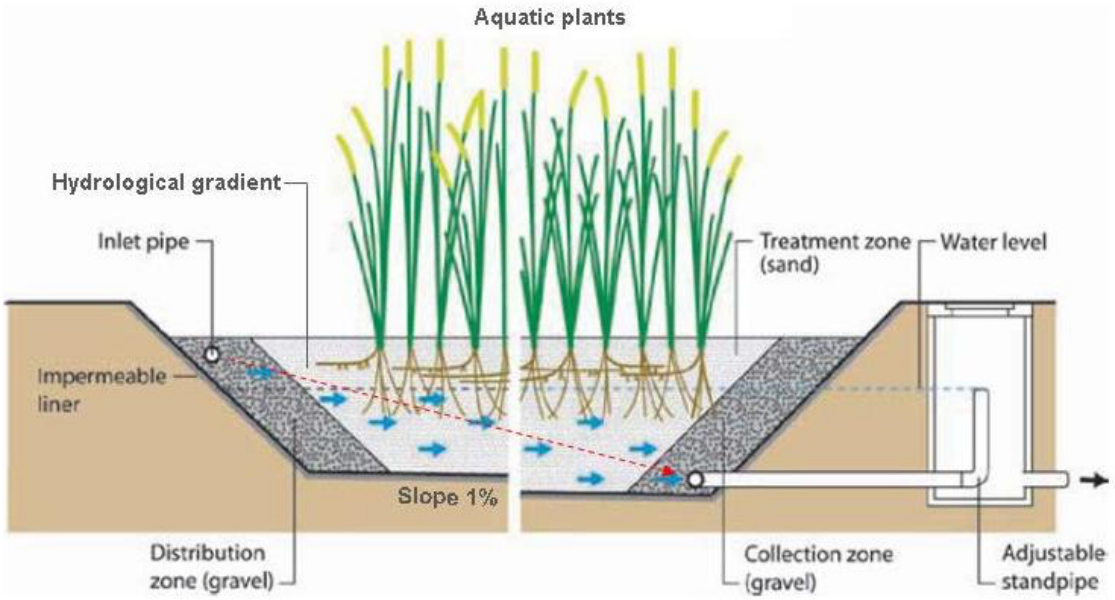


Figure 5.20: Horizontal flow subsurface wetland

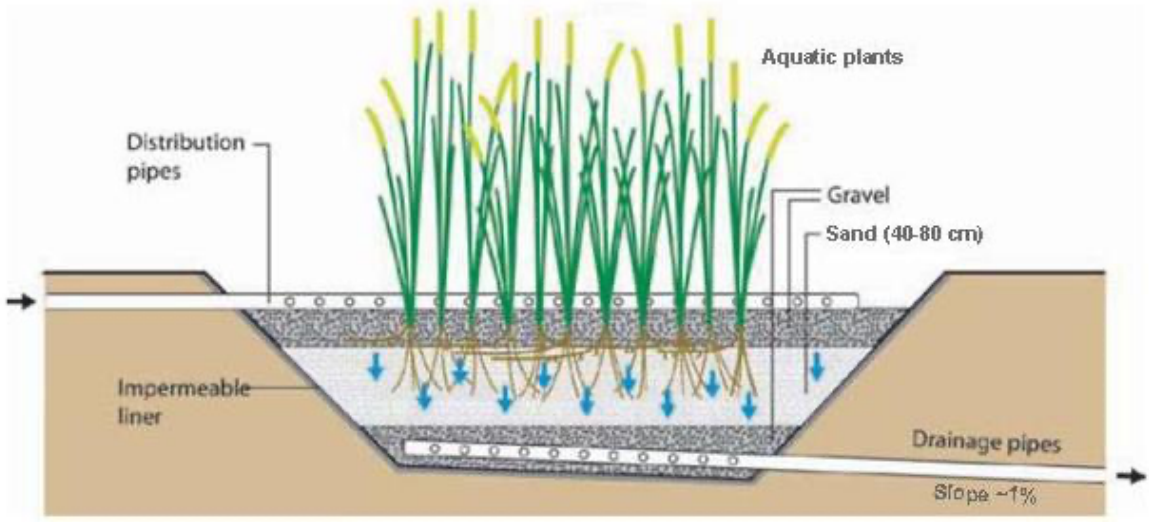


Figure 5.21: Vertical flow subsurface wetland

An experimental study by Leung et al. (2016) compared the efficiency of mangrove plants (*Aegiceras corniculatum* and *Bruguiera gymnorrhiza*) and non-mangrove plants

(*Acorus calamus, Canna indica,* and *Phragmites australis*) for treating toxic wastewater, including nutrients (TOC, TKN, TP, NH4+ and NO3 −) and toxic pollutants (heavy metals, PAHs and phenol). After 6 months, mangrove plants remained healthy, while non-mangrove plants were impaired. Both types of plants aided in the removal of nitrogenous compounds, but mangrove plants (particularly *A. corniculatum*) were more efficient. Pollutants were mostly absorbed into the sediment. Tidal flushing was important to facilitate the removal of nutrients and prevent the production of NO3-. Hydraulic retention time in this study was 10.6-12 hours.

Another experimental study by Wu et al. (2008) examined the role of mangroves (*Kandelia candel*) and hydraulic retention time (HRT) on nutrient removal. Removal of all nutrients was higher in the planted systems rather than unplanted systems. HRT of 10 days had better removal than HRT of 5 days.

An example from Akumal, Mexico (Whitney et al., 2002) highlights the potential issues when proper maintenance does not occur. Two subsurface-constructed wetlands were installed in 1996 with a total area of 81.2 m^2, designed to service 24 people. In 1998, Nelson 1998 found that the wetlands had a diverse ecosystem containing more than 54 tropical plant species, an 85% reduction in the BOD, a 75% reduction in both nitrogen and phosphorus, a 99% reduction in coliform bacteria, and a 40% reduction in suspended solids. The wetland, at the time of evaluation, was operating at about 21% of its design flow. No maintenance was completed between 1998 and 2001. By 2001, the wastewater flow into the wetland had increased by 300% (from 0.76 m^3/day to 2.27 m^3/day). Plant biodiversity had decreased to 20 species, and root penetration was confined to the top 15 cm of substrate. This root mat limited oxygen transfer and resulted in anaerobic conditions in the deeper substrate. This all resulted in limited nitrification and reabsorption of other nutrients.

Constructed Wetland Type 2: Surface Flow

Surface flow or free water surface wetlands are characterized by the horizontal flow of wastewater across the roots of plants in a series of flooded planted channels and basins. They are better suited to stormwater drainage from a non-point source but require a relatively large area to purify water in comparison to subsurface flow wetlands. They rely on algal mats and macrophytes for water purification. The advantages of a free water flow system include biological habitat creation, aesthetically pleasing, high reduction of biological oxygen demand and suspended solids, moderate pathogen removal, relatively easy to build with locally available materials, no electrical energy required, no major odors if designed and maintained correctly, no chemical treatments required, low operating costs, and they can be combined with aquaculture and agriculture. Some challenges and disadvantages include the potential for mosquito breeding, the requirement of a relatively large land area, long start up time to work at full capacity, require expert design and construction, and require some supervision and maintenance.

An integrated constructed flow wetland is an unlined free surface flow constructed wetland with vegetated areas and local soil material. These may be more robust than other constructed wetlands as they have greater biological complexity and generally relatively larger land use area, which is associated with longer hydraulic residence time.

The catchment area of a free water surface constructed wetland should be large enough to ensure effective operation and counter the risk of drying out in prolonged dry periods. Generally, the surface area should be 1-5% of the catchment area.

There is no consistent vegetation species that is more effective than another. The most common applications utilize native species, and the most studies have included *Typha latifolia, Phragmites australis, Typha angustifolia, Juncus effusus, Scirpus lacustris, Scirpus californicus and Phalaris arundinacea.*

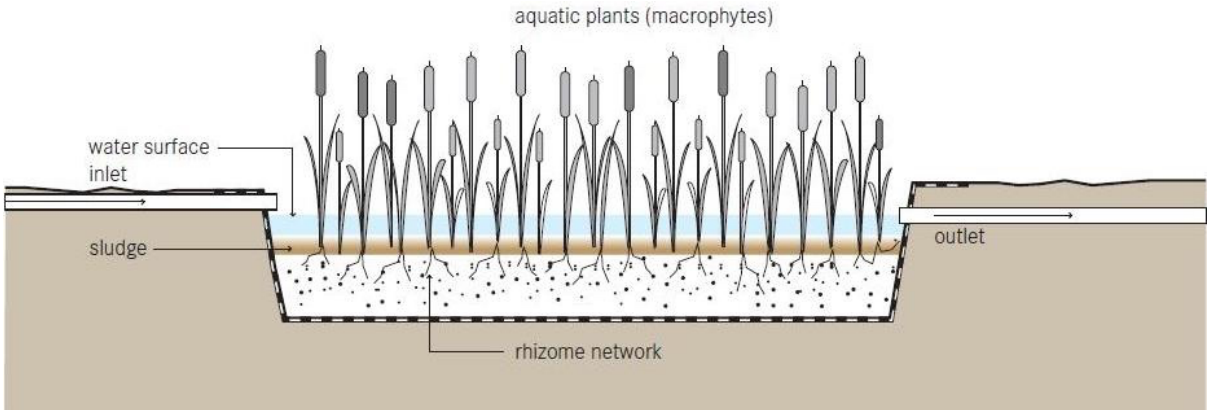


Figure 5.22: Free water surface flow wetland

In an example from Leece in Southern Italy (Semeraro et al., 2015), a free water surface wetland was used to refine effluent water from a sewage-based treatment plant, processing pollution from ~41,000 residents. The plant contains 6 reservoirs covering 5.1 ha. Reservoir depth is 20-70 cm and surface area ranged between 4.2-10.4 m^2. Hydraulic retention time for the flow rate of 2,530 m^3/day is reported to be 14 days, while for the maximum capacity of 4,370 m^3/day was approximately 8 days. Overall biodiversity was significantly higher than surrounding areas after 4 years of operation (2009-2013).

A natural example of a mangrove wetland and a newly planted mangrove-constructed wetland in Thailand were compared by Boonsong et al (2003). The natural wetland occupies ~167,582 ha and the most important species are *Rhizophora apiculata*, *R. mucronata, Bruguiera gymnorrhiza, B. cylindrica, B. parviphora, Ceriops decandra,* and *C. tagal*. The CW was planted with these same species. Overall, the CW produced similar results to the natural wetland. The authors recommended implementing ways to enhance water and substrate aeration to increase available oxygen.

In an example from Tampa Bay, Florida, USA, (Osland et al., 2012), 20 years of mangrove and salt marsh restoration and creation efforts were assessed to determine their functional equivalence with mature, undisturbed wetlands. They showed that vegetation transitioned from the planted herbaceous layer dominated by *S. alterniflora*, to a mangrove forest dominated by *Rhizophora mangle*, *Laguncularia racemosa*, and/or *Avicennia germinan*. Vegetation density is presented in the figure below. Younger wetlands had an herbaceous layer of salt marsh plants, which is thought to aid in mangrove recruitment, while mature (13+ years) wetlands did not. Soil properties differed on all metrics between constructed and natural wetlands. Soil carbon and nitrogen increased over time. Similarly, created wetlands had higher porewater temperature and pH relative to natural wetlands, but there was no effect of time.

5.4.3.3 The role of integrated constructed wetlands for Rosewood Barbuda Resort

The wetland system was envisioned by the science team and discussed with the (then) master plan team, drainage engineers, and development team. The envisioned design will be an integrated free water surface system, where the primary water source will be surface runoff from the Barbuda Highlands. The general approach and recommendations are provided here. However, the hydrology and flow rate studies need to be completed and the exact species planting pattern established. In addition, at the time of writing, CM&D had recently replaced the master planning team and certain features are still under consideration. In summary, the Rosewood Barbuda development is committed to protecting the existing wetlands and enhancing the wetland area through integrated constructed wetlands, but the specific details of the plan and method remain to be finalized.

In Barbuda, potable groundwater occurs in sub-surface lenses that float above saline groundwater. These are recharged by rainfall and this water generally moves to be discharged at the coastline and swamp boundaries, which are both environments in the proposed development. Mather (1971) indicated that these freshwater lenses are found beneath most of the island, including the proposed development area. The development area is also known to experience severe flooding after rainfall. Annual rainfall in Barbuda is 750-900 mm. Drought periods are critical to water availability on the island, and 10 drought periods, with annual rainfall <705 mm, were reported between 1965 and 2000. In these periods, the groundwater has become more saline.

The water catchment area of the Barbuda Highlands is approximately 21.47 km^2. The total area of proposed constructed wetlands in the development is 0.42 km^2, which equates to approximately 2% of the total catchment area.

Table 5.9: Measured proposed wetland areas

	Area (km^2)	Perimeter (m)
Barbuda Highlands water	21.47	
Wetland 1	0.40	2,100
Wetland 2	0.02	650

The proposed constructed wetlands will occupy existing low-lying wetland areas with mangrove communities. Mangrove plants have a high demand for nutrients, and many mangrove habitats struggle with nutrient deficiencies. Mangrove plants are also able to withstand environmental stresses, including high salinity, waterlogging, alternating aerobic and anaerobic conditions, and unstable substratum. Their extensive root systems create significant aerobic zones in the rhizosphere for oxidation and harbour diverse microorganism communities that play essential roles in nutrient transformation.

During the initial stages, low-level marsh species should also be planted to stabilize the substrate until mangrove trees mature. These marsh plants have been shown to contribute to the colonization of mangrove trees.



Figure 5.23: Existing wetland areas on the development site



Figure 5.24: Map of the development area indicating the two wetlands. Their relative surface areas and perimeters are displayed in Table 5.9.

5.4.3.4 Design considerations

The optimal constructed wetland design for this development is likely to be a mangrove-dominated free-water flow wetland. This concept is not a constructed wetland per se but also a restored wetland, termed an integrated constructed wetland. This maintains a hydrological connection to water bodies other than the source (i.e. groundwater, the sea), connection to nearby ecosystems, and adaptive succession. This will be achieved by expanding the existing wetlands and connections to groundwater. Overall, there is less initial construction intervention and the overall focus is on natural processes.

Pre-treatment of any wastewater should occur to remove garbage and solid materials. This includes runoff from drains. This may be particularly important during the construction phase when there will be larger amounts of solid waste. Any pre-treated runoff can be directed to the system as appropriate.

In the event of extreme drought, additional inputs to the system may be required to maintain the health of the wetland ecosystem. This may include the diversion of greywater from the development.

To create an optimized free surface flow constructed wetland, we need to determine the volume of water entering the system. Ideally, the hydraulic retention rate (HRT) should be optimized to approximately 8 to 14 days before it is removed via outflow, evaporation or evapotranspiration. Optimally, the channel or basins are lined with an impermeable barrier (clay or geo-textile) covered with rocks, gavel, and soil and planted with native vegetation. The optimal depth for nutrient filtration is 10 to 45 cm, however areas of the ponds may be deeper.

The basin edges should be scalloped where possible to increase the perimeter, and they should be planted advantageously with native plants, including emergent, submerged, and floating plants. Free flow surface systems can be aesthetically pleasing when integrated with pre-existing wetland areas. There should be natural transition zones around the edge of the wetlands to include wildlife corridors and open space.



Figure 5.25: Scalloped edge of a constructed wetland pond, where coconut trees are planted on the fingers (outlined in red) and aquatic areas between the fingers are planted with reeds.

Once in the pond, the wastewater flows slowly through the basin and heavier particles settle, also removing nutrients that are attached to the particles. Plants and the communities of microorganisms that they support (on the stems and roots), take up nutrients like nitrogen and phosphorus. Chemical reactions may cause other elements to precipitate out of the wastewater. Pathogens are removed from the water by natural decay, predation from higher organisms, sedimentation, and natural UV irradiation (sunlight). Although the soil layer below

the water is anaerobic, the plant roots release oxygen into the area immediately surrounding the root hairs, thus creating an environment for complex biological and chemical activity.

Activity in a free water surface flow wetland can be enhanced through natural methods, such as wind and temperature cells, as well as artificial methods, such as artificial aeration, pH buffering and bio-augmentation.

5.4.3.5 Potential risks and how to avoid them

There are several challenges and risks associated with the design of surface flow wetlands:

- Water stagnation and odors – The proper design of pond systems will ensure water flow throughout the system. The consistent flow will minimize the production of NO^{3-} gas, which is the primary contributor to odors.
- Mosquito breeding – This is reduced and limited by maintaining consistent water flow and with no stagnation. Fish and other brackish water organisms living in the system will eat any mosquito larvae. Bats can also be used to control mosquitoes, and dedicated bat nesting areas can be included nearby.
- Drought – Maintenance of the wetland in times of low rainfall needs to be considered and will be addressed in the planning phase

5.4.3.6 Operation and Maintenance

To maintain the efficiency of the managed wetland system, ongoing maintenance may be required. In general, these requirements are simple for free surface flow wetlands and typically require no high-tech appliances or chemical additives.

Regular maintenance should ensure that water is not short-circuiting or backing up because of fallen branches or garbage blocking the wetland outlet. Vegetation may have to be periodically cut back or thinned out. If improperly maintained, systems may have problems with clogging and unintended surface flows. The water surface may need to be cleaned in areas where solids and floating substances have accumulated.

Pre-treatment facilities (drainage pipes, septic tanks) may require additional maintenance. The filter bed of the constructed wetland may also be changed sometimes, approximately every 8-15 years. The old material, full of earth and organic matter, may be directly used as soil amendment or composted first, like a planted drying bed.

It is important to ensure that the wetland design allows maintenance vehicles and personnel to safely access each pond with minimal disturbance.

Management effort can extend the useful life of an integrated constructed wetland.

5.4.3.7 Performance evaluations

If there are any issues with the functioning of the wetland system, it is critical to diagnose them as soon as possible. As such, regular assessment of the following performance metrics will be performed:

- **Water quality metrics** including nitrate, phosphate, salinity, pH, oxygen, biological oxygen demand, temperature, turbidity, Enterococci, and fecal coliform

- **Soil quality metrics** including soil depth, soil organic carbon (SOC), pH, total soil porosity

- **Species richness and abundance surveys** are expected to increase as the wetland community matures.

The final design options for integrated constructed wetlands are currently being developed by the ecological team in conjunction with the Master Planning Team and hydrological engineers. They will be submitted to DCA and DoE.

5.4.4 Threatened and endangered species

Four endangered sea turtle species are found in Antigua and Barbuda. No recent nesting activity has been reported either by members of the local community or WideCast (2019). However, sea turtles (endangered hawksbill species) were observed in the water and on seagrass in front of the proposed development by members of the science team during initial pre-survey assessments.

Ongoing sea turtle monitoring by the Barbuda Sea Turtle Team has documented nesting activity closer to the Palmetto Point. Sea turtles require specific conditions and vegetation for nesting. These are present at the center and western side of the development site indicating potential for nesting activity in the area. These ecological conditions must be maintained throughout the development. Additionally nesting females and hatchlings can be disturbed by noise or attracted by bright lights, resulting in disorientation. Any nesting activity should be recorded.

5.4.5 Birds

Five bird surveys were completed within the Rosewood Barbuda site by Barbudan Calvin Gore on April 15, 16, 17, 18, and 26, 2024. Across these surveys, 185 individual birds of 23 species were recorded (Table 5.10). Of these, 7 species are protected under the EMPA (2019), specifically Barbuda warbler (*Dendroica subita*) which is also regionally endemic and Near Threatened on the IUCN Red List, Antillean crested hummingbird (*Orthorhyncus cristatus*), Least tern (*Sternula antillarum*), Lesser Antillean flycatcher (*Myiarchus oberi*), Magnificent frigate bird (Fregata magnificens), Mangrove cuckoo (*Coccyzus* minor), and White crowned pigeon (*Columba leucocephala*) (Figure 5.26). Additionally, the Ruddy turnstone (*Arenaria interpres*) is listed as Near Threatened on the IUCN Red List.

The Barbuda warbler is endemic to Barbuda (Figure 5.26 a). Its natural habitat is tropical dry shrubland. In 2017, the population is estimated at between 1,000-25,000 but exact details of populations and distributions are largely unknown.

The Ruddy turnstone is a migratory coastal and wetland bird species (Figure 5.26 b). Antigua falls within its non-breeding geographical range. Similar migratory birds can benefit greatly from wetland habitats, such as that proposed at the center of this development, as it provides crucial food, rest, and shelter during their long journeys.

The White-crowned pigeon is a species primarily found in the Caribbean (Figure 5.26 c). It is listed as Near Threatened by the IUCN Red List, and this status is primarily due to habitat

loss. It requires separate nesting and feeding habitats and typically breeds in red mangrove forests. The planned wetlands in the Rosewood Barbuda development can provide essential habitat for this protected species in an area where it is already present.

As its name suggests, the Lesser Antillean flycatcher is endemic to the Lesser Antilles region of the Caribbean (Figure 5.26 d). Its natural habitat is subtropical or tropical moist lowland forests.

In these surveys, 90% of the sightings were visual, while the remaining 10% were by flyover. No sightings were aural. Across all surveys, the sky condition code ranged from 0-2, and the most sightings (57%) occurred under sky code 2. Sky condition code 0 indicated clear sky or few clouds, condition code 1 indicates partly cloudy or variable sky conditions, and condition code 2 indicates cloudy or overcast conditions. Wind speed ranged between condition codes 1-3, which represent wind speeds of 1-12 mph (2-19 kph), but there was no clear pattern in sightings related to wind code.

Codrington Lagoon is one of the primary nesting colonies of Magnificent frigate birds (*Frigata magnificent*) in the West Indies, with over 10,000 birds. The birds now frequent the created wetlands on the Palmetto peninsula and can be expected to utilize the integrated constructed wetlands on this development.



Figure 5.26: (a) Barbuda warbler (by Josh Noseworthy), (b) Ruddy turnstone with non-breeding plumage (By Charles J. Sharp), (c) White crowned pigeon, and (d) a Lesser Antillean flycatcher.

Table 5.10: List of bird species recorded in April 2024

Common name	Scientific name	Count	Conservation status
American kestrel	*Falco sparverius*	2	
Antillean crested hummingbird	*Orthorhyncus cristatus*	3	Protected under EMPA (2019)
Bananaquit	*Coereba flaveola*	15	
Barbuda warbler	*Dendroica subita*	3	IUCN Red List - Near Threatened, Protected under EMPA (2019), nationally endemic
Black faced grassquit	*Tiaris bicolor*	40	
Brown pelican	*Pelecanus occidentalis*	3	
Carib grackle	*Quiscalus lugubris*	4	
Caribbean elaenia	*Elaenia martinica*	11	
Common ground dove	*Columbina passerina*	25	
Gray kingbird	*Tyrannus dominicensis*	7	
Helmeted guinea fowl	*Numida meleagris*	5	
Laughing gull	*Larus atricilla*	12	
Least tern	*Sternula antillarum*	5	Protected under EMPA (2019)
Lesser antillean bullfinch	*Loxigilla noctis*	2	
Lesser antillean flycatcher	*Myiarchus oberi*	5	Protected under EMPA (2019)
Magnificent frigate bird	*Fregata magnificens*	1	Protected under EMPA (2019)
Mangrove cuckoo	*Coccyzus minor*	1	Protected under EMPA (2019)
Pearly-eyed thrasher	*Margarops fuscatus*	2	
Ruddy turnstone	*Arenaria interpres*	2	IUCN Red List - Near Threatened
White crowned pigeon	*Columba leucocephala*	11	IUCN Red List - Near Threatened, Protected under EMPA (2019)
White winged dove	*Zenaida asiatica*	17	
Yellow warbler	*Setophaga petechia*	4	
Zenaida dove	*Zenaida aurita*	5	

5.4.6 Coral reefs and sensitive marine habitats

Coral reefs form complex and highly productive ecosystems that provide critical habitat for many near-shore and commercially important species. They are composed of combinations of stony corals, which are the most important for reef growth, as well as soft corals, anemones, and sea fans. They also provide natural protection of shorelines from storm surge and wave energy and provide the sand and coral fragments found on beaches. They are essential to fisheries, and play a large role in recreation and tourism, particularly in scuba diving and snorkelling.

Seagrass grows in shallow protected areas where currents are relatively gentle, wave action is low, and the sea floor sediment is appropriate. Seagrass ecosystems are highly productive, absorbing and storing large quantities of carbon. They prevent coastal erosion by stabilizing sediments with their root systems, provide essential nursery habitats for juveniles of

commercially important fish species, and they absorb nitrogen from the water column, which reduces coastal eutrophication and the risk of harmful algae blooms.

Both coral reef and seagrass habitats are in decline globally due to anthropogenic, climate-change, and environmental stressors, including coastal pollution, physical damage from boating activities and hurricanes, and sediment loading from stormwater runoff. High water temperatures have led to widespread coral bleaching and mortality in 2023 and 2024.

Coral reefs and seagrass ecosystems are at risk from development. We discuss mitigation recommendations in Sections 6.0 and 8.3 to reduce any potential negative impacts on these habitats. Although the development area is not classified as a critical environmental area under SIRZMP (2011), it is immediately adjacent to the Codrington Lagoon National Park (CLNP) Ramsar site, and the waters in front of and adjacent to the development contain critical coral reef and seagrass habitat. Under the Physical Planning Act (2003 rev. 2024), coral reef and seagrass ecosystem habitat function must be maintained during any development. Their conservation greatly benefits the Rosewood Barbuda development and the Barbuda community because of the range of services these ecosystems provide.

Marine surveys were completed by the Deborah Brosnan & Associates science team on May 5-6, 2024. 18 survey sites were identified using Google Earth to cover the nearshore area spanning the length of the proposed development site and extending to approximately 500 m offshore. The locations of the sites are shown in Figure 5.27. At each site, a 30 m transect was laid in a southwest direction. Along the transect, all species (benthic, fish and other organisms) were identified on 0.5 m on each side of the transect for a total 1 m width by 30 m long.

The marine surveys (results below) identified a distinct coral reef area directly in front of the proposed development and close to shore. There are few living stony corals on the reefs but there is a good diversity of other marine life. Coral reef structures are vital for biodiversity, habitats, fisheries, tourism among other ecosystem services. The ecological team recommends that these reefs be actively protected and monitored by the development and that coral gardens be established that can be stewarded by trained local members of the community. These can also become a key positive and unique environmental feature of the Rosewood Barbuda brand along with the mangrove lagoons.



Figure 5.27: Locations of the 18 marine survey sites.

5.4.6.1 Benthic composition

The survey area is characterized by relatively small patch reefs of approximately 1-50 m in length that are surrounded by seagrass and sand.

All benthic substrate composition was recorded based on distance. During the analysis, benthic data was classified into the following 9 broad categories, which were used to calculate percentage cover:

1. Healthy seagrass (Figure 5.28, Figure 5.29)
2. Octocorals (Figure 5.36 a)
3. Patch reef (Figure 5.33)
4. Rocky hard bottom (Figure 5.32)
5. Sand (Figure 5.35)
6. Seagrass and cyanobacteria
7. Seagrass, cyanobacteria, and macroalgae
8. Seagrass and macroalgae (Figure 5.30, Figure 5.31)
9. Silty mud (Figure 5.34)

Seagrass

The percentage cover of each of these categories at the 18 sites surveyed is shown in Figure 5.38. Across the 18 survey sites, the most common benthic types in the area surveyed are patch reef (11 sites) and seagrass (15 sites). Seagrass was subdivided into 4 categories: healthy seagrass without any other benthic groups present (8 sites) (Figure 5.28, Figure 5.29), mixed seagrass and macroalgae (7 sites) (Figure 5.30, Figure 5.31), seagrass overgrown with cyanobacteria (1 site) and mixed seagrass and macroalgae overgrown with cyanobacteria (1 site).

The three species of seagrass present were *Thalassia testudinum* (Turtle grass), *Syringodium filiforme* (Manatee grass), and *Halodule wrightii* (Shoal grass). The invasive species *Halophila decipiens* (Paddle grass) is also present in Barbuda but was not recorded in these surveys.

Patch reefs

The patch reefs were comprised of old reef structures predominantly overgrown with macroalgae. This is characteristic of Caribbean reefs, where macroalgae commonly covers 50-90% of the benthos. Sections of the old reef structure were prominently characterized by old *Acropora palmata* skeletons. No living or recently-dead *A. palmata* colonies were observed.

16 stony coral species were recorded across the site (Table 5.11). The most common species were *S. siderea (*Massive starlet coral) and *P. astreoides* (Mustard hill coral), which were both recorded at 12 of the 18 sites. This was followed by *P. porites* (Finger coral), which was found at 11 sites and *S. radians*, which was recorded at 9 sites. All other coral species were recorded at between 1 and 5 sites. *P. astreoides* was the only coral species that exhibited signs of coral bleaching, while none of the other species showed signs of recent bleaching or death.

Octocorals (corals that typically do not build reefs e.g., sea fans) were recorded at 11 sites, and these were comprised of sea fans (4 sites) and all other octocorals (10 sites) species.

Algae

Algae is the predominant benthic cover on the patch reefs, specifically, macroalgae and crustose coralline algae, and macroalgae commonly interspersed the seagrass at many of the survey sites, as shown in Figure 5.30, Figure 5.35 and Figure 5.37. Seven macroalgae genera and species were recorded, most notably: *Amphiroa* sp., *Caulerpa* sp., *Dictyota* sp. (Y-branched algae), *Halimeda* sp., *Udotea* sp. (Mermaid fan algae), *Padina* sp. (White scroll algae), and puff ball algas.

Crustose coralline algae were also prevalent on the patch reefs. They have been shown to facilitate the recruitment and growth of juvenile corals (Jorissen et al., 2021). This correlation was observed on the rocky hard bottom at M13, where the predominant benthic cover comprised crustose coralline algae, and several coral recruits less than 5 cm in diameter were documented. This site was particularly shallow (0.5-1 m deep) and formed a shoal. It is likely the increased wave action resulted in lower macroalgae growth than on the other reef sites. Although more corals were able to colonize here, their future growth will be limited by the depth of the water and wave action, while in deeper areas where corals may grow to larger sizes, they are outcompeted by macroalgae.

Human impacts

This coastal zone is highly impacted by human activities due to its proximity to the current port and industrial activities. The ferry docks daily, and other industrial barges are loaded with goods, and with sand from local sand-mining activities. There are several small fishing boats that operate from the beach. The survey site M17 was closest to the ferry dock and was dominated by silt and seagrass covered in silt (Figure 5.34). There was evidence of boat anchor scars in the seagrass at M05. Old fishing lines, hooks, and weights from line fishing were observed entangled on several of the patch reefs, particularly at M14 and M18.

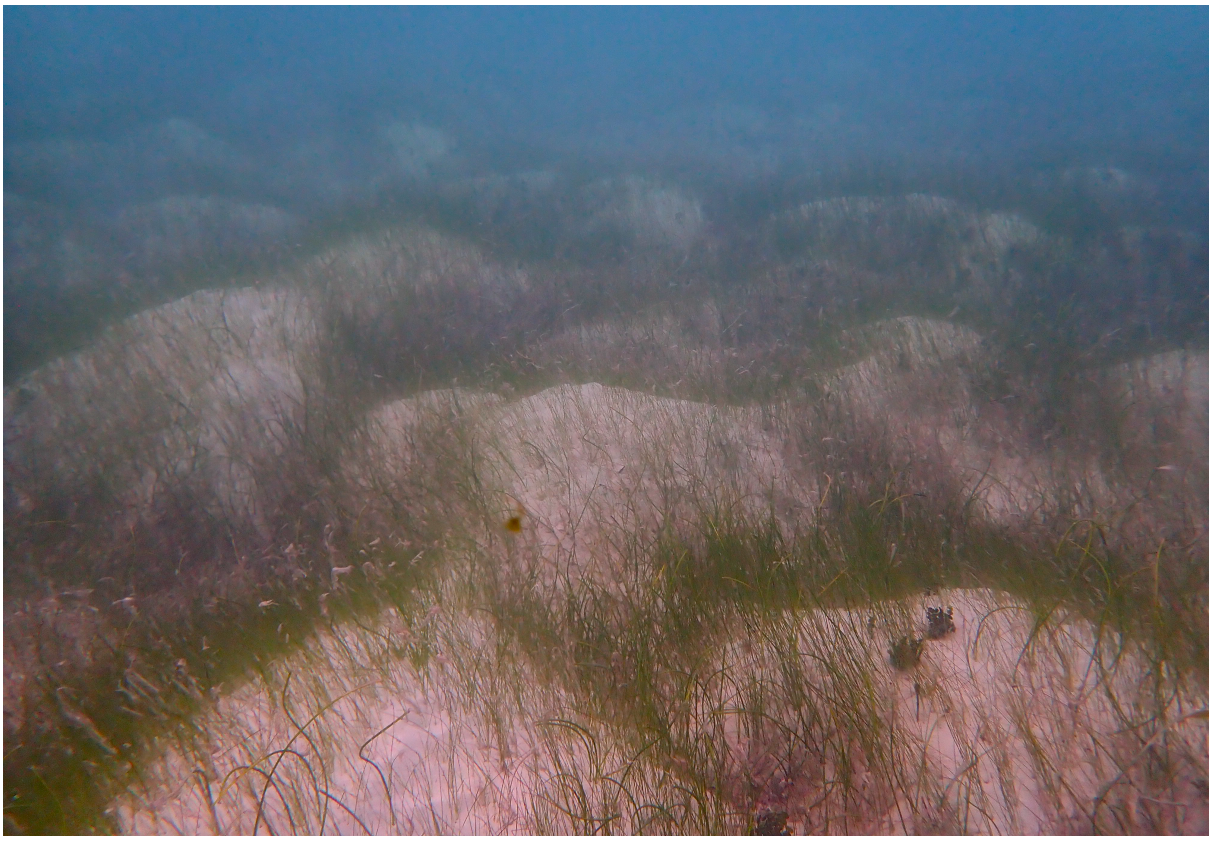


Figure 5.28: Healthy seagrass *Syringodium filiforme* at M09.

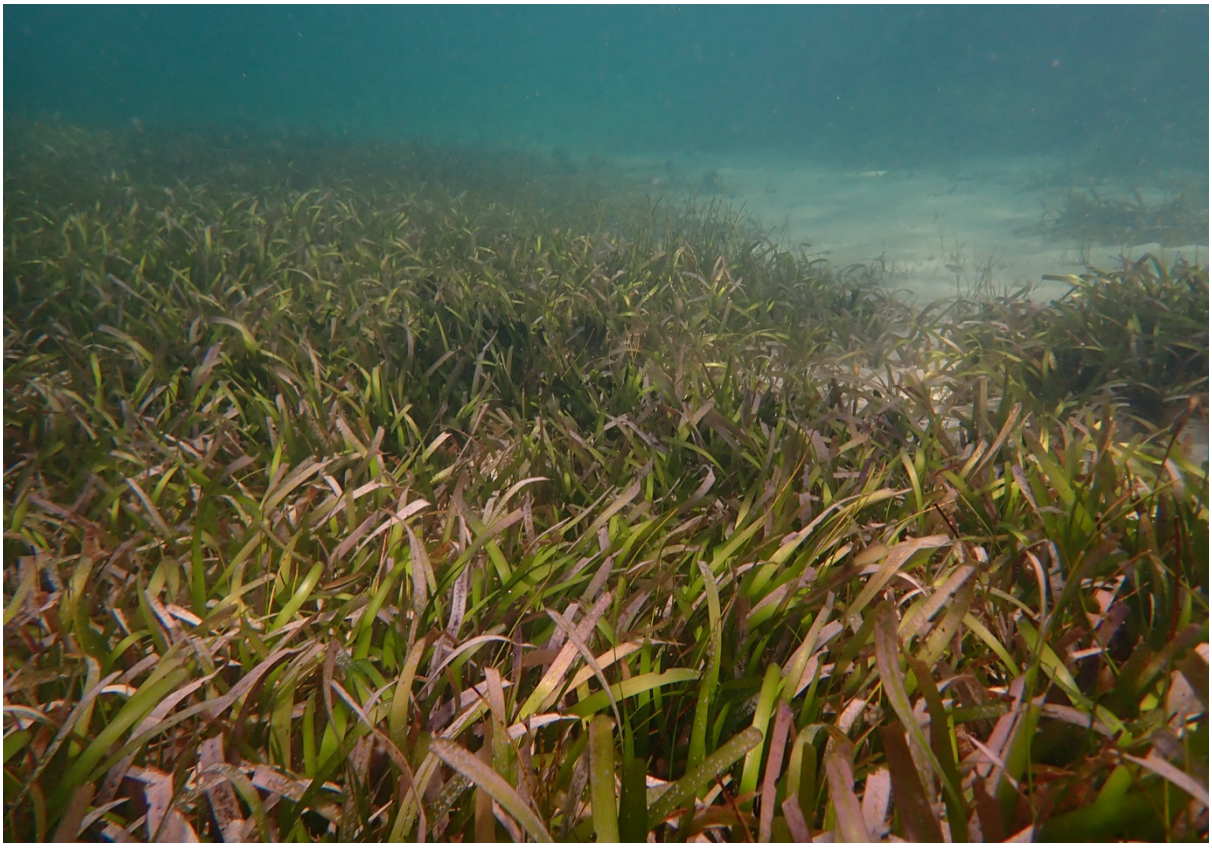


Figure 5.29: Healthy seagrass *Thalassia testudinum* at M12.

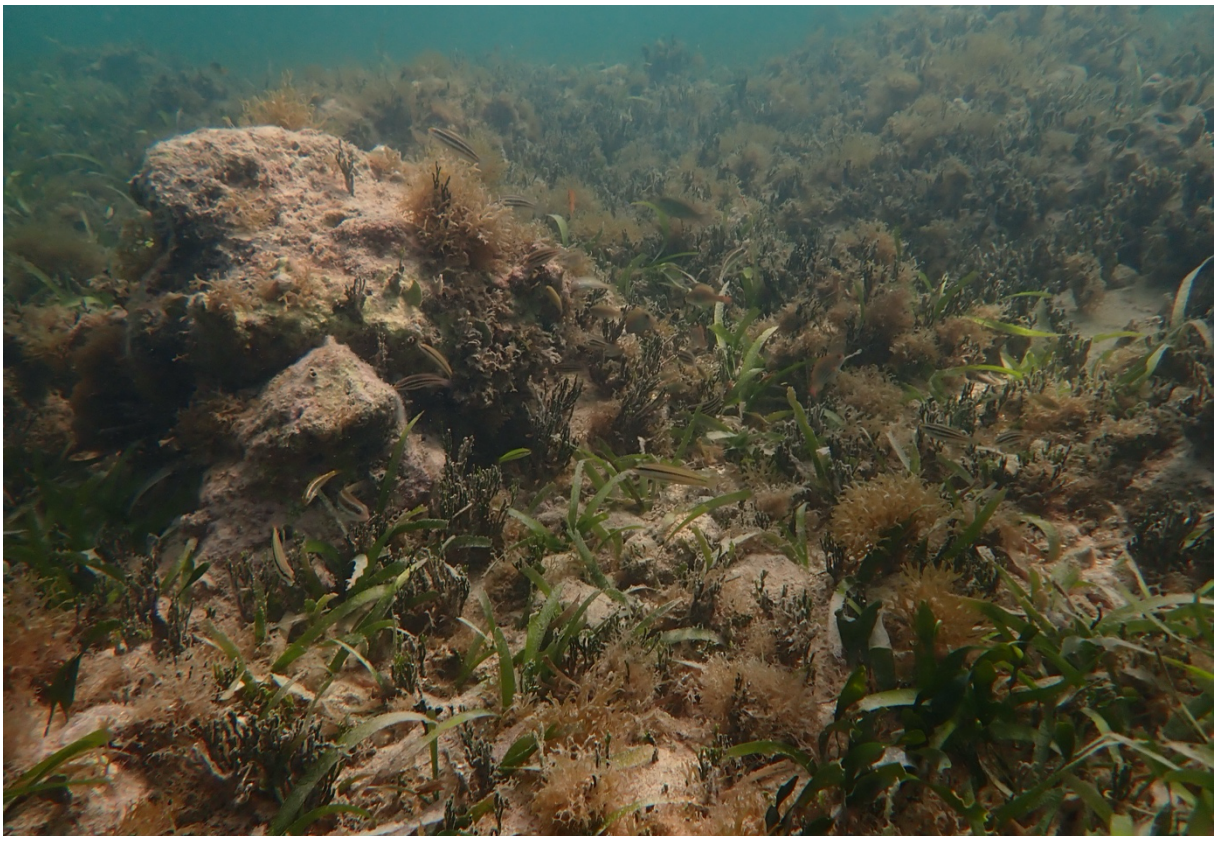


Figure 5.30: Seagrass (*Thalassia testudinum)* and macroalgae on rocky hard bottom.

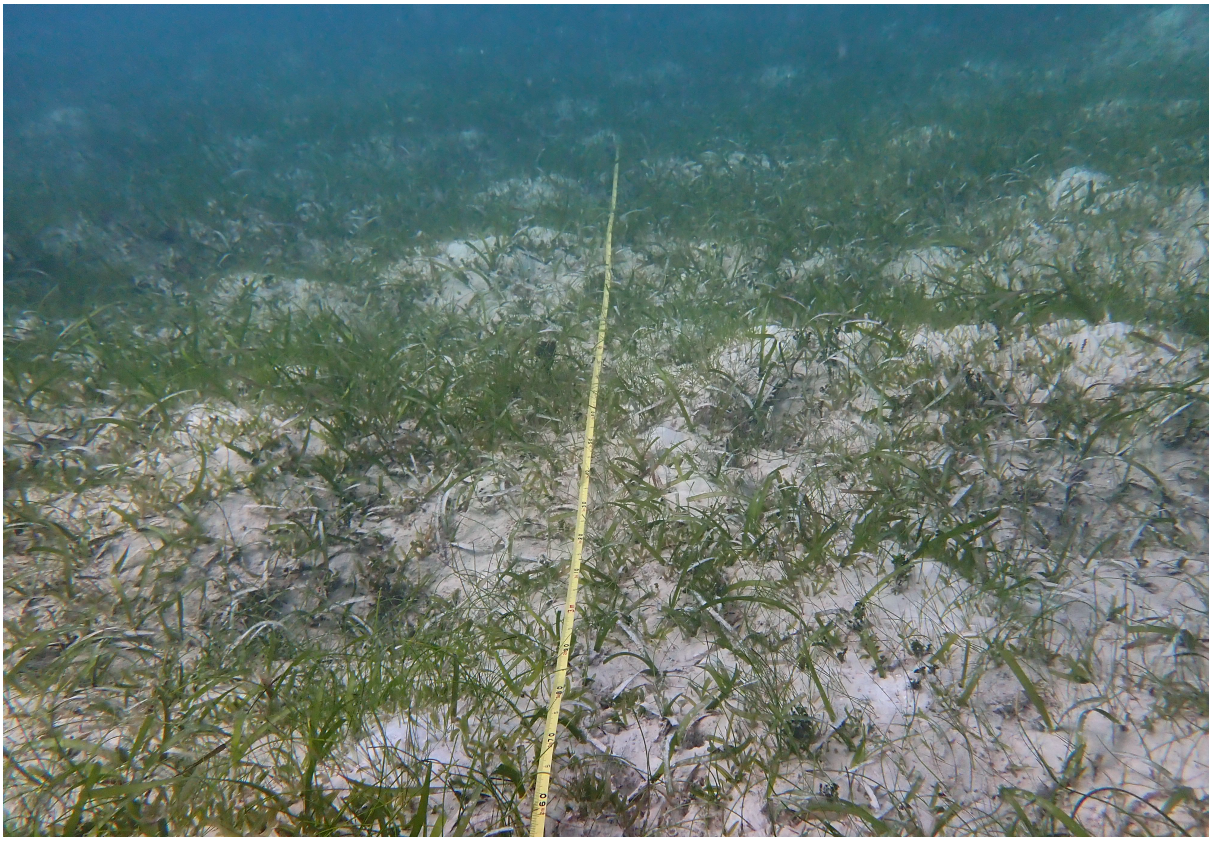


Figure 5.31: Seagrass and macroalgae at M01.

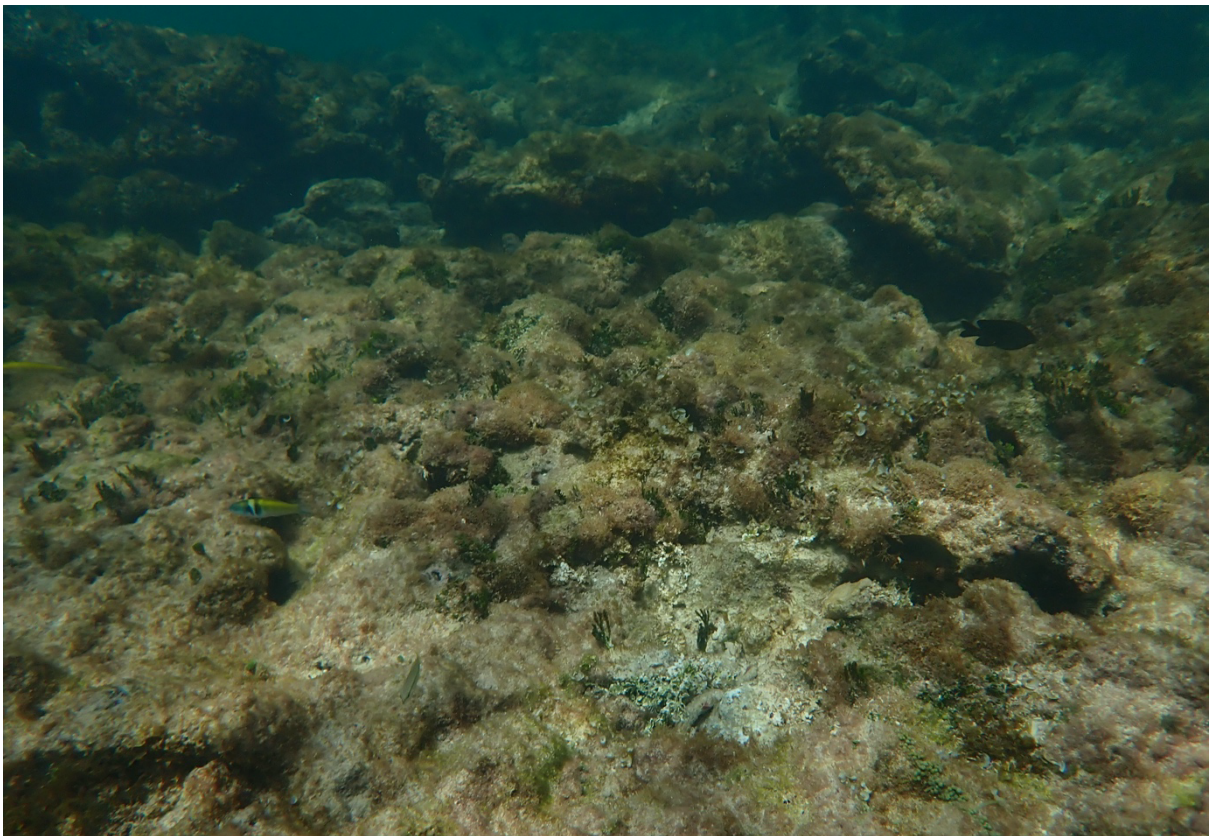


Figure 5.32: Rocky Hard bottom habitat at M13.



Figure 5.33: Patch reef at M07.

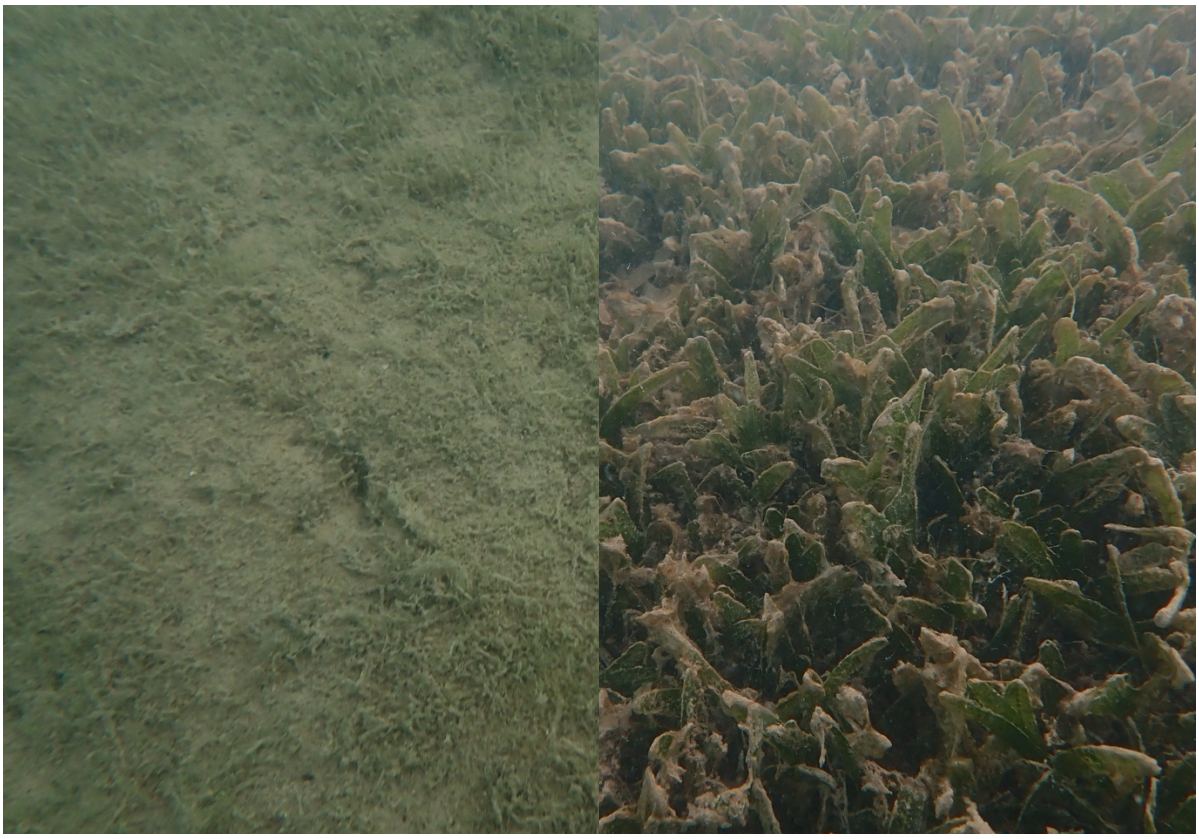


Figure 5.34: Silty mud and seagrass covered in silty mud at M17.



Figure 5.35: Sand at M04.

Table 5.11: List of coral species recorded. No corals were recorded at M17 or M18.

Common name	Scientific name	Transects recorded
Boulder brain coral	*Colpophyllia natans*	M03, M08
Grooved brain coral	*Diploria labyrinthiformis*	M03
Golfball coral	*Favia fragum*	M13, M14
Sea ginger	*Millepora alcicornis*	M02, M03, M04
Great star coral	*Montastraea cavernosa*	M03, M10
Boulder star coral	*Orbicella annularis*	M07, M08, M10
Mountainous star coral	*Orbicella faveolata*	M02, M03, M08, M10, M14
Mustard hill coral	*Porites astreoides*	M03, M04, M05, M06, M07, M08, M10, M11, M12, M13, M14, M16
Knobby brain coral	*Pseudodiploria clivosa*	M08, M12
Finger coral	*Porites porites*	M02, M03, M05, M06, M07, M08, M10, M11, M12, M13, M14
Symmetrical brain coral	*Pseudodiploria strigosa*	M07, M08, M11, M12
Smooth star coral	*Solenastrea bournoni*	M14
Blushing star coral	*Stephanocoenia intersepta*	M03
Lesser starlet coral	*Siderastrea radians*	M02, M03, M08, M11, M12, M13, M14, M15, M16
Massive starlet coral	*Siderastrea siderea*	M02, M03, M04, M05, M06, M07, M08, M10, M11, M13, M15, M16
Octocorals		M06, M07, M11, M15
Seafan	*Gorgonia ventalina*	M06, M08, M13, M14

(a)

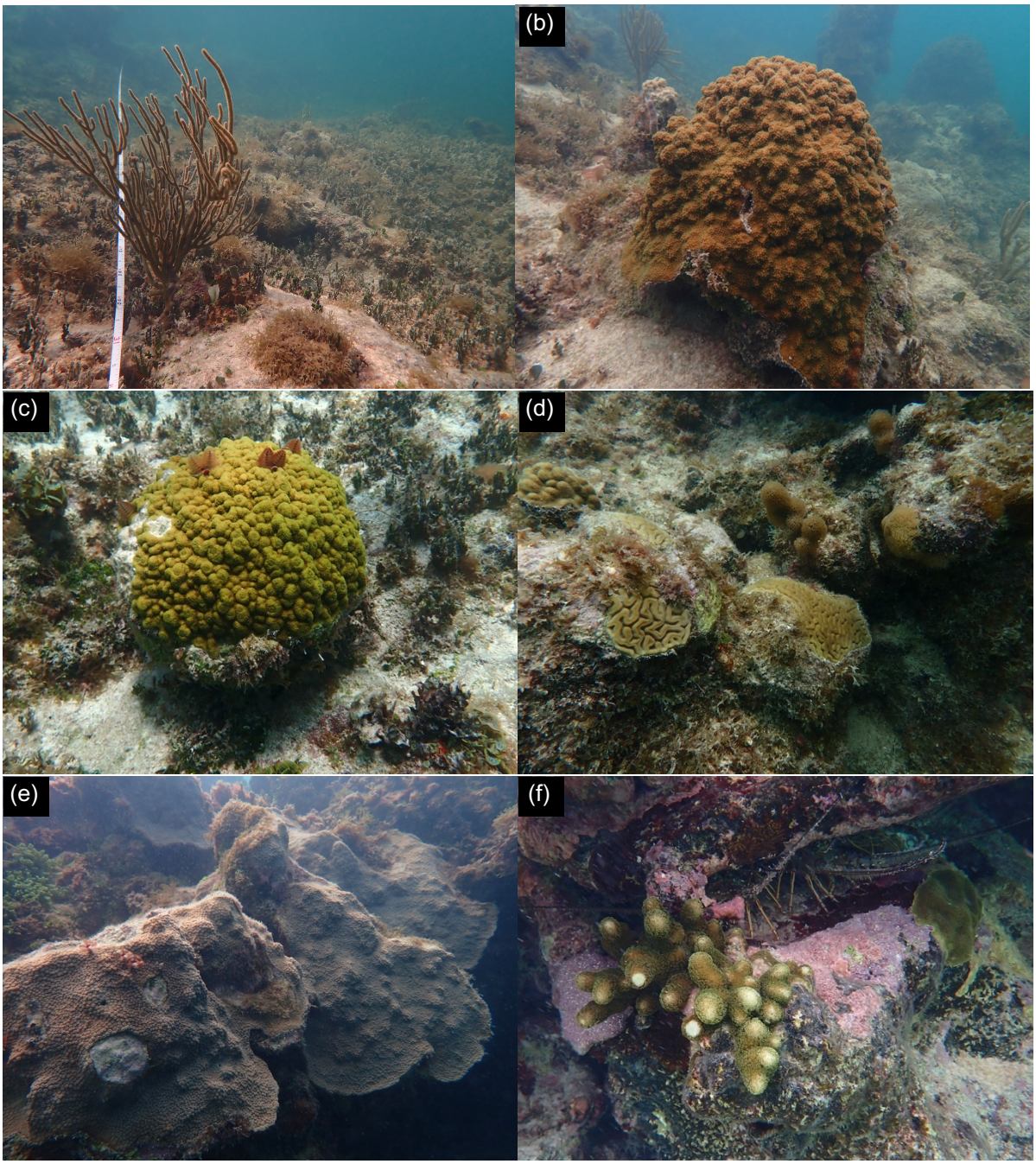


Figure 5.36: (a) Octocoral on M14, (b) *Oorbicella* sp. at M10, (c) *P. astreoides* at M4, (d) *D. labyrinthiformis* at M03, (e) *O. faveolata* at M03, and (f) *P. porites* (left), *P. astreoides* (right), and Caribbean spiny lobsters at M13.

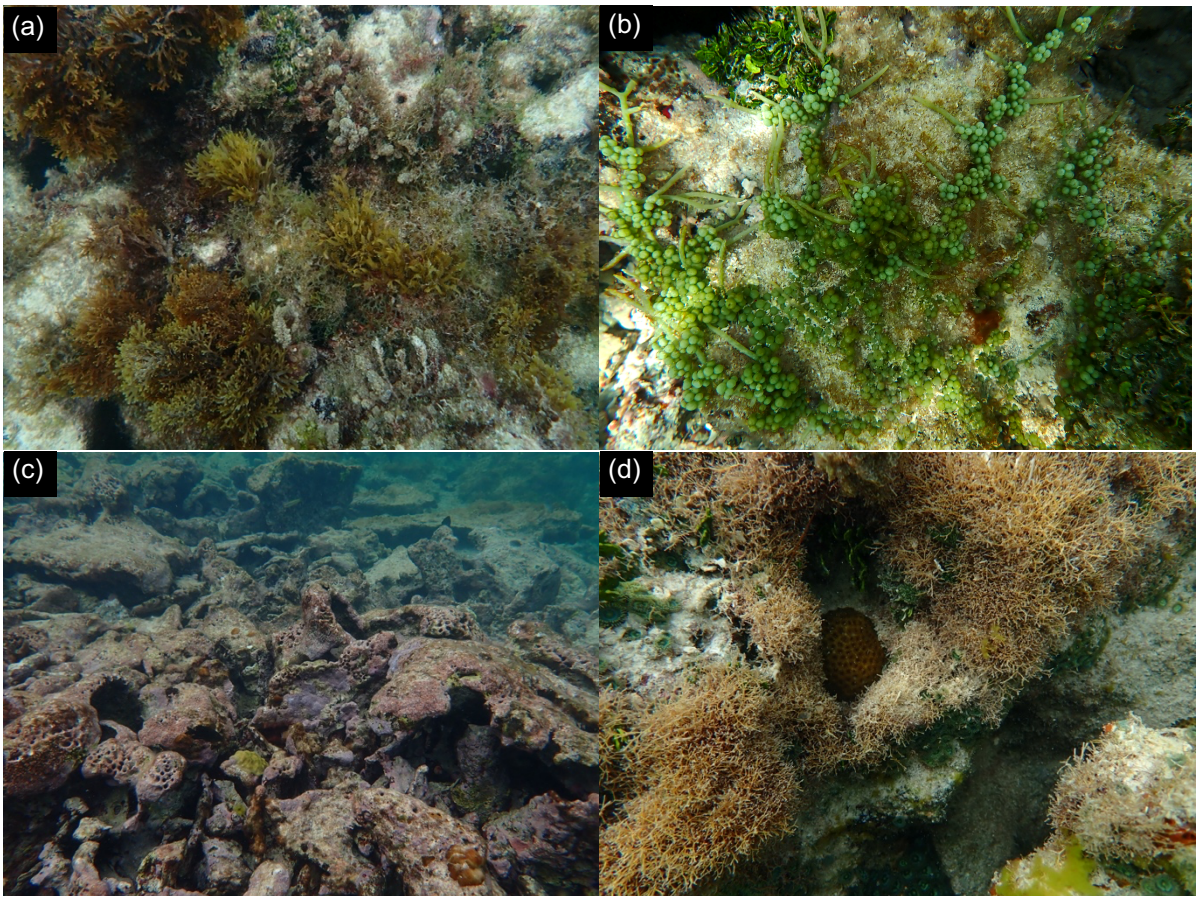


Figure 5.37: Algae recorded during the marine surveys included (a) Algae at M10, (b) *Caulerpa* sp. at M13, (c) crustose coralline algae M13, and (d) *Amphiroa* sp. at M16

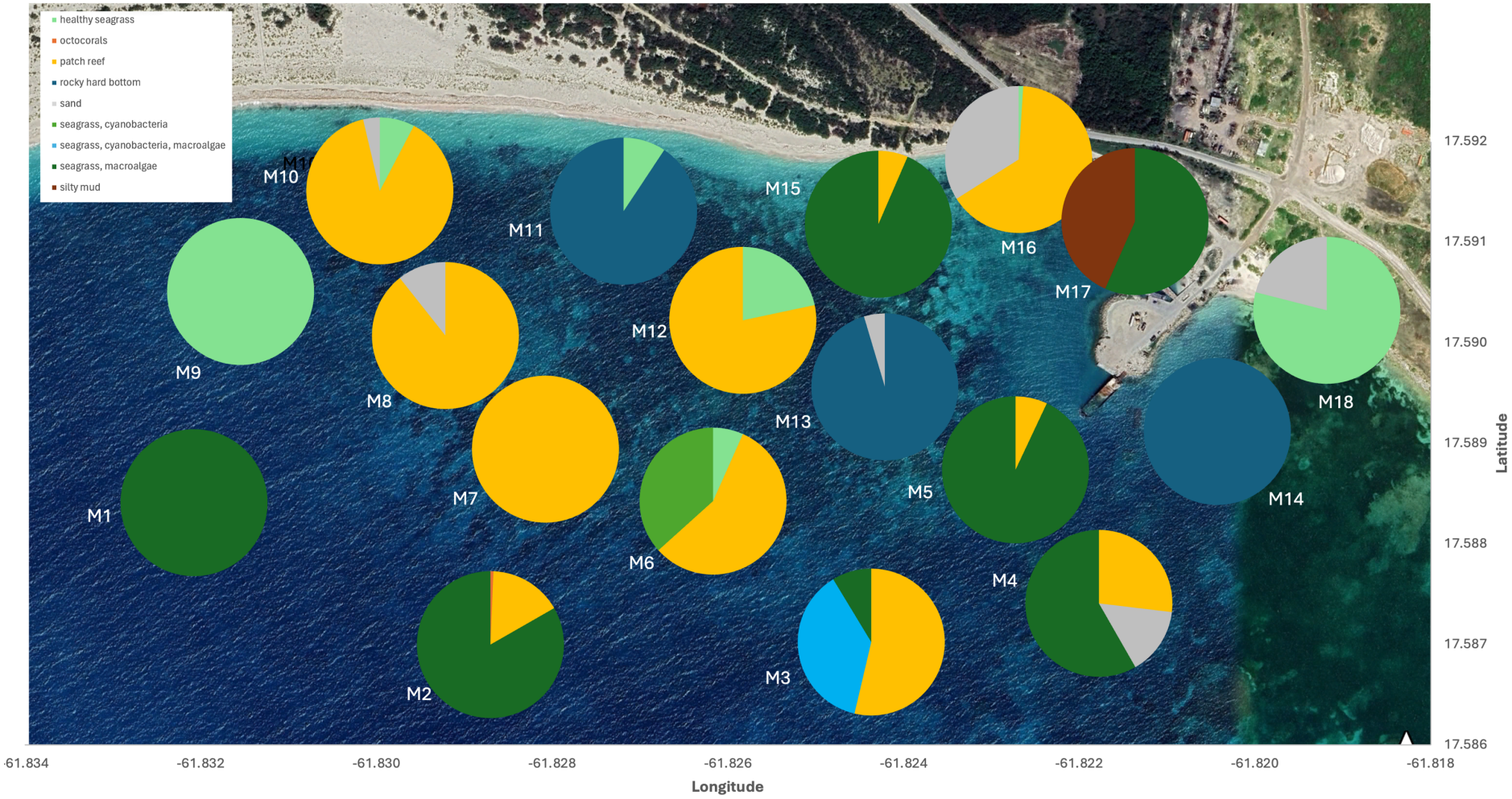


Figure 5.38: Pie charts showing the relative percentage cover of the major benthic groups over 30 m transects at 18 survey sites.

5.4.6.2 Fish

Fish are important elements of the nearshore coral reef and seagrass ecosystems. There were 39 species of fish recorded across the 18 survey sites. The most common group was parrotfish, which were recorded at 15 of the 18 sites. These were predominantly juvenile parrotfish, which would be expected because shallow seagrass and coral reef systems form primary nursery habitat for reef fish species.

Fish species and genera from different trophic levels were present across the sites (Table 5.12). Blue tang (*Acanthurus coeruleus*), and Ocean surgeonfish (*Acanthurus bahianus*) are primary consumers or grazers, which are important for controlling turf and macroalgae on reefs. These were recorded on many of the survey sites. Damselfish species are also grazers, but their behavioral activity involves cultivating algae 'gardens.' Banded butterflyfish (*Chaetodon striatus*) and Four-eye butterflyfish (*Chaetodon capistratus*) are corallivores and spongivores, consuming live coral polyps and marine sponges. All parrotfish species are also corallivores, as well as primary grazers on marine turf algae, and schools of juvenile parrotfish were present on both seagrass and patch reef zones (Figure 5.39). Parrotfish are essential to the health of coral reefs primarily because of their algal-grazing activity (Mumby, 2009; Shantz et al., 2020), and they also produce sand that contributes to beaches. It is critical that their abundance be maintained. In 2024, the Antigua and Barbuda Cabinet moved to pass a ban on the fishing of parrotfish. Secondary consumers or carnivorous fish include predatory fish such all groupers, grunts, graysbys, snappers, and trumpetfish.

The primary commercially important fish species include Nassau grouper and red snapper, which were recorded at multiple survey sites (Ruttenberg et al., 2018). These are commonly sold in markets and restaurants. Local, small-scale fishermen also catch many other species of reef fish, which are not necessarily sold, but are important for subsistence within the community.

Table 5.12: List of all fish species recorded and the transects where they were recorded.

Common name	Scientific name	Transects recorded
Banded butterflyfish	*Chaetodon striatus*	M16
Bar jack	*Carangoides ruber*	M02, M09, M15, M17
Barred hamlet	*Hypoplectrus puella*	M03, M10
Blenny		M13
Blue tang	*Acanthurus coeruleus*	M02, M03, M04, M06, M07, M08, M10, M11, M13, M14
Bluehead wrasse	*Thalassoma bifasciatum*	M03, M04, M06, M07, M08, M10, M11, M12, M13, M14, M16
Ceasar grunt	*Haemulon carbonarium*	M02, M11, M13, M16
Clown wrasse	*Halichoeres maculipinna*	M12, M13, M16
Damselfish sp.	*Stegastes* sp.	M02, M03, M04, M06, M07, M08, M12, M13, M14, M15
Fairy basslet	*Gramma* loreto	M06
Four-eye butterflyfish	*Chaetodon capistratus*	M07, M12, M14, M16
French grunt	*Haemulon flavolineatum*	M03, M07, M10, M13

Common name	Scientific name	Transects recorded
Goatfish	Family: Mullidae	M04, M10, M11, M12, M13, M14, M15, M16
Graysby	*Cephalopholis cruentata*	M13
Grunts sp.	Family: Haemulidae	M05, M07
High hat	*Pareques acuminatus*	M05
Lane snapper	*Lutjanus synagris*	M13, M14
Nassau grouper	*Epinephelus striatus*	M15, M16
Ocean surgeonfish	*Acanthurus bahianus*	M02, M04, M08, M11, M12, M13, M14, M15, M16
Parrotfish	*Scarus* sp. or *Sparisoma* sp.	M03, M04, M05, M06, M07, M08, M10, M11, M12, M13, M14, M15, M16, M18
Red snapper	*Lutjanus purpureus*	M03, M08, M10, M11, M14, M16, M18
Saucereye porgy	*Calamus calamus*	M04
Schoolmaster snapper	*Lutjanus apodus*	M07, M11, M12, M13, M14, M16
Sergeant major	*Abudefduf saxatilis*	M14, M16
Sharpnose puffer	*Canthigaster rostrata*	M01, M02, M06
Slippery dick	*Halichoeres bivittatus*	M11, M12, M13, M14, M15, M16
Southern stingray	*Hypanus americanus*	M02
Squirrelfish	*Holocentrus* sp.	M02, M03, M13, M14, M16
Stoplight parrotfish	*Sparisoma viride*	M06, M07, M16
Tiger grouper	*Mycteroperca tigris*	M04
Tobacco fish	*Serranus tabacarius*	M12, M13, M14, M16
West Atlantic trumpetfish	*Aulostomus maculatus*	M02, M07
White grunt	*Haemulon plumierii*	M13
Yellowfin mojarra	*Gerres cinereus*	M07, M13
Yellowhead wrasse	*Halichoeres garnoti*	M07, M12, M13
Yellowtail damselfish	*Microspathodon chrysurus*	M07, M16
Yellowtail parrotfish	*Sparisoma rubripinne*	M02
Yellowtail snapper	*Ocyurus chrysurus*	M02, M03, M04, M05, M12, M14, M16, M18



Figure 5.39: Juvenile parrotfish at M04.

5.4.6.3 Other organisms

Corals and fish are the primary focus of many reef-oriented studies, but many other species contribute to the diversity coral reef ecosystems. In these surveys, 11 other reef organisms were recorded across the 18 sites, and they were only recorded on patch reefs (Table 5.13). The most common groups were sponges and bryozoans, which were each recorded at 4 sites.

Spiny lobster (*Panulirus argus*) was recorded at 3 sites (Figure 5.40 a). This is the only species of commercial importance within this category. These shallow waters are important nursery grounds for spiny lobsters, which comprise a primary fishery in Barbuda.

White sea egg urchins (*Tripneustes ventricosus*) were recorded at just 1 site. These are important grazers of macroalgae on reefs and can help with controlling macroalgae cover, which then allows more space for the colonization and growth of corals. Increased abundance of these urchins would be beneficial to the ecosystem health of this area.

No live Queen conch (*Strombus gigas*) were recorded in any of the surveys, but cracked, dead, empty shells were recorded (Figure 5.40 c). These may result from conch that were fished in other areas that were discarded by fishing boats coming back to the dock.

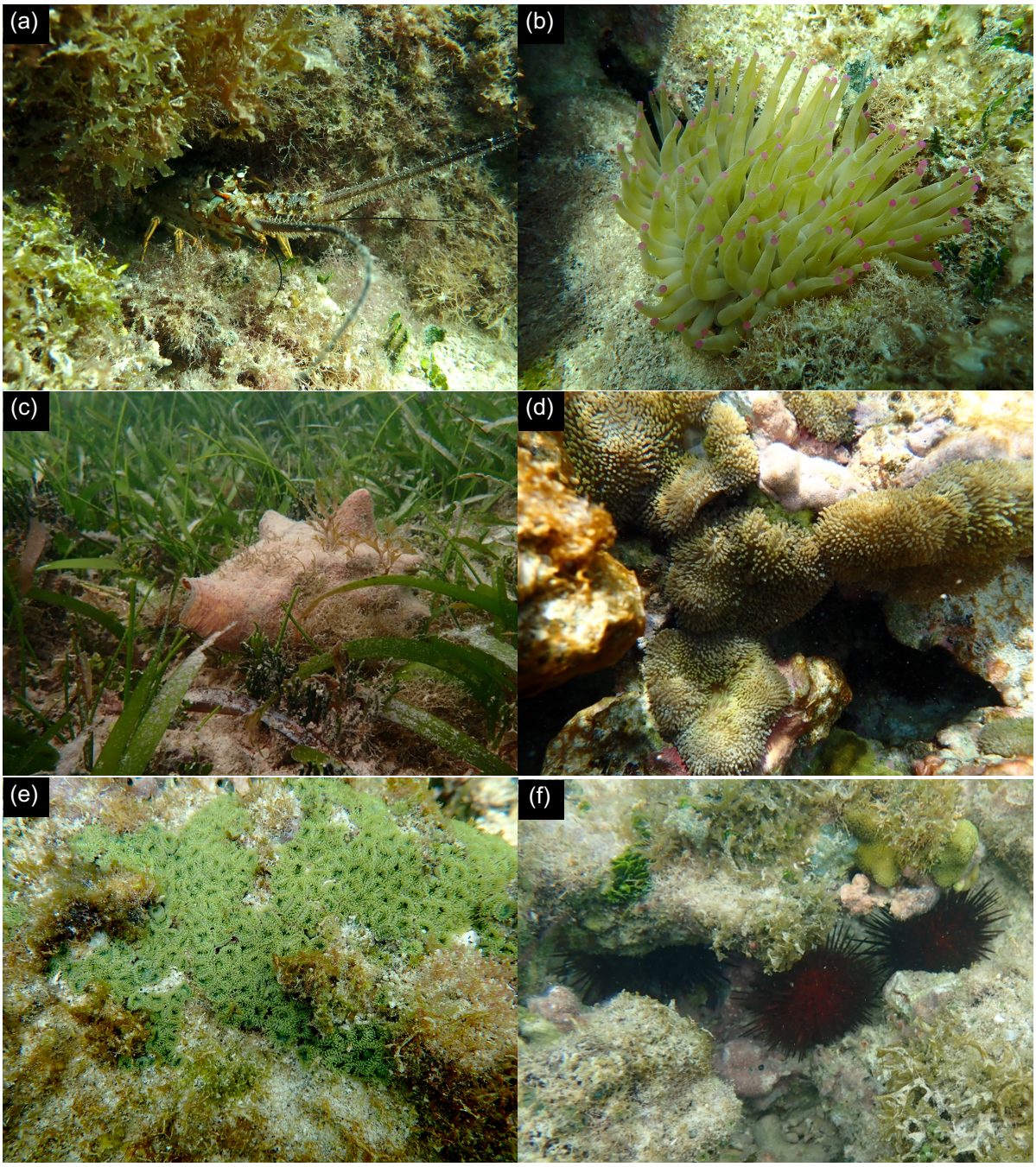


Figure 5.40: Other benthic organisms, (a) including Spiny lobster on M14, (b) anemone on M14, (c) Queen conch shell on M14, (d) sun anemone on M12, (e) zoanthids on M13, and (f) rock boring urchins at M16.

Table 5.13: List of all other reef organisms recorded and the transects they were recorded on.

Group	Transects recorded
Anemones	M02, M12
Bryozoans	M02, M04, M05, M06
Cyanobacteria	M14

Group	Transects recorded
Feather worm	M15
Red urchins	M11, M13, M14
Sea cucumbers	M04
Sea egg urchin	M14
Spiny lobster	M03, M13, M14
Sponges	M06, M08, M13, M14

5.4.7 Species of commercial importance

Near-shore fisheries, including snapper, grouper, Queen conch, and Spiny lobster, are commercially important in Barbudan waters. The presence of lobster, snapper, and grouper species was confirmed in the nearshore habitat during marine surveys conducted in March 2024 (Section 5.4.6). No live Queen conchs were recorded in these marine surveys.

Fishing is a key component of the local economy and provides a livelihood to many residents. This is discussed further in the socio-economic study in Section 5.6 and Appendix 8.

5.4.8 Species with the potential to become nuisances or vectors

Mosquitoes and sandflies are common in Barbuda, particularly during the crepuscular period in coastal areas and near stagnant waters, where they can breed. Water management, especially of potentially stagnant water, will be a key consideration in the project design and to ensure water flow. Proactive control measures and mitigation should be considered, especially, as mosquitoes are vectors for several diseases including, dengue, zika, and chikungunya.

The vegetation surveys showed that three invasive species, alabamba (*Acacia macracantha*), neem (*Azadirachta indica*), and logwood (*Haematoxylum campechianum*), were present and pervasive throughout the site. Two native pest species, Love vine (*Cassytha filiformis*) and Sandbur (*Cenchrus spinifex*) were also recorded. Land disturbance, including sandmining, has facilitated the establishment and spread of these invasive species and at the expense of native species. Invasive species should be removed where possible during the land clearance and development and native species should be planted. The vegetation assemblage is described in more detail in Section 5.4.1.

The Islands of the Caribbean, including Antigua and Barbuda, have been affected by Sargassum seaweed (*Sargassum* sp.) since 2011. Sargassum blooms have originated off the coast of South America and have been affecting the Caribbean Island Chain with various detrimental ecological and economic effects. The scale of the problem has been increasing with beaches and bays being closed from time to time because of the amount of sargassum and its toxic impacts. Several resorts and communities have installed offshore booms to mitigate the problem. Collecting the weed from the beaches is expensive and also results in sand removal. The beach on the Rosewood Barbuda property is only infrequently affected by sargassum weed and currently we do not recommend offshore booms as necessary. If large

amounts of weed come ashore it can be removed, placed on mesh drying racks so that the sand can be returned to the beach.

Lionfish (*Pterois* sp) are an invasive species that are spreading throughout the Caribbean. They have a detrimental impact on coral reefs as they are voracious predators of small fish. While they have been documented in some locations off Antigua and Barbuda, none were recorded during the marine surveys off the Rosewood Barbuda property.

5.5 Natural Hazards

5.5.1 Tropical storms and hurricanes

Barbuda is located in the Atlantic hurricane belt, where the typical hurricane season is between June and November annually. The Lesser Antilles of the Northeast, including Antigua and Barbuda, are hit, on average, by three tropical depressions (DT) per decade, representing a moderate rate of cyclonic activity. Antigua is located on the west side of the major region for the development of the DT ("Tropical Depression Main Development Region"). This region represents a corridor, oriented from east to west in the North Atlantic, where waves from Africa develop in DT in the Cape Verde region and eventually travel to the Caribbean and the Americas. The maximum frequency of DT that affects this region per decade is 4-5, which is similar to the frequency observed in the Gulf of Mexico and the western region of the Caribbean Sea. Overall, this is a lower rate than the 6-7 TD per decade that effect the US coast (Rey et al 2019). NOAA's historical hurricane tracker indicates that 32 category 1-5 hurricanes passed within 50 miles of Antigua, of which 11 hurricanes were category 4 and 2 hurricanes were category 5 between 1842-2024 (Figure 5.41).

Antigua's Physical Development Plan (SIRMZP, 2011) requires hurricane-resistant building guidelines to be applied for all construction throughout Antigua and Barbuda. Buildings in the development are being designed to meet the requirements of the 2021 International Building Code (IBC). The wind loads used for the structural design of the main lateral force resisting system are code prescribed from IBC 2021 with an ultimate design wind speed (700-year return period) of 160 mph. The 160 mph ultimate design wind speed is provided in the Organization of Eastern Caribbean States Building Code 7th Edition (OECS 2016).

The development site is in an area at risk of flooding, storm surge, and sea level rise. Some protection from wave action is currently provided by the ferry dock and breakwater to the southeast side of the property.

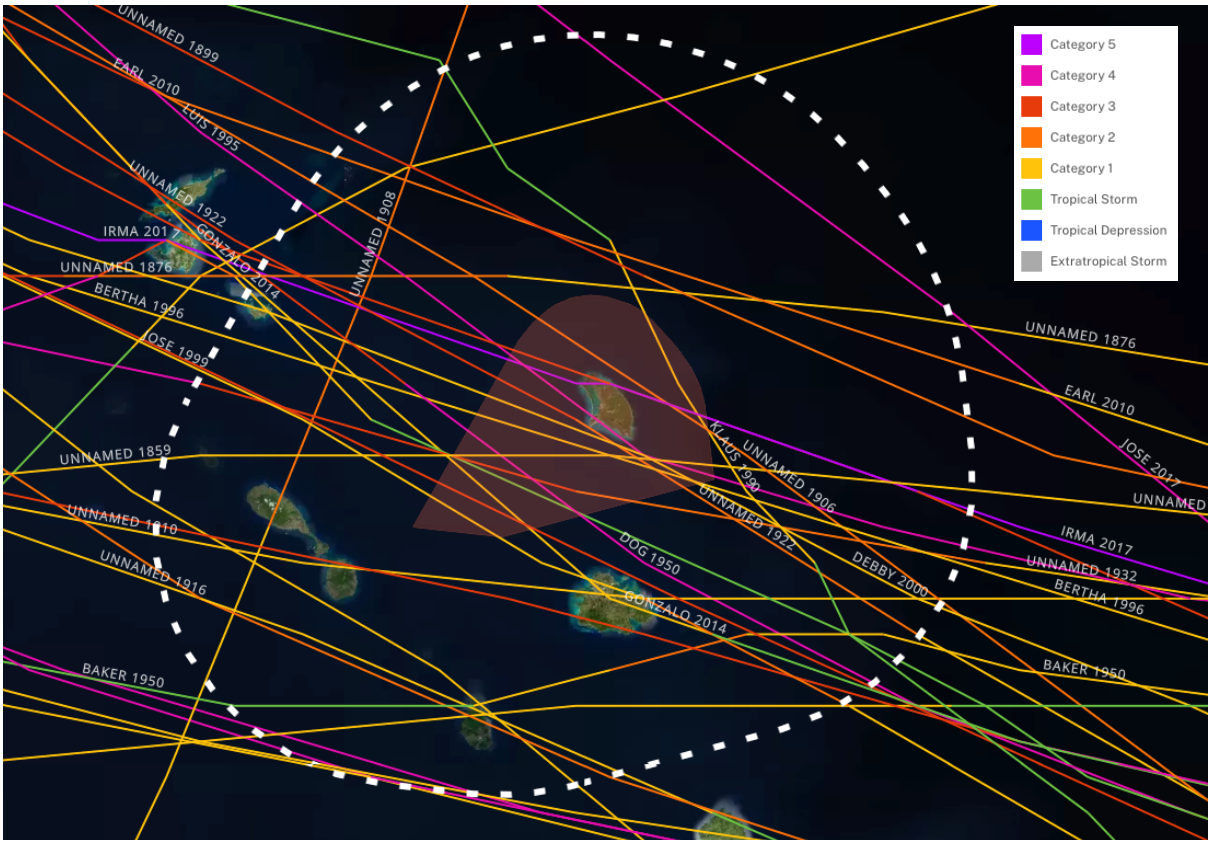


Figure 5.41: Hurricane tracks within 50 miles of Barbuda (delineated in white) between 1842-2024 (NOAA).

5.5.2 Tsunamis

The Caribbean region is exposed to several hazards such as cyclone, seismic, eruptive, and tsunami hazards. While tropical hurricanes affect the region frequently, tsunamis are rarer, averaging 19-22 years between deadly events. Their effects are often limited to certain coasts or islands and not to the entire region. Between 1482 and 2000, 91 possible tsunamis were documented. Of these, 53 were defined as "probable tsunamis", and of these, 19 were confirmed as tsunami waves and swells, some more than 10 m high. The last destructive tsunami in the Caribbean occurred in August 1946.

Antigua and Barbuda lies on the tectonic plate boundary between the North American plate and the Caribbean plate. The two primary causes of tsunamis are volcanic activity and earthquakes (Figure 5.42). One of the earliest earthquake-generated tsunamis was recorded in Antigua and Barbuda on April 6, 1690, and was triggered by landslides at Nevis Peak (UWI Seismic Research Centre, 2010). The islands were also affected by another tsunami on November 18, 1867, caused by an earthquake and associated underwater landslide in the Virgin Islands.

The strength of the generating event and the distance from the source largely determine the type and intensity of tsunamis. If a tsunami was triggered by an earthquake in Nevis or volcanic activity in Montserrat, waves of 2-3 m could impact Barbuda within 40 minutes (Pelinovsky et al., 2004). Nevis lies directly to the southwest of Barbuda, and if a tsunami event was triggered there, not only the proposed Rosewood Barbuda development but the entire southwest coast

of the island would be affected. Coastal low-lying areas are naturally the most vulnerable during tsunamis as they are easily flooded, but areas up to 3 km inland have been previously impacted. The orientation of the coastline also plays an important role in local effects. For example, following a tsunami caused by an earthquake in November 1867, Basseterre in Guadeloupe reported a 1 m tsunami, while Pointe-à-Pitre warned of only a slight swell.

There are four sources of tsunamis in the Caribbean, which are described in the following sections.

1. Teletsunamis

These tsunamis result from tectonic events originating 1,000 km or more from the island. They are rare and devastating. According to historical reports, only two teletsunamis affected the Caribbean, both of which originated from the coast of Portugal. The first, from Lisbon, Portugal in 1755, took 9.5 hours to reach the Caribbean. A second teletsunami, generated by an aftershock in 1761, had no serious impacts in the Caribbean. Teletsunamis are damaging events, so the many hours between the tectonic event and the arrival of the wave in the region allow nations to prepare. If a similar event were to happen again, the large areas of the coastline of Antigua would be threatened, and the evacuation of all citizens to high shelters would be necessary.

2. Tsunamis generated by a landslide

These tsunamis are created by landslides and underwater collapses at sea. These tsunamis are usually triggered by earthquakes, and their destructive effects are frequently limited to areas in the vicinity of the original event. As the source of a landslide is normally near the shoreline, the warning time can be only a few minutes. This is the source of previous tsunamis effecting Antigua, triggered by landslides in Nevis. Since Nevis is directly to the southwest of Barbuda, the island would be affected by any tsunami from this origin.

3. Volcanic tsunamis

Volcanoes can generate tsunamis in several ways, including explosion, caldera collapse, and pyroclastic flows. The size and impact of the wave created are related to the physical importance of the event (for example, the amount of material flowing into the ocean during a pyroclastic event), the distance from the volcanic event, and the orientation of the coastline. This is the most common type of tsunami in the Eastern Caribbean. The most recent volcanic tsunami to impact Antigua and Barbuda followed an eruption of the volcano in Montserrat in 1997. Montserrat reported a tsunami flooding of adjacent rivers and bays, Guadeloupe was only slightly affected, and other islands, including as far north as St Barths, reported small tsunami-like waves and conditions.

4. Tsunamis of tectonic origin

These tsunamis are generated by earthquakes created by the movement of tectonic plates. Typically, an earthquake must be 8.0 mV or higher to trigger a major tsunami. However, smaller earthquakes can produce waves that have the capacity to damage coastlines on a regional scale. For tsunamis triggered near land regions, the preventive time is, on average, 30-60 minutes, which is usually enough to evacuate low-density underground places. This type of tsunami, nevertheless, would affect the entire beach and possibly a large part of the coastline of the island.

Some parts of the Caribbean are more susceptible to certain types of tsunamis. For example, Jamaica is more at risk for tsunamis related to landslides, while Puerto Rico and the Virgin Islands are more likely to be affected by tsunamis of tectonic origin. At-risk populations are

advised to watch for a recession of the sea after an earthquake and to take shelter on higher ground. In the Eastern Caribbean, including Antigua and Barbuda, most tsunamis come from volcanic activity and earthquakes. Since volcanic eruptions can last for several days or even months or years, local authorities should advise residents to make appropriate decisions.

5.5.2.1 Tsunami risks for the Rosewood Barbuda Resort development

In the event of a tsunami striking Barbuda, the residents, guests, and employees of Rosewood Barbuda Resort and all other properties on the southwest coast of Barbuda will be similarly impacted. The type and scale of a tsunami and proximity of origin to Barbuda will play a role in impact and effectiveness of any preventative measures and responses.

A tsunami resulting from volcanic or seismic activity on e.g., Nevis would transmit rapidly to Barbuda within approximately 60 minutes. The nearest and most likely source of this type of activity is the Montserrat volcano (which is still considered active). A large tsunami from here was previously considered unlikely and Barbuda would potentially be protected by Antigua.

At the national level, the government is responsible for managing the risks associated with natural disasters as outlined in the Disaster Management Act (2002). The agency has previously conducted tsunami exercises. Additional information on tsunami warning services and programmes in the Caribbean and adjacent areas is provided in the Caribbean Tsunami Warning Program (CTWP).

In addition to government-led procedures, the Rosewood Barbuda Resort can take safety measures. It should install warnings and establish an evacuation plan. Residents, guests, and staff should be educated to recognize the warning signs of tsunamis, such as ocean retreat, and should be instructed to move quickly to a designated higher place. Directional signs and fact sheets should be placed in residences and guest rooms (Table 5.14), and annual disaster response training can be provided to staff. These steps, that are part of a standard preparation are outlined below.

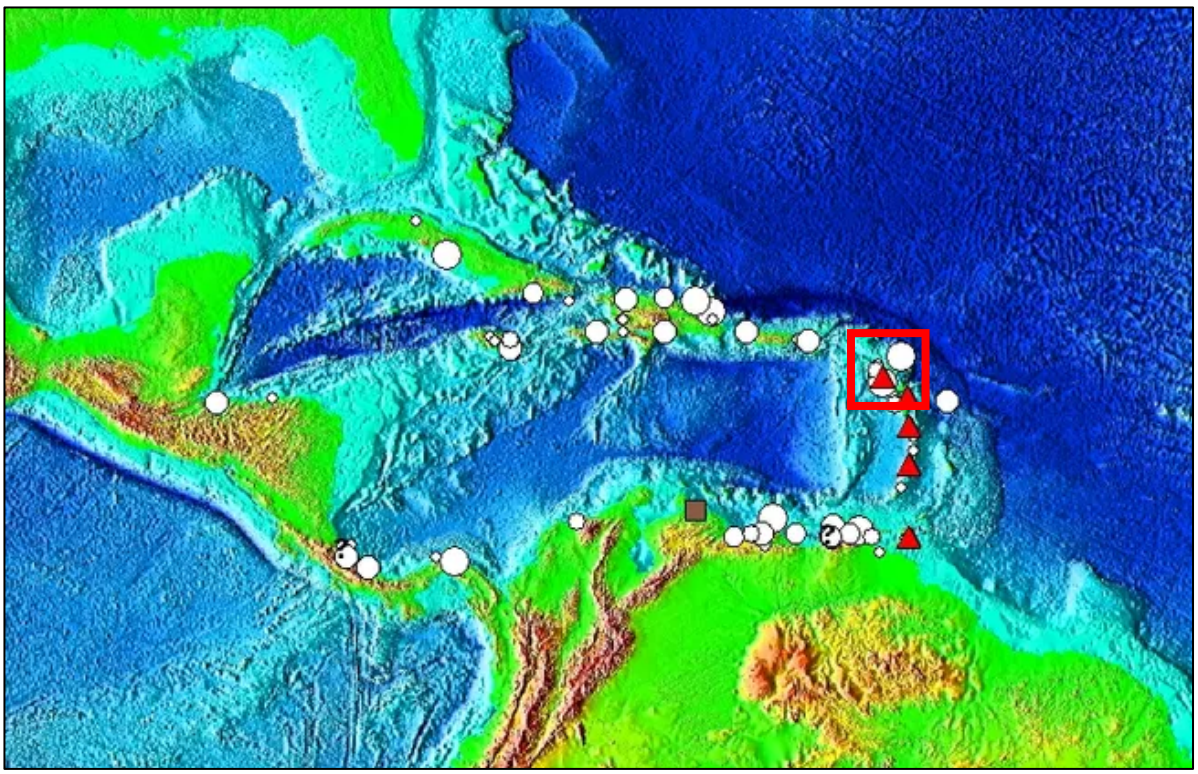


Figure 5.42: Tsunami source locations in the Caribbean Sea. The symbols indicate the cause of the tsunami: Brown Square is a landslide, Red Triangle is a volcanic eruption, and White Circle is an earthquake and the size of the circle is graduated to indicate the earthquake magnitude. where the location of Antigua and Barbuda is represented by the red box (National Geophysical Data Center/World Data Center).

Table 5.14: Universal signs for tsunamis

		
Area susceptible to tsunamis	High ground shelter site: the sign is placed at a designated location as high ground that serves as a tsunami shelter	Shelter site in a building: the sign is placed at the entrance of a large building designated as a tsunami shelter area

5.5.2.2 Evacuation instructions for the Rosewood Barbuda Resort

It is recommended that the Rosewood Barbuda Resort institute an evacuation plan and instructions according to the "Guide to Tsunamis for Hotels" created by the Intergovernmental

Oceanographic Commission of UNESCO (Appendix 7). The Guide outlines the steps needed to develop a comprehensive plan, such as preliminary readiness assessment using a checklist, recognizing warning signs, choosing an evacuation strategy, considering the hotel as an evacuation zone, and standard tsunami operating procedures.

This guide is divided into five sections. The first section provides a brief description of tsunamis and explains the importance of managing this hazard in the hotel industry. Section 2 describes the risk of tsunami in the North-East Atlantic and Mediterranean Seas (all applicable to the Caribbean), and the measures that have been taken to reduce the impact of this hazard. The third section explains how to increase the effectiveness of precautions and elaborates on three different situations that influence evacuation strategies. Section 4 explains the prerequisite for establishing the hotel as an evacuation zone. Finally, the final section explains the standard planning and evacuation procedures that can serve as operational procedures for the development in the event of a tsunami. It is recommended that Rosewood Barbuda Resort develop an evacuation plan as part of a participatory approach (with staff and management), to increase ownership of the plan by all.

5.5.3 Earthquakes

The Leeward Islands area, which includes Barbuda, is the most seismically active zone in the Eastern Caribbean due to the subduction zone between the Caribbean plate and the North American plate (Figure 5.43). These earthquakes are generated up to 200 km beneath the earth's surface. The largest earthquakes in the region since the 1600s have been recorded in this area (UWI Seismic Research Centre, 2024). The average number of background earthquakes is relatively consistent, with the islands being affected approximately every 13 days. Between 16-40 earthquakes with magnitude 4+ were detected annually between 2014 and 2024. Activity in the area has been elevated since 2011, which may be the precursor for earthquakes of more significant magnitude (UWI Seismic Research Centre, 2024).

Hazards from earthquake activity result from the effect of the ground shaking. Buildings can be damaged by the shaking itself or from the subsidence of the ground settling at a different level than before the earthquake. In Antigua and Barbuda, rock-falls and landslides are significant hazards (NODS, 2017). A primary hazard, particularly for low-lying sites close to the water table, is soil liquefaction. This is the destabilization of sand or soil when groundwater is forced out from between the grains by the shaking. When this occurs, the strength of the substrate is reduced and may cause land slippage and the failure of building foundations. Building construction needs to incorporate sufficient earthquake ratings for the soil and location.

Earthquake preparedness for Antigua and Barbuda at a national level is described by the Country Document for Disaster Risk Reduction: Antigua and Barbuda, 2016 (NODS, 2017) and the CDEMA Standard for Tsunami/Earthquake Drill (CDEMA, 2015). Earthquake risk in Antigua and Barbuda was assigned a hazard priority score of 1 out of 6 based on the frequency and severity of past effects (NODS, 2017).

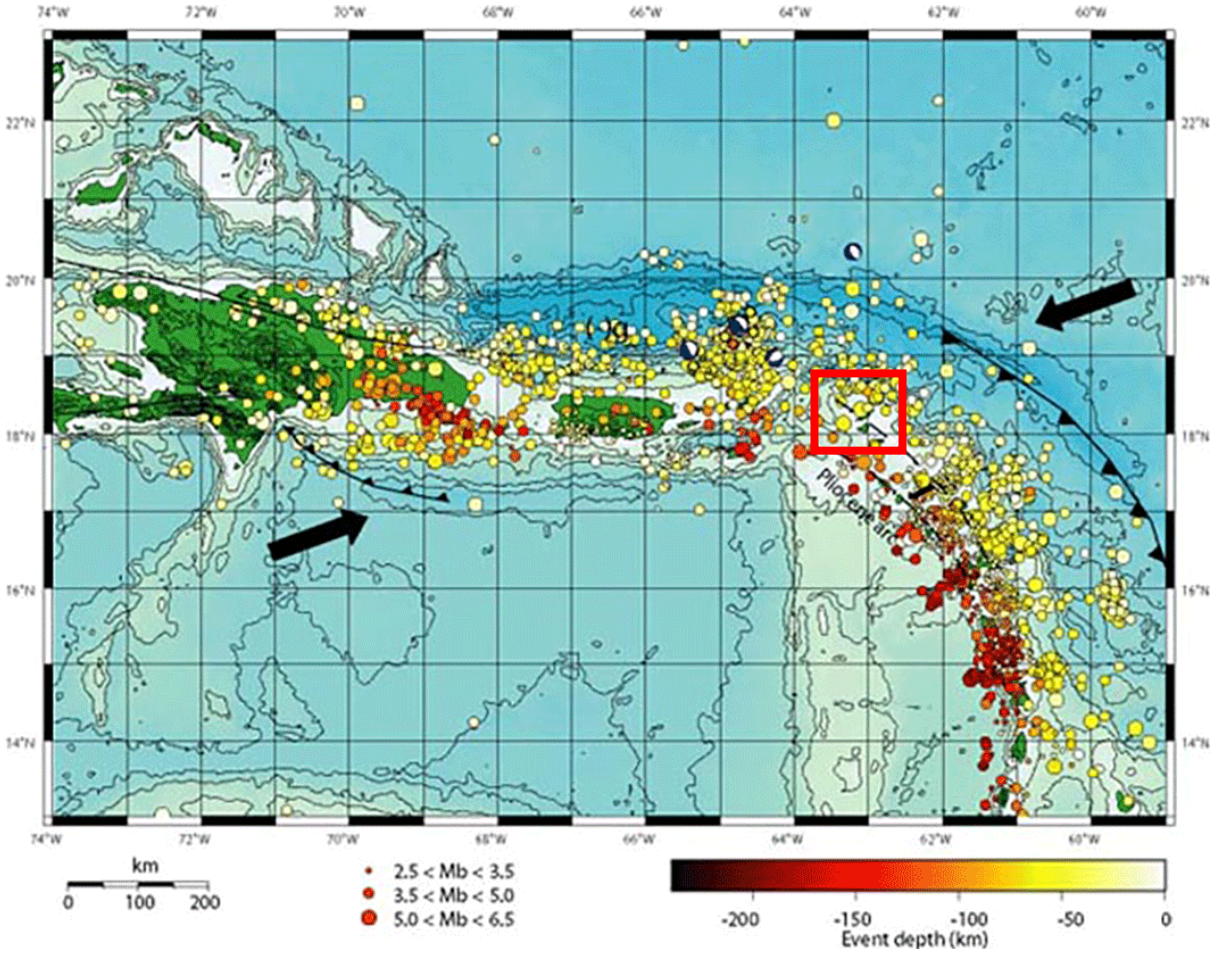


Figure 5.43: Location, magnitude and epicentre depth of earthquakes around the Caribbean (USGS), where the location of Antigua and Barbuda is represented by the red box.

5.5.4 Climate change

The Caribbean islands are considered at high risk from climate change due to changes in the frequency and intensity of natural disasters, like hurricanes, floods, and drought forecasts, as well as rising sea levels and coastal erosion leading to greater beach loss. Sea level rise (SLR) resulting from climate change is a very real threat to Caribbean Small Island States, like Antigua and Barbuda. In the Caribbean, it is estimated that SLR will result in a 0.3-1 m rise in sea level by 2050, affecting the 28 million people who live on the coast. Many of the island's most populated and economically important coastal areas have flat, low-lying topography and porous bedrock. This will have a direct effect on the potential for more damaging storm surge and flooding in coastal areas like Barbuda, which has very little elevation above current sea level. Protection and restoration of dunes, protecting beach sand provides nature-based resilience against SLR. The incorporation of integrated constructed wetlands into the design of the development will help to address flooding and storm surge. Development and construction such as incorporating setbacks and FFEs that minimize the risks from climate change is also essential.

Sea temperatures in the Caribbean region were among the hottest recorded in 2023 and 2024. By mid-July 2023, NOAA reported water temperatures throughout the Gulf of Mexico and in the Caribbean Sea, as approximately 1-3˚C (1.8-5.4˚F) warmer than normal (NOAA, 2023). Coral bleaching (driven by higher temperatures) was prevalent throughout the Caribbean in 2023, and in September 2023, cumulative heat stress hit 22°C-weeks (40°F-weeks), nearly triple the previous record for the region. NOAA issued a bleaching level 2 alert (the highest level) in August 2023, which continued through to mid-October (Hansen, 2023). In Barbuda many *Acropora* sp. corals were observed, and in Antigua, the Elkhorn Marine Conservancy reported large losses in coral cover due to bleaching, with survival of only 30% of their nursery corals (Elkhorn Marine Conservancy, 2023).

Global temperatures on land have also soared in recent years including in the Caribbean; Antigua recorded temperature of 33°C in both August and September 2023 (WorldBank, n.d.-b). Average temperatures have increased between 1920 and 2024 (Figure 5.44), where the average temperature across that 104-year period was 26.6°C. All temperatures have been above that mean line since 1980 (Figure 5.44). While in the Paris Climate Agreement, countries pledged to limit global warming to less than 2°C, aiming for 1.5°C, a recent World Meteorological Climate update indicated a 66% likelihood of exceeding 1.5°C increase between 2023 and 2027.

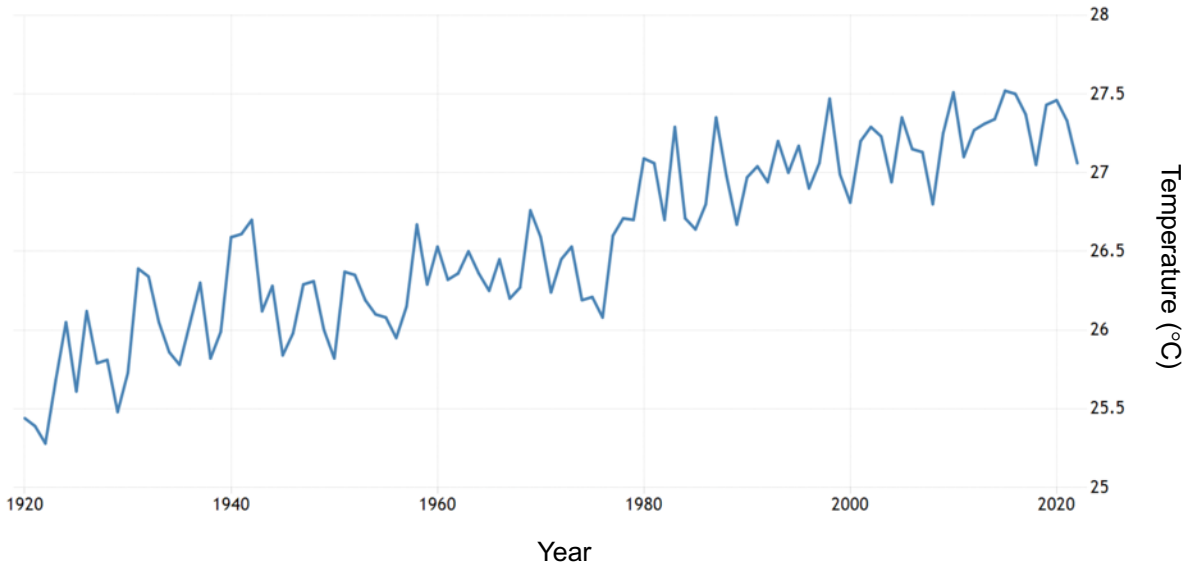


Figure 5.44: Monthly temperature data in Antigua and Barbuda between 1920-2024 (WorldBank, n.d.-b).

Beach loss from rising sea level and storms is a major concern for several beaches in Antigua and Barbuda. Beach tourism accounts for as much as 50% of GDP. Changes in rainfall are also a growing concern: droughts cause chronic losses in agriculture.

Natural disasters impose a huge burden on Small Island Developing States (SIDS) and climate change has raised the stakes. SIDS are constantly trapped in the cycle of attempting economic growth and incurring large debt to recover from the most recent natural disaster. This vicious cycle has impacted many SIDS including their ability to raise capital and invest in sustainability and climate resilience. The Rosewood Barbuda development has a responsibility to the island and to its shareholders to ensure that climate-resilience is central to its design and operations. This will also reduce any recovery “down”-time from natural

disasters, thus providing economic and RoI benefit and help to provide greater job and economic security to the community,

5.6 Socio-economic and Health Environment

The baseline socio-economic and health environment for the Rosewood Barbuda Resort development was assessed in two analyses: These comprised an archaeological assessment of the site and a socio-economic assessment and stakeholder engagement assessment and report.

The archaeological assessment was completed by Dr. Reginald Murphy, MBE, GOH, Ph.D., MA, (Antigua) a renowned expert in Antigua and Barbuda archaeology, to determine historical use and identify any areas of historical and cultural significance. Various artifacts and evidence of a small, previously unknown building were found on the site, however, Dr Murphy indicated that none of the findings were deemed to be of sufficient size, quality, and structural interest to justify it as an historical site of importance. However, the presence of an archaeologist during construction is recommended. The Strombus line runs through some of the development site and preserving this line is recommended. The full archaeological report is included in Section 5.6.2. The Martello tower is an important cultural and historic site that is outside of this development. However, the Rosewood Barbuda development has offered to help restore this site as a tourist and educational facility and support the Barbuda Council and community in this effort. The restored site would be under the ownership and control of the Council with support provided by the project.

The socio-economic assessment and stakeholder engagement report was conducted by Federico Scodelaro and Cristina Esteban. The report included two site visits, several stakeholder interviews, and desktop research. The Socioeconomic Impact Assessment was designed to explore the range of potential impacts, both positive and negative, that the project may have on the local community and the context in which they occur. A project of this scale can contribute to social and economic growth, but it may also impact local socioeconomic activities, traditions, and the environment. Understanding these broader social effects is also important for developing a mitigation plan that ensures the project is sustainable and inclusive. The study was carried out to IFC standards and accounting for the Ecazu Agreement. During the assessment, the authors made several attempts to meet with the Barbuda Council via the Chairman but were informed by the Council Chair that no meeting would be organized and instructed the assessment team that they were not to meet with Council members or other officials to present or discuss the project. However, the assessment team was able to conduct extensive interviews with community members and representatives and organizations. For ease of reading, a short summary is included here Section 5.6.3, and the comprehensive socio-economic report is provided in Appendix 8. We believe that the reader should consult the full and comprehensive report as it is not possible to include all details in the summary in this section.

5.6.1 Historic land use

The first known colonization of the northern West Indies is known as the Archaic Age, between 4000-2000 BP. In Barbuda, evidence of the Archaic Age is provided by a linear shell midden following the former southwestern shore of the island. This line currently extends through the proposed Rosewood Barbuda Resort site (Figure 5.45). This shell midden is called the

Strombus Line after the Queen Conch (*Stronbus gigas*) shells of which it is primarily composed.

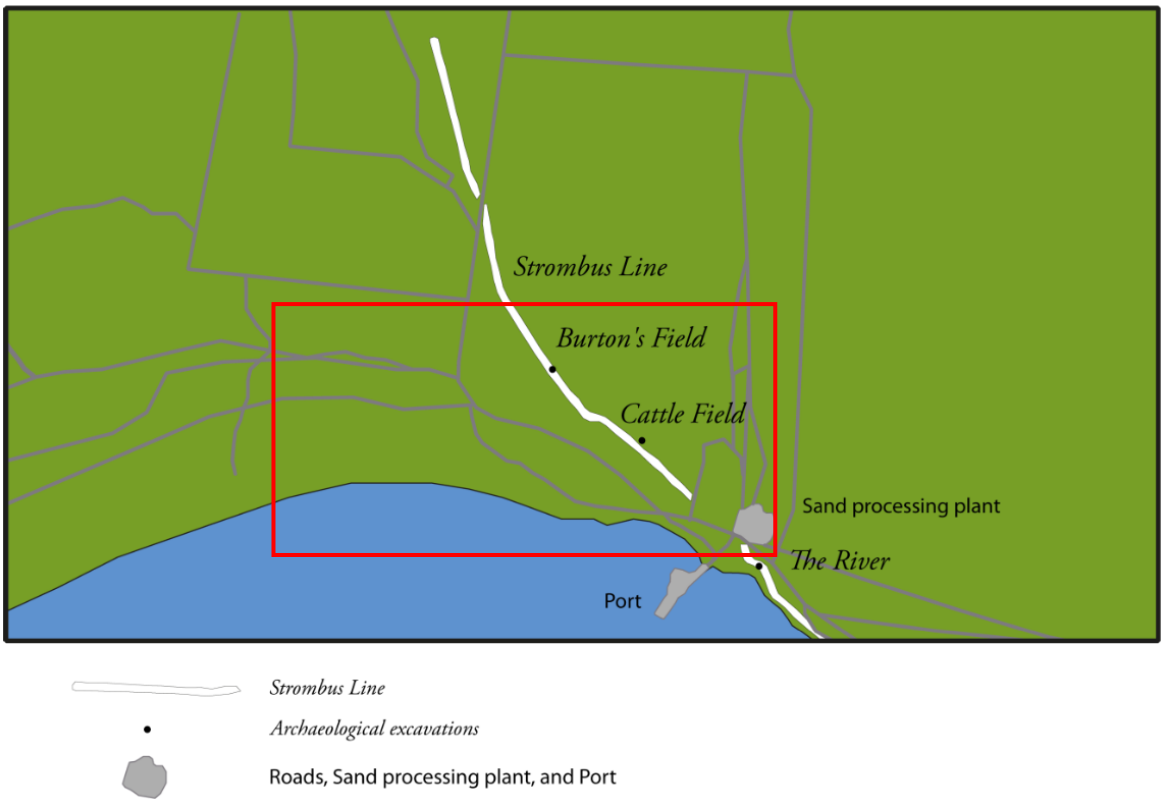


Figure 5.45 Map of the Strombus Line (Rousseau et al., 2017) showing the outline of the development site in red.

5.6.2 Archaeology

As part of its work in completing the ESIA for Murbee Resorts Inc., Deborah Brosnan & Associates commissioned an archaeological study to meet the requirements and specifications of the Terms of Reference issued by the Department of Environment. Dr. Reginald Murphy, MBE, GOH, Ph.D., MA, a renowned expert in Antigua and Barbuda archaeology conducted the study. He structured the assessment based on conducting an initial and rapid site assessment (phase 1), the results of which indicate if there are any key findings and determine any subsequent work if required.

Based on the findings of the Phase 1 report, Dr. Murphy indicated that a Phase 2 assessment of the River Area was warranted. The Phase 2 assessment included a two-day archaeological project that succeeded in locating small feature of an unknown building. As a “stand-alone” historical feature, it was deemed to be not sufficient in size, quality, and structural interest to justify it as a historical site of importance. This limits the site’s potential use as a heritage tourism site. If this structure is a part of the lost Palmetto House that dates to the same time as the artifacts excavated, it would be a significant find, but at present, this small single feature of unknown origin and function cannot be justified as a heritage site of importance unless there is historical documentation or additional archaeological research to support its importance as a historical site and or a place of memory.

The report by Dr. Murphy covers phase one archaeological analysis and the findings of the assessment.

5.6.2.1 Archaeology – Phase 1

Abstract

This rapid assessment provides an overview of the site to inform planning and guidance for research and additional archaeology, if necessary, prior to development.

Objectives

The objective of this project was to carry out a Phase 1 archaeological assessment of an area of land on the south coast of Barbuda known as the River (Figure 5.46 and Figure 5.47). A Phase 1 survey involves an initial desk research study to gain insights into the past use of the site, its topography, geology, biodiversity, current and past land use, and more. This rapid assessment provides an overview of what we know about the site and enables forward planning for research and archaeology. The desk study is followed by a physical assessment of the site by a walk-over inspection, testing, mapping, and collecting specimens for further study. The results of Phase 1 will determine if further work, Phase 2, which would include excavations, cataloging, analysis of artifacts, and considerably more scientific analyses, field time, reporting, and documentation, is necessary.

After two days of search and review of maps and archaeological research papers, the site visit was carried out from Wednesday, 5th June 2024, to Friday 7th June 2024. This was concluded by an additional two days of analysis and reporting.

Methods

A map of the area with the demarcated boundaries of the site to be surveyed was provided. The area was divided into four sections as outlined by the existing roads. The study assessed the area within the property boundaries. As discussed with the client, the historic 18th-century Martello Tower area was not surveyed because it is outside the Rosewood Barbuda property boundary. No archaeological sites are known to Dr. Murphy in the area proposed for the area of the new road. This study assessed the area within the property boundaries. The sections evaluated were as follows:

Section 1: The beach or southwest side of the road to the Palmetto Development.
Section 2: The inland area northwest of Section 1, on the road to Palmetto Development.
Section 3: The waterfront and beach area southeast of the Tower.
Section 4: The inland area northeast above the road from the sand sieving to the west.

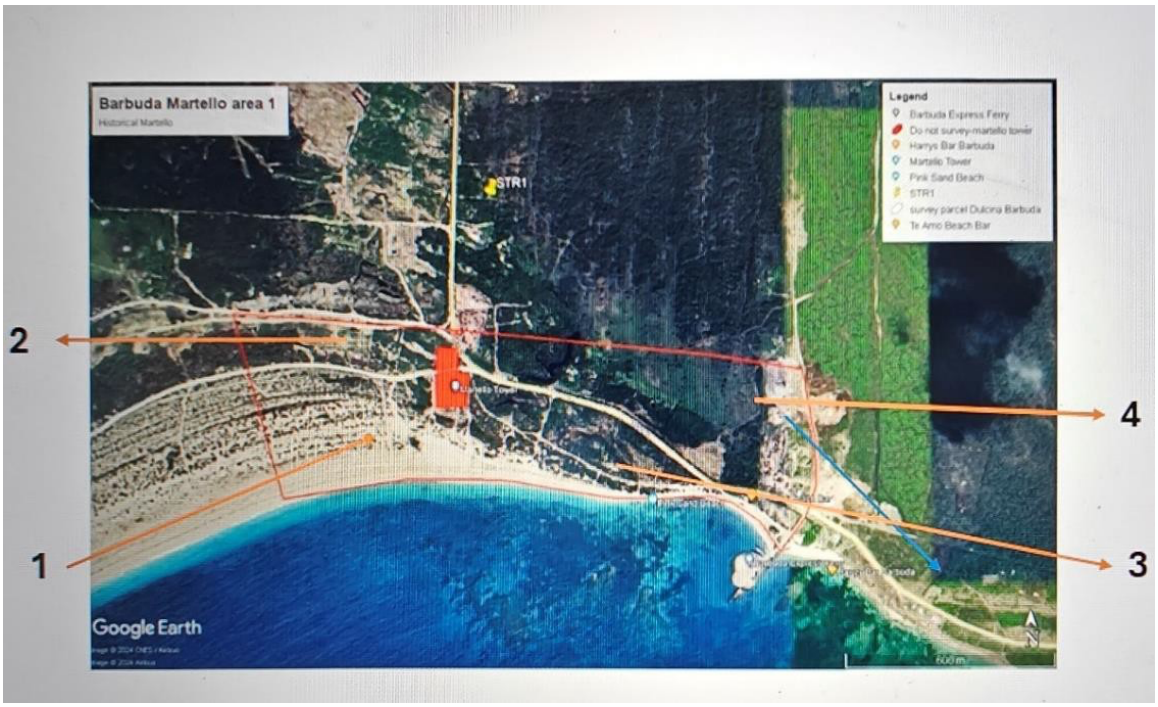


Figure 5.46: Map identifying each section surveyed.



Figure 5.47: Archaeological survey area, excluding the Martello Tower.

Physical setting descriptions

Section 1.

The current landscape is a mixed coastal dry tropical formation, bordered on its entire southern boundary by a pink and white sand beach. It is an extensive dune system with very few large woody species of trees. Cocoplum (*Chrysobalanus icaco*), and “gullfeed” (*Scaevola plumieri*)

dominate the dunes, but as one progresses inland the vegetation becomes more diverse and established. Behind the dunes the effects of human activities including roads, trenching for road drainage and security, as well as natural forces such as flooding, are evident. This sandy section has no historical period cultural materials, and the only objects found during the survey were modern refuse and the remains of a destroyed cottage close to the west fence line of the Martello fort.

Section 2.

This area has been extensively impacted by sandmining, that has removed meters of sand. A few large trees with mounds of sand provide evidence of the original surface level. The area is low and is the collection point for surface water from the large wetlands of the interior to the east.

The water course, also known as the River, drains into this area and then into the Codrington Lagoon. This area or Section 2, while interesting from an ecological perspective, it is sterile of historical cultural material, due to the mining activities.

Section 3.

The southeastern quadrant of the site, on the southern side or waterfront is the most developed quadrant. The port and landing pier and associated infrastructure mark the eastern boundary of the site. The pink sandy beach and dunes behind the beach are covered with vegetation. There are low areas of wetland on the northern side, beyond the dunes, where water is trapped by the road and feeds the black mangrove and brackish-water pool with numerous crab holes and woody species of trees. To the westernmost area, ruins of the former Rosewood Barbuda hotel structures and considerable amounts of modern garbage are to be found closer to the Martello Tower. This section was also devoid of any evidence of historical period materials.

Section 4.

Section four is the northeastern quadrant from the sand processing facilities in the east to the main road in the west. It is a large area of mixed landscape that includes ponds of freshwater, open pasture, and a substantial natural drainage system with isolated natural wetland pockets. It is also the only section with archaeological materials. The area was reportedly farmed until recently by the Burton Family. At the western area along the main road to Codrington, two lots have recently been cleared and partially fenced by persons unknown, not the developers of this surveyed area. Surveying of Section four located two areas with archaeological materials, both of historical importance to the history of Barbuda and the Eastern Caribbean. Location maps are presented in this report. The location was also mapped by surveyor Otto Kentish who was also carrying out a survey of the property.

Prehistoric Site and Feature

The first area of importance is perhaps the last remaining intact section of an archaeological deposition known as the Strombus Line, defined in Section 5.6.1. This “line” consists of exceptionally large depositions of conch shells creating a feature that began at Spanish Point and ends on the west coast of the island (Figure 5.48). Deep black sub-soil deposition noted from excavations nearby indicates ancient mangroves and a wetland environment of the paleo-shoreline. To understand the relevance of this area and site, it is necessary to provide a brief historical context, discussed in the History and Archaeology of the Island section.

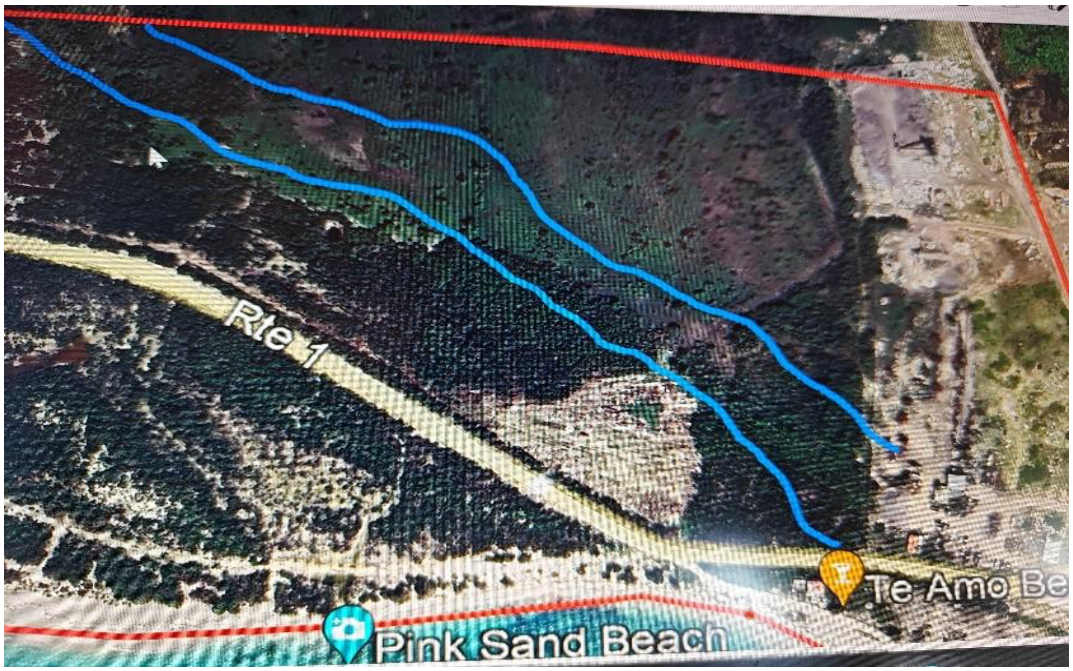


Figure 5.48: Blue line mark location of archaeological feature Strombus Line.

Findings in the Area of Interest (section 4)

Historical Period

The second area of historical interest was found along a new fence line being cleared on the property close to the westernmost end of the section and concrete columns were being erected at the SW corner. A backhoe was used during the clearing of the bush to place the fence posts and to run the wire. The clearing, which was done by persons not involved with the developers (or this development), uncovered evidence of an area of settlement. The artifacts include fragmented Delft tin-glazed ceramics, iron nails, loose bricks with lime mortar, iron straps, earthenware pottery, and fragments of glass bottles. These objects are of considerable age and are from either a domestic area associated with the Martello Tower, or an undocumented historical structure in the area.

5.6.2.2 Archaeology – Phase 2 Barbuda Excavation

Abstract

An archaeological survey conducted by Dr. Reginald Murphy in July 2024 noted 18th century ceramics and other artifacts on the surface in an area of interest. As nothing is known of that specific area, an excavation was requested to investigate evidence of any activities that may have taken place on the site during the historical period.

Background

A Phase 1 archaeological survey of the area north of the Martello tower (River Fort) in July 2024 identified an area with concentrations of historical period artifacts along a recently cleared

pathway where a fence was being installed. The clearing, which was done by individuals who are not involved with the developers (nor this development), had uncovered evidence of an area of a possible settlement. The artifacts are of considerable age and are typically found in areas of domestic activities. As the site is close to the Martello Tower or River Fort, it could be evidence of an undocumented historical structure that could have been related to activities at the fort. A Phase 2 archaeological study was therefore requested to investigate this new area of the archaeological interest. This phase involves standard archaeological methods of excavation, recovery of materials, analysis, documentation, and additional research to gain insights into the history of the site.

Research

Phase 2 research began with an archival review of the history of the area, particularly as it is associated with the Martello Tower or River Fort. Fortifications normally require support systems such as barrack structures for soldiers and support staff, stables, a kitchen, domestic structures, storage, and more. Discussions with Barbudans provided information that foundations of buildings once existed on the northeast side of the main road, in our area of interest. They further claimed that the structures were likely "recycled" for building materials. There were no foundations or clear evidence of structures, but the type and diversity of artifacts found in Phase 1 lends support to this claim.

The focus of Phase 2 study was therefore, to excavate all the areas where artifacts were recovered during the Phase 1 survey. Field time consisted of two days, and excavations were carried out on the 21st and 22nd of August 2024 by Dr. Reg Murphy, who was assisted in the excavations, sorting, and fieldwork by Barbudan Calvin Gore. A backhoe was used during the initial stages of excavation, scraping in layers of 4 cm. On exposure of artifacts, the excavations were continued by hand trowelling to sterile subsoil. The backhoe then continued excavating to an average depth of 1.5 meters of sterile soil. The sterile subsoil of this area was a deep layer of yellow/white sand. A total of eight units of varying sizes were excavated, a total of 27sq meters.

Findings

Findings were sparse in all but one unit. The most productive area was Unit 6, located between two tamarind trees. This area had four bricks, an iron nail, and two bottle bases on the surface. Ten centimeters below the surface, a brick feature or floor was uncovered. The upper portion of the feature had been sheared off, and no materials or rubble remained, to indicate the type and function of the structure. The artifacts recovered are listed below:

Excavation Units

- Unit 1. 2.0M x 3.0M (bottle bases, Staffordshire porcelain, conch, 2 bricks, iron nails)
- Unit 2. 2.0M x 2.0M (1 pc. Brick subsurface, 2 complete on surface)

Unit 3.	1.0M x 1.0M	(no artifacts)
Unit 4.	1.0M x 2.0M	(2 pcs. *Cittarium pica* shells)
Unit 5.	1.0M x 2.0M	(shells and brick fragment -2)
Unit 6.	3.0M x 3.0M	(brick floor feature with numerous findings)
Unit 7.	1.0M x 2.0M	(2 brick fragments surface)
Unit 8.	1.0M x 2.0M	(no artifacts)



Figure 5.49: Map of the archaeological site showing (a) the entire site (blue oval) and (b) the area of highest concentration and features (yellow pin.

The total number of artifacts recovered from this site was unexpectedly low. Most excavation units had no subsurface remains or evidence of structures, and the few artifacts were probably disturbed and redeposited during the recent fence line clearing activities that used a backhoe. Subsurface artifacts were primarily marine molluscs, and these were expected considering the proximity of the Strombus Line and the marine environment nearby.

The area of exception was Excavation Unit 6, where a feature and likely source of the scattered surface bricks was finally located. The feature was a brick covered "floor" that appears to have had a raised circular edge. There were a few remaining bricks on the outer edge, indicating that there were sloping sides, like an ornamental pond or water feature. Some of the bricks were glazed and the bedding material was lime mortar on limestone rubble stones. This area also yielded two pieces of Staffordshire green and yellow glazed brown earthenware pottery, broken glass bottle bases, a spent pistol musket-ball, and bricks with rounded shaped ends. The north side of the feature had evidence of a paved subfloor with lime mortar and brick surfacing. Flat earthenware pottery typical of roofing tiles were also uncovered nearby. The feature was left intact and backfilled with sand. Its depth is 10 to 25 cm below the surface.

It is 1.90 meters by 1.70 meters with an additional 75 cm of lime rubble sub-base on the north side. The complete excavation of this feature would have required about a week of field time and additional archaeologists. Small pieces of iron straps, a small iron nail, and small pieces of colonial-period ceramics were observed on the surface. The “site” is located between to two tamarind trees along a recently cleared access path where a fence was being erected. No other artifacts were observed in the forested area beyond the feature. Of interest is that the site is marked by two tamarind trees, one considerably older that the other.



Figure 5.50: Brick floor from an unknown structure

Date of Site

The date of the site is based on the (mean) manufacturing dates of the artifacts found in context with the feature and surface nearby. This indicates that the site was likely occupied in the early 1700s until the mid to late 1800s. The date where all the artifact dates overlap is about 1750 but the number of artifacts found is too low to provide an absolute date. However, this relative date reflects a period of colonial development and prosperity for the Codrington family estates on Antigua and Barbuda. The structure may have indeed been part of the Martello Tower and landing area land use in an area cleared for farming, defense, and other activities (see Tweedy Maps below).

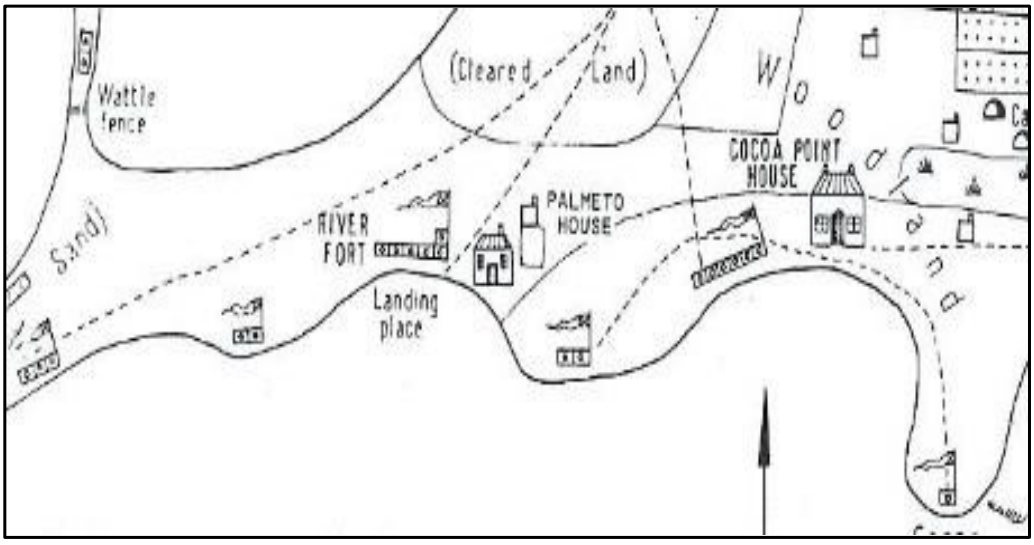


Figure 5.51: Tweedy map of Barbuda: Landing, River Fort and Palmetto House area.

Materials recovered and manufactured dates

- Delft plate and bowl fragments (1640 – 1800)
- Broken gin bottle (1680s to 1850s)
- Staffordshire bowl fragments (2) 1580 - 1800
- Creamware (not dated)
- Salt glaze English white (1690 – 1770)
- Unglazed earthenware, kiln fired (14 pcs)
- Unglazed earthenware (local pottery/Afro-Antiguan) (2 pcs)
- Stoneware jar fragment (1) 1690 – 1780)
- Section of clay tobacco smoking pipe stem (thick stem with small borehole) (1) (1750 – 1800). The pipe was well-used, and the short stem had bite marks.
- Brown interior glazed earthenware jar fragment (1) (not dated)
- Antigua Long Island flint (fire striker) (2) (not dated...likely salvaged from the prehistoric site nearby)
- Small lead-ball (pistol) (1) (not dated)
- Iron strap (possibly barrel hoop section) (2)
- Bricks (2” height by 4” width by 10” long)
- Iron nails (5)
- Marine shellfish (conch, whelks, clams) (15 pcs)
- Tooth (goat, deer, or sheep) -to be identified.
- Small piece of long bone (goat, deer, or sheep)

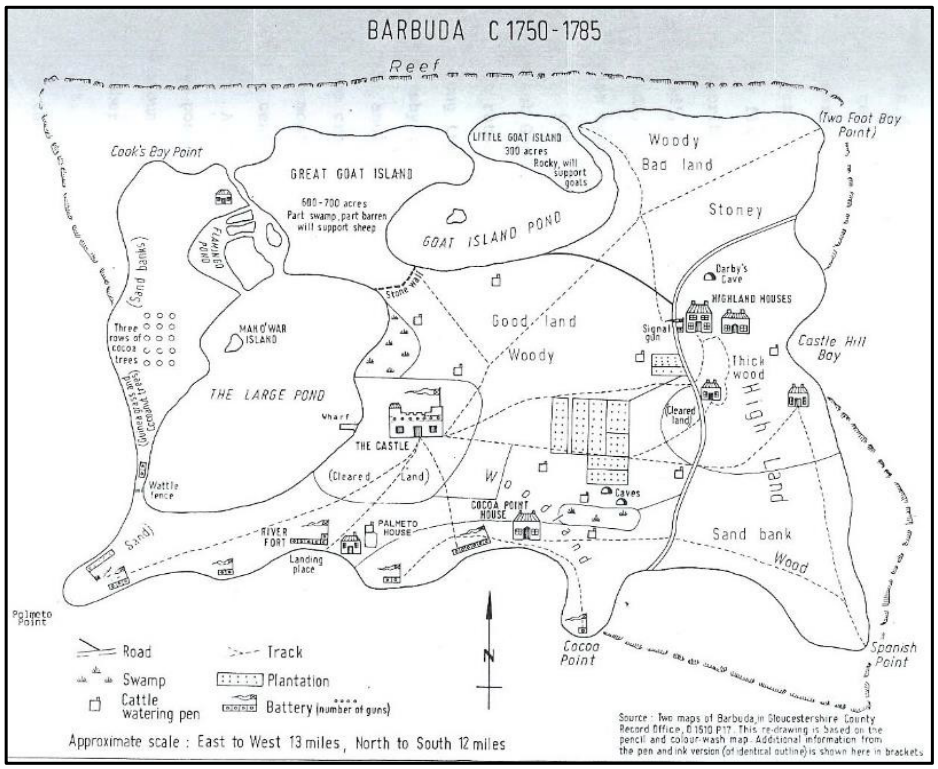


Figure 5.52: Map of Barbuda 1750-1785

Discussion

The primary questions for this Phase 2 archaeological investigation are:

1. *Is there archaeological evidence for an area of settlement in this area close to the River Fort/Martello.*
2. *What is the significance of the findings and their contribution to the history, knowledge and values of the area/site?*
3. *What is the date of the site or period of occupation?*
4. *How does the site and findings impact potential reuse of the site?*
5. *Can the feature and site add any heritage tourism values to the island?*

The majority of objects found at the site were ones typically associated with British historical period structures and “domestic” sites. They included tableware, bottles, food remains, glass fragments, iron nails, and pottery. These items found were not significant enough in quantity to clearly determine the use of the site in a domestic capacity.

Numerous bricks were found with residue of lime mortar, indicating that they were at one time used in a structure. The partial remains of an unknown feature or floor was discovered in excavation unit 6, but it was disturbed and too small to determine its function.

Food remains, an animal tooth, a piece of long bone (to be identified), and a stem from a tobacco smoking pipe were also found within the excavated structure, and bases from bottles were also recovered, but not in sufficient numbers to confidently state that the site was a domestic structure. Long-term residential areas create considerable midden deposits, and a

structure of importance would have had foundations and would have been placed on the maps of the time.

Items of particular interest are the numerous bases of wine bottles found across the site. Bottles are not easily obtained, so they retain value, and were frequently recycled, so it cannot be assumed that they were necessarily being used for alcohol. Also of interest is the short section of the smoking pipe. The bowl was missing entirely, but when in use, smokers had to bite the end of the stem firmly between their teeth, and this left observable wear marks. It can also be questioned who the user was. Clay pipes were cheap, so quickly discarded by the smokers. As an artifact, another question is, was this pipe "salvaged" and reused, or was it cherished "to the end"?

Two sherds of likely African-Antiguan "slave" pottery were recovered. These were typically found at all colonial sites as they were ideal for cooking and storage and were easily replaced. However, the English ceramics and material culture was far more dominant, which indicates that the structure was occupied by persons of status and not the enslaved Africans.

The archaeological materials or findings from the site clearly indicate that there was a structure or structures and that alcohol, food, and tobacco were consumed. This is supported by the types of artifacts listed above. These objects provide a "relative date" of the site occupation between the 1650s to 1800 at the extreme, but clustering between 1700 and 1800. The quantity of the findings and brickwork are not sufficient in size, which may reflect the limited field time, to determine the purpose or function of the structure. However, it would be logical to state that it was likely related to the nearby fort and its required outer infrastructural and management needs. The few pieces of glazed bricks and ceramics suggest a connection, perhaps links to the island's managers and visiting elite from Antigua who visited Barbuda for hunting holidays. Another line of thought could be a supervisor's station for controlling exports such as livestock and produce, but this is speculative without further evidence.

An inspection of the Tweedy map shows a structure known as Palmetto House situated close to the River Fort and Martello. However, the map is not to scale and cannot be used to support evidence that the brick floor and materials found are from the long-lost Palmetto House. However, as no precise location for the house is currently known, it cannot be discounted.

Conclusion

In conclusion, the two-day archaeological project succeeded in locating a small feature of an unknown building. As a "stand-alone" historical feature, it is not sufficient in size, quality, and structural interest to justify it as a historical site of importance. This limits its potential use as a heritage tourism site. However, very little is known about it, and if it is indeed a part of the lost Palmetto House that dates to the same time as the artifacts excavated, it would be a significant find. Regardless, additional excavations with a larger team, longer time in the field, and further archival research will be needed.

In sum, a small single feature of unknown origin and function cannot be justified as a heritage site of importance unless there is historical documentation or additional archaeological research to support its importance as a historical site and or a place of memory.





Photo of coarse English earthenware.



Photo of bricks on site.



Photo of pistol ball.

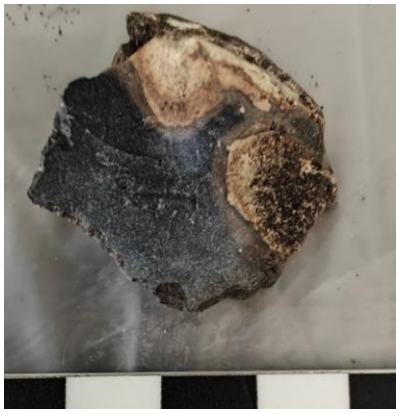


Photo of Long Island flint used as a fire starter.



Photo of iron spikes.





Photo of clay tobacco smoking pipe stem and pottery.



Brick floor excavation.



Excavation unit 1-5, topsoil on sand base.



Photos of brick floor during excavation.





5.6.3 Socio-economic assessment and stakeholder engagement report

A summary and primary conclusions of the socio-economic assessment and stakeholder engagement report is outlined but we recommend reading the full assessment in Appendix 8.

The socio-economic analysis conducted for the project was structured around primary field work and secondary data collection. Secondary data was gathered from authoritative sources such as government statistics, reports from international organizations, including the World Bank and United Nations, and academic studies. This data provided a solid foundation for understanding key demographic trends, economic conditions, and social dynamics in Barbuda, serving as a backdrop for the more localized insights gathered through fieldwork.

Primary fieldwork played an essential role in grounding the analysis in the realities of the Barbuda community. Two field visits were conducted in Codrington and surrounding areas. These visits included site inspections, stakeholder interviews, and public consultations. The first visit (July 2024) focused on the socio-demographic analysis and initial stakeholder engagement. During this time, interviews were conducted with representatives from various sectors, including education, healthcare, construction, hospitality, fishing, and public services. These interviews provided qualitative data that offered a nuanced understanding of the potential impacts on different community groups. Observations of key community amenities and their usage patterns were also recorded.

The second visit (August 2024) aimed to validate initial findings through further public consultations and data verification. This stage of the research was vital for ensuring that the conclusions drawn from the analysis accurately reflected the experiences and concerns of the local population. By integrating public feedback into the assessment, the project team sought to build trust and engage meaningfully with the community, ensuring that local voices played a significant role in shaping the development's social strategy.

In addition to local data and fieldwork, the social impact assessment aligns with international regulatory frameworks, such as International Finance Corporation (IFC) Performance Standards. These standards are widely recognized as best practice guidelines for managing environmental and social risks in development projects. The project aligns with IFC Performance Standard 1, which focuses on the Assessment and Management of Environmental and Social Risks and Impacts. This standard requires a systematic approach to identifying, managing, and mitigating risks throughout the project lifecycle, from planning to construction and operation.

The socio-economic analysis for the project aims to establish a thorough understanding of the demographic, social, and economic characteristics of the affected population. This baseline data is crucial for identifying potential impacts during both the construction and operational phases of the project. Key aspects of the socio-economic environment that were analyzed include population trends, employment patterns, income levels, and the structure of local economic activities.

Understanding the cultural and social dynamics of the Barbuda community was also a primary objective of the analysis. Barbuda's culture is deeply rooted in its natural environment, and the community has traditionally engaged in activities such as fishing and small-scale farming. These activities not only sustain livelihoods but also form the backbone of the island's social fabric. By analyzing these dynamics, the socio-economic assessment provides insights into how the resort project might influence local traditions, social networks, and cultural practices.

The assessment also includes a detailed identification of stakeholders, ensuring that all affected groups are considered in the planning process. Key stakeholders include local

residents, business owners, workers in the fishing and sand mining industries, and representatives of cultural and historical institutions, such as those responsible for the preservation of the Martello Tower. Engaging with these stakeholders was critical for understanding their concerns and ensuring that their perspectives were integrated into the project's social management strategy. Attempts to meet with the Chair of the Barbuda Council were not successful, and he indicated he did not wish the team to engage with Council members. However, there were several key stakeholder engagements, and the findings and input of these stakeholders is provided in the full report in Appendix 8.

The potential social impacts and risks of the project were evaluated. The key social impacts identified include:

- **Road and Traffic Impacts**: Increased traffic during both construction and operational phases could disrupt local mobility and access to essential services.
- **Occupational and Community Safety Risks**: Construction activities pose risks to both workers and the community, including the potential for accidents and safety hazards.
- **Cultural Heritage**: The presence of the Martello Tower within the project area raises concerns about potential damage to cultural and archaeological heritage.
- **Impacts on Utilities**: The project could interfere with essential services such as water and electricity, particularly during construction activities.
- **Impacts on Employment and Economic Activities**: While the project is expected to generate new jobs, it may also disrupt existing economic activities, particularly in sectors like fishing and sand mining.

To mitigate these potential impacts, the project will implement a comprehensive Social Management Plan (SMP). Key programs within the SMP include:

1. Monitoring and compliance control
2. Occupational and community health and safety programs
3. Traffic and pedestrian management strategies
4. Community information and participation initiatives
5. Grievance Redress Mechanisms to address community concerns.
6. Socio-environmental training for workers
7. Cultural heritage preservation and archaeological contingency plan
8. Gender equity and inclusion programs
9. Fishermen’s livelihood restoration plans

Table 5.15 presents a matrix outlining potential impacts of the project on various receptors, along with corresponding impact evaluations, mitigation programs, and residual impacts, and Table 5.16 highlights key areas for consideration to guarantee the effective implementation of social measures at all stages of the project.

These programs collectively ensure that the project balances development goals with the well-being of the Barbuda community, supporting a sustainable and socially responsible approach.

Finally, the project represents a significant investment in Barbuda's future, promising economic growth, job creation, and enhanced infrastructure. However, the success of the project will depend not only on its ability to deliver these benefits but also on its capacity to manage and mitigate the social risks associated with large-scale development. Through a thorough socio-economic assessment, adherence to international standards, and the implementation of a robust Social Management Plan (SMP), the project aims to foster sustainable development that respects the unique cultural and social fabric of Barbuda while enhancing the community's quality of life.

This Social Impact Assessment serves as a comprehensive tool to guide the project in balancing economic objectives with social responsibility, ensuring that the Rosewood Barbuda Resort Development contributes positively to both the local community and the island's broader socio-economic landscape.

Table 5.15: Summary of social Impacts and Mitigation.

Receptor	Potential Impact	Impact Evaluation	Mitigation Program[1]	Residual Impact
Community Safety	Road and Traffic Impacts	Construction phase: Negative Operational Phase: Positive	Traffic and Pedestrian Management Community Information and Participation	Negligible
Local Economy and Livelihood	Impacts on the River Dock	Negative	Community Information and Participation Program to mitigate impacts to economic activities	Moderate
Community safety	Interferences with main utilities (water or energy)	Negative	Coordination with Service Providers. Interferences	Minor
Community safety	Risk of accidents	Negative	Occupational and Community Health and Safety Traffic and Pedestrian Management	Minor/ Moderate
Local Economy and Livelihood	Impacts on employment, business, and services	Positive	N/A	N/A
Local Economy and Livelihood	Impacts on economic activities settled in the operational area (Sand mining, construction activities, fishers' activities)	Negative	Community Information and Participation Grievance Redress Mechanism Program to mitigate impacts to economic activities	Minor/ Moderate

[1] For all impacts, Monitoring and Control of Compliance with Mitigation Measures Program is considered

Receptor	Potential Impact	Impact Evaluation	Mitigation Program[1]	Residual Impact
			Fishermen livelihood restoration plan	
Cultural heritage	Negative impacts on cultural and archaeological heritage	Negative	Cultural heritage preservation Plan Archaeological Contingency Plan	Minor
Community safety	Landscape and public space	Positive	N/A	N/A
Local Economy and Livelihood	Economic development	Positive	N/A	N/A

Table 5.16: Key areas for consideration to guarantee the effective implementation of social measures at all stages of the project.

No.	Specific area	Consideration and recommendation
1	**Strengthening Stakeholder Engagement and Communication Channels** **Ongoing Public Socialization and Participation:**	Create continuous opportunities for public participation throughout the project's lifecycle: • **Socialization of the Final ESIA** (Environmental and Social Impact Assessment): Once the ESIA is finalized, socialize its findings and the mitigation measures planned. This ensures transparency and community understanding of the project's environmental and social impacts. • **Regular Project Updates**: As the project moves forward, maintain a steady flow of communication with the community through newsletters, meetings, and digital platforms. These updates should cover project progress, important environmental and social measures taken, and anticipated milestones, such as construction completion timelines. • **Pre-construction and Operational Communication**: Before construction starts, organize public engagement sessions to update the community on final timelines, mitigation strategies, and construction phases. During the operational phase, continue to inform the public of any changes, impacts, or relevant developments. Establish a formal communication channel to create reliable and private communications between the project developers and the community, including an institutional email address and regular follow up meetings with key community groups, including fishers, business owners and local institutions.
2	**Fishermen and Dock Relocation**	Engage with the local fishermen to negotiate and agree on a suitable relocation site for the dock, ensuring minimal disruption to their livelihoods. • **Collaborative Decision-making:** The project team should work closely with the fishing community to identify an alternative docking location in the south of the island that is both accessible and safe. Meetings should be held to address the concerns of fishers and agree on a mutually beneficial solution. • **Dock Improvement Plan:** Once the relocation site is chosen, create a plan that includes upgrades and infrastructure that will benefit the fishermen, ensuring that they have the facilities needed for their work post-relocation.

No.	Specific area	Consideration and recommendation
3	**Cultural Heritage Preservation and Community Engagement**	As the Martello Tower is within the project area and holds cultural significance, it is imperative to: • **Define Responsibilities for Restoration**, including the development of the restoration plan • **Community Consultation and Transparency**: Share detailed plans with the local community regarding how the Martello Tower will be preserved. This includes a public presentation of the timeline for restoration, renders, materials to be used, and any other heritage preservation actions.
4	**Economic Compensation and Support for Affected Businesses**	Provide clear documentation to the community regarding the compensation agreements made with business owners affected by the project. These documents should include: • **Compensation Details**: Specify the types of compensation offered, such as financial payments, relocation assistance, or alternative business opportunities. This ensures transparency and addresses any concerns about fairness or exclusion. • **Public Presentation of Agreements**: Hold community meetings or release documents outlining the specific conversations held with business owners in the area, making it clear how each will be compensated for any loss or disruption of business.



SECTION 6.0 ANTICIPATED ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

The Rosewood Barbuda project has benefits to the community but also carries risks that must be avoided or mitigated.

The steps involved in the assessment of impacts and risks are:

1. **Identification of risks and impacts** – determine what can potentially occur at all stages of the project including site preparation, construction and operational phases based on the project design and planned activities and the environment on which the project can take place.

2. **Assessment of risks and impacts** – evaluation of the significance and potential severity of impacts and risks, considering their occurrence probability, magnitude and sensitivity of the environment.

3. **Identify risk types** – those that can be avoided (and should be avoided); mitigated and those which cannot be mitigated

4. **Identification of mitigation actions** – identify appropriate measures for mitigating negative impacts and enhancing positive impacts.

5. **Assessment of residual risk** – evaluate the significance of impacts assuming successful and effective implementation of all mitigation measures.

6. **Monitor and review**

7. **Risk/Impact compensation**. For risks that cannot be mitigated compensate for the risks.

During the project, all efforts will be made to avoid and mitigate for environmental impacts. Potential impacts, their severity and any mitigation measures are outlined in Table 6.2. Avoidance is the first and preferred option to manage negative environmental risks. If the impacts are unavoidable, mitigation measures will be implemented on site to reduce the effects. Finally, if an impact cannot be avoided or sufficiently mitigated for on site, compensation for the impact should be undertaken and at an external site and at a ratio identified by the regulatory agencies.

Cumulative impacts typically result from incremental impacts that compound when added to past, present and reasonably foreseeable future actions. Actions by third parties, e.g. government, other developments, or different sectors, are relevant when considering cumulative impacts.

Monitoring and adaptive management are essential tools in mitigating risks. These are discussed in more detail in the Environmental Monitoring and Management Plan (EMMP) in SECTION 8.0

The development includes three specific phases each of which carry particular risks.
1. Site preparation phase
2. Construction phase
3. Operational phase

The phases are inter-related as for instance changes to the landscape during site preparation and construction can cause operational risks.

The risk and impact assessment was prepared principally by Dr. Holly Trew. It is based on the likelihood of the hazard or impact occurring and the potential severity of the impact. The

assessment uses the risk assessment matrix provided by the Department of the Environment in the ToR for this ESIA. This matrix is show below in Table 6.1. The description of each risk or impact, its significance, mitigation measures to be employed, and residual risk are detailed in Table 6.2.

Table 6.1: Risk assessment matrix

	Severity of Impact		
Likelihood of hazard/ Impact	Low	Medium	High
	Medium	Low	High
	High	High	High

Table 6.2: Summary assessment and mitigation of environmental impacts, where risk significance is designated as low, medium or high.

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
Land Environment	Soils	The soil in this area is primarily comprised of sand and limestone. In Section 5.1.1, the soil analysis showed that nutrient levels (nitrates and phosphates) were elevated in some areas in the site, while the geotechnical report indicated that the soil structure was generally weak and highly porous. The water table was recorded at 0.2-7.3 m below the surface. Clearing and grading of the site will involve disturbance and removal of a portion of the topsoil. This may be replaced by new topsoil once grading/construction are complete, and landscaping commences.	Medium on land, to high for marine life	During the site preparation and construction and operational phases, the soils of the plot could be impacted by soil leaching or runoff during rains. These impacts can be managed through pre-designed stormwater and discharge management plans. To maintain nutrient levels in the soil within mandated levels across all phases, the use of nitrogenous compounds, like fertilizers, should be controlled.	Low, if proper nutrient and management are maintained
	Light pollution		Medium	Once the development site is fenced and secured there will be additional security lighting. Any construction activities outside daylight hours will require addition spot lighting. Since artificial lighting is currently not present across much of the development site, there will be an increase in light pollution. During the operational phase, lights will be present on all buildings, roads	Medium

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				and structures throughout the development. However, there will be no spotlights directly near the beach, and mature vegetation in the proposed constructed wetlands and landscaping will break up well-lit areas. Any future sea turtle nesting may be impacted.	
	Beach erosion	The development site borders the coastline, which is considered relatively stable to accreting.	Currently low but risks increase with SLR and potential development	Throughout the site preparation, construction and operational phases there should be a ban on driving of vehicles or heavy machinery on the beach. Setbacks for construction as mandated by the DoE are 60 m on the zone to the west of Martello Tower, and 40 m for the zone to the east. Sand dunes will be created to a height of 4 m along the back of the beach to protect against storm surge. These will be thoroughly planted with local dune vegetation to stabilize the beach and prevent erosion.	SLR will continue to be an ongoing risk for SIDS, including Barbuda. Short term risks will be low if setbacks and mitigation are adhered to properly.
Air environment	Air quality	The eastern side of the development area is already subject to high levels of dust in the	Medium to locally high	During the site preparation and construction phases, dust can be generated, and this will be	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
		air due to the batch plant and sand mining activities on unpaved roads.		suppressed using water, preventing airborne particles leaving the immediate site area. Freshwater does not need to be used for this. Other methods of dust suppression include: • Paving or sealing any new roads created. • Clearing vegetation in staged manner. • Use of water trucks to spray down exposed areas or surfaces. • Sealing and/or re-vegetating disturbed areas as soon as possible after completion of each stage of construction works. • Planning haulage routes on sealed surfaces and using dust suppression on unsealed roads within construction sites. • Covering loads on public roads. • Using wind breaks. • Minimizing double-handling of materials. • Seeding, stabilizing, covering, or containing stockpiles where necessary The completed development will benefit from various trees and vegetation, as well as paved roads,	

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				that will contribute positively to the overall air quality in the area.	
	Cyclone frequency	The frequency of tropical storms and hurricanes is predicted to increase due to the effects of climate change.	High	Damage to the property from storms can be mitigated for based on design of the site and buildings. Measures that will be incorporated here include: • Appropriate setbacks, here 40-60 m as mandated by the DoE. • Construction of 4 m sand dunes to physically block storm surge. • Thorough planting of beach and dune areas to minimize beach erosion from storm surge. • Design of buildings to hurricane standards and use of appropriately rated materials. • Implementation of the hurricane preparedness plan described in Section 7.0 and Appendix 6.	These impacts are due to external factors associated with climate change and not site-related actions. These risks can be reduced but not eliminated and remain at medium risk.
Noise environment	Noise pollution	Noise pollution from construction activities can impact the surrounding environment and workers on site. Once all construction phases are complete, no noise pollution is anticipated.	Medium during site preparation phase, High during construction phase, Low during operational phase	Site preparation and construction should be completed during daylight hours and can be restricted under the Physical Planning Act. There are few neighbouring properties that will be impacted by construction outside daylight hours, but construction noise may still impact the biological environment, including nocturnal sea turtle nesting activities.	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
Water environment	Climate change and sea level rise	Climate change is associated with global temperature increases and sea level rise (SLR). SLR is particular concern for low-lying island nations, like Antigua and Barbuda, and coastal developments. This ESIA focuses on how natural ecosystems can be leveraged to mitigate some of the impacts of SLR and climate.	High	Mitigation methods specifically include: • Maintaining healthy seagrass and coral reef communities that can continue to grow and accumulate sediment to provide natural protection against increased sea levels and storm surge. • Maintaining healthy beach vegetation to reduce erosion from higher sea levels. • Design of the development with climate-resilient setbacks from the sea (40-60 m in this case) and no vertical structures on beach areas to facilitate scouring erosion. • Siting of critical infrastructure at low-risk locations within the development. • Incorporation of integrated constructed wetlands to naturally reduce flooding, provide a sink to recharge local groundwater, act as a buffer against and enhance wetland habitat for native species.	These impacts are due to external factors associated with climate change and not site-related actions, these risks can be reduced but not eliminated and remain at medium-high risk.
	Water quality	There are several upwellings of fresh or brackish water on the site, and the site is on the coast.	Medium	Prevent excessive runoff or discharge from both the construction site and operations of completed development by having adequate	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				waste retention and processing facilities on site. Water used for dust suppression and other construction-related activities will be retained on site. Ensure safe disposal of all waste materials from both construction and operations. The water source of the proposed created wetlands will be rainfall and runoff from the highlands. This water will flow across the surface and limestone subsurface of the island to the development site, during which period it may accumulate contaminants. The water entering and circulating throughout these wetland systems will be monitored during both construction and operational phases to ensure acceptable levels are maintained to support these wetland ecosystems. Water from the wetlands and sea adjacent to the site will also be tested throughout the construction and operational phases to ensure acceptable levels are maintained in accordance with the water quality standards for Class A waters as outlined in Schedule VII (Part C)(2)	

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				of the EPMA (2019). These are fully outlined in Section 8.4.1.	
Biological environment	Effects on native vegetation	The vegetation on the site is comprised of native assemblages, including several native tree and plant species protected under the EPMA (2019). These assemblages and species are detailed in Section 5.4.1.	Medium	Prior to site preparation, all individuals of the protected and native plant species should be identified on site and either salvaged to a nursery environment to be replanted after construction or conserved in place. The constructed wetlands that form the centrepiece of the development will be highly planted with native plant species to enhance pre-existing wetland ecosystems. Thus, many more native plants will be present by the operational phase. Beach vegetation along the coastline, which forms the line of permanent vegetation, and aids in protection against beach erosion. Landscaping and planting in the development, and specifically in the constructed wetlands, will utilise native flora as much as possible and will focus on mangrove enhancement and restoration, and replanting vegetation along the coastline.	Low-Medium

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
	Terrestrial wildlife		Low	The terrestrial wildlife populations present will be inconvenienced during the construction phase. Mobile animals such as birds, lizards, etc. will likely relocate and will be able to recolonize the area once the work is finalized. No red-footed tortoise or deer (neither are native) were recorded during the wildlife surveys, but the development should monitor for their presence and protect and relocate any observed tortoises that may wander onto the site. The completed development will include a richer habitat assemblage than the current one in that; wetland habitats that are currently degraded will be restored and expanded, and landscaping efforts will focus on planting native species. The aim is to create and restore native ecosystems and assemblages that will be more attractive to both native and migratory species, and facilitate the growth of highly connected ecosystems. Overall, the development does not represent the destruction of	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				important bird or wildlife habitat and aims to enrich the habitat in the area.	
	Seagrass health	There is extensive seagrass habitat along the entire coastline of the development. This described in Section 5.4.6.1.	Medium	Coastal runoff into waters must be controlled so that the development does not impact the seagrass habitat. The existing environment in near the ferry dock is currently highly disturbed due to boat activity. Seagrass health, cover and species composition will be assessed during regular monitoring as outlined in the EMMP.	Low
	Coral reef health	There is considerable coral reef habitat along the coastline of the development, with higher concentration in the middle and eastern side. This is described in Section 5.4.6.1. The live coral cover on the reefs is low and evidence of physical impacts of boats on the reef was observed.	Medium from the development but high from climate change.	Coastal runoff into waters must be controlled so that the development does not impact the coral reef ecosystem. Establish coral reef gardens in the nearshore coral reef habitats to protect biodiversity and increase bio-diversity-based tourism. Coral health, cover and species composition will be assessed during regular monitoring as outlined in the EMMP.	Low from the development but mitigation will not eliminate impacts from climate change and higher sea temperatures.
	Fish	Nearshore fish communities were assessed during the marine surveys described in Section	Low	Coastal runoff into waters must be controlled so that the development	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
		5.4.6.1. Some ecologically important species (e.g. parrotfish) and commercially important species (e.g. spiny lobster, Nassau grouper, red snapper) were present.		does not impact the nearshore fish community is anticipated. Ongoing assessment should include coastal water quality and marine surveys.	
	Sea turtles	Several sea turtles have been observed in the waters directly offshore of the beach at the development site. Nesting sea turtles (hawksbill and leatherback) have been documented on the beaches on the western side of the development site, towards Palmetto Point. These species are classified as Critically Endangered by the IUCN and is essential that their nesting activities are not disturbed.	Medium	Since their nesting activities predominantly occur at night, it is essential that • Loud noises (>80 dBA) from construction are constrained to daylight hours, • No bright white lights are located on or near the beach, or shine directly onto the sea, • Sea turtle friendly lighting with red bulbs may be used near the beach in nesting areas, • Any established nests are fenced off. These policies are applicable during both construction and operational phases of the development. All construction subcontractors and personnel will be trained in the best management practices for recognition of nests and nesting activities.	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				If any nesting is observed, contact the Barbuda Sea Turtle Monitoring Team	
Socio-economic environment	Culture	Although the archaeological assessment of the site indicated that none of the findings were of sufficient size, quality, and structural interest to justify the site as one of historical importance, various artifacts were uncovered, and the historically relevant Strombus line is present on the site. The Martello tower is an important cultural and historic site that is outside of this development. The Rosewood Barbuda development has offered to help restore this site as a tourist and educational facility and support the Barbuda Council and community in this effort. The restored site would remain under the ownership and control of the Council with support provided by the project.	Medium	Restoration of the Martello Tower and preservation of the Strombus line will provide cultural and educational benefit. An archaeologist should be present on-site during construction. Provide locally-guided cultural and educational tours for guests. These should also be available to non-local workers to educate them on the importance of local traditions. The project should actively engage with the community in a transparent manner to help integrate and protect the cultural traditions that are important to the Barbuda community. Regular meetings with community representatives about the project will improve communication and help to build trust and dialogue. Establish a community liaison officer position.	Low, provided mitigation measures are adopted

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				Support community initiatives that have been identified by the community as ones that are important and relevant to community members.	
	Human health	This related to (1) protection of workers and personal protective equipment, and (2) potential for diseases on site, with specific focus on mosquitos as vectors.	Medium	During the site preparation and construction phases, health and safety standards will need to be enforced for the safety of the construction crews and staff. Dust and noise will result from the construction and should be minimized to reduce impacts on the workers and community. Once operational, the project is not expected to create any significant additional risks to human health. The development should take recommended precautions to reduce the density of disease-transmitting mosquitos, including stocking the constructed wetlands with fish and encouraging local bat populations. A health and safety manger should be employed.	Low
	Maintenance of public beach	The beach at the eastern side of the site, near the ferry dock, is commonly used by fishermen and recreationally by members of the	High	Provide adequate access at the western side of the property and maintain access at the port side.	Low provided the mitigation measures are

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
	access and beach use	local community. Several fishing boats are kept on the beach that will be part of the property. Beach access will not be maintained throughout the length of the property but will be provided for at the West side. There is an existing beach bar on the property. We are informed that the owner considers it a temporary "pop-up" type bar and is aware that he must relocate it, but nonetheless it is currently used by the local community.		Address the needs of the current users including fishermen to create an acceptable solution for boats and swimming. From a safety perspective, access to the area around the existing ferry dock may be limited during the period of construction.	adopted by all parties.
	Relocation of existing users	Existing land users include the batch plant industrial development, small non-permanent beach bars and vendors. The owners/partners have indicated that the leases have been secured from local Barbudans and agreement to relocate the batch plant has been agreed with the current user.	High	Prior to any site preparation or construction, the agreements to move need to be confirmed. Where additional demolition/construction is required DCA and DOE must be engaged	Low
	Employment	The development plans to employ 200-250 construction jobs in Phase I and 50 jobs in each of the subsequent phases, as well as 1,752 in the operational phase.	Low negative, but high positive through job creation	Provide jobs and training preferentially to the local community Housing and support services for workers must be provided. This can	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				be located in the planned Back of House area.	
	Public services	An increase in work force will require outside labor and this will stress existing facilities including health care.	High	Local staff are already integrated into the community, However, the development needs to provide support for the increased labor force to minimize impacts on Barbuda's publish services. The project should consider an onsite clinic, medical evacuation services, and other key services to support the workforce, their families and the community.	Low- Medium
Infrastructure, waste and pollution	Chemical spills	Various chemicals will be required on site during both construction and operational phases.	Medium	To reduce risk of spillage and contamination, • Ensure all chemicals are stored and handled in accordance with their Materials Safety Data Sheet (MSDS). • Any chemical spill is treated immediately. • Excavate and remediate and potential contamination of groundwater. • Follow the Disaster Response protocols.	Low
	Electricity	There is insufficient energy to support the development, and the project is designed to be fully self-sufficient.	Medium	All electricity will be created on site. In the site preparation phase, modular diesel generators will be	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				used until the main system is constructed. In the construction and operational phases, electricity will be created on site from liquid propane gas (LPG) with backup diesel generators. Solar and photovoltaic systems will also be considered to supplement these energy systems.	
	Fresh water	It is estimated that 60,000-80,000 gal/day will be required during peak occupancy and operations of the development.	Medium during the initial phase due to lack of water resources	During the initial stages of site preparation, a small reverse osmosis plant will be used to generate water for workers and the nursery. This system will be scaled during the development and all freshwater will be created on site during the construction and operation phases. Deep water injection wells will be used to both obtain water and dispose of brine. Casing of pipes will eliminate impact to aquifers.	Low
	Waste management and pollution	There is potential for pollution during both the construction and operational phases of the development from solid waste from construction, municipal waste including sewage, biodegradable and recyclable waste, hazardous	Medium	Throughout the site preparation, construction and operational phases, waste should be managed using the following protocols from the US EPA (2007): • Designate trash and bulk waste-collection areas on-site	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
		waste such as chemical products and e-waste. These categories are discussed in more detail in Section 6.1.3.		• Recycle materials whenever possible (e.g., paper, wood, concrete, oil) • Segregate and provide proper disposal options for hazardous material wastes • Clean up litter and debris from the construction site daily • Locate waste-collection areas away from streets, gutters, watercourses, and storm drains. Waste-collection areas (dumpsters, and such) are often best located near construction site entrances to minimize traffic on disturbed soils. Consider secondary containment around waste collection areas to further minimize the likelihood of contaminated discharges. An on-site incinerator should be considered as an effective and sustainable method for waste disposal.	
	Sewage and wastewater	All sewage will be processed on site by a membrane bioreactor system.	Low, assuming this is addressed early in the process	The sanitary sewer collection and wastewater treatment systems will consider the entire proposed development plan. Wastewater will be treated on site. Clear water effluent will be stored on	Low

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				site and used for irrigation of green areas. Clear water from wastewater treatment plants can be high in concentrations of COD, TSS, nitrogen, phosphorus, bacteriology. Quality of this discharge will be in accordance with the standards in force at international and national levels. In normal operation, given the discharge quality objectives, the impact of the discharge on the quality of aquatic environments (groundwater, surface, and coastal water) will be negligible.	
	Traffic increases and parking requirements	This will impact the development site and community	High during construction phase, medium during operational phase	During the construction phase, an increase in heavy machinery and trucks on site is unavoidable. All machinery and building materials will be imported at the ferry dock, which is adjacent to the site reducing transportation. The increase in activity and workers will contribute to higher traffic between the site and Codrington. Road relocation is planned (outside the scope of this ESIA). This and other developments will increase traffic and parking needs. Adequate planning that includes developers,	Medium

Category	Area of Impact	Brief Description	Risk Significance	Mitigation Measures	Residual Risk
				Barbuda Council and relevant agencies is needed. Roads created on the site should be sealed during the construction period to reduce air pollution by dust and particulates. During the operational phase, there will no longer be heavy machinery on site, but there will still be increased traffic from cars, taxis and delivery trucks between the development and Codrington due to operational requirements.	

6.1 Specialised studies and plans

In the ToR for this ESIA, the Department of the Environment requested several specialized studies and plans to assess the impacts of this project and the mitigation measures to guide the planning of the development and workers on site. Specifically, these include a hydrological study, and a pollution control and waste disposal plan.

6.1.1 Hydrology and hydrodynamics

At the time of writing a comprehensive hydrodynamic study to assess coastal vulnerability under current and climate-change conditions requested by the ecological and climate scientists had just been completed and provided by the coastal engineers (December 24, 2024). This report covers metaocean conditions, shoreline vulnerability and considerations for the construction design. This study is provided in the Appendix 12.

There has been insufficient time available to the team to incorporate the findings into the final master plan and landscape design. These discussions are underway and the development team at CM&D have informed all parties of the intention to submit final assessments and risk-managed designs to the DCA and DoE at the end of January 2025.

6.1.2 Hydrology and drainage

Drainage of the site as a whole will orient around the constructed wetlands that are at the center of this development. Runoff from the surrounding land will provide water to maintain these wetlands, and they will also perform flood-control, absorbing flood waters and preventing flooding of constructed lands. For extreme events, an overflow pipe will facilitate water flow into the ocean.

Harris Civil Engineers (HCE) performed a preliminary drainage assessment for the site, which is summarized below, and the full report is provided in Appendix 9. The hydrology study is in progress and will be provided when available.

In their evaluation of the primary stormwater management system for the Rosewood Barbuda development project, HCE evaluated the following:

1. Determine the water quality requirements.
2. Determine water attenuation requirements.
3. Evaluate the off-site and on-site drainage basins both in the pre-construction and post-construction conditions.
4. Evaluate the sizes of the proposed primary ponds and convergence systems in relation to their ability to provide water quality, attenuation, and conveyance for the on-site and off-site contributing basins.
5. Render an opinion as to the appropriateness of the pond areas for environmental and aesthetic purposes.

Note that this report was completed for the original master plan (including the marina) and focuses on the contributing areas that discharge to the three main ponds on the western 2/3 of the site, and not the water that discharges to the southwestern-most pond (that previously was previously a marina).

Additional models based on the updated master plan, including three ponds, where Pond 3 is connected to the ocean via a 24” pipe are included in Appendix 10. Conditions under 2 year-

24 hour, 10 year-24 hour, 50 year-24 hour, and 100 year-24 hour storms were assessed and are presented here.

6.1.2.2 Water quantity requirements

HCE has developed criteria to evaluate the water quality requirements for the site. A common standard is that the water quality requirements are the greater of 1" of runoff over the entire contributing area, or 2.5" of runoff from the impervious area within the contributing area. It is important to note that HCE determined that these rules should be applied to the on-site contributing areas for only two reasons:

1. The off-site contributing area is so large and so flat that the water coming from that area will already likely have been filtered.
2. Even though we are accepting off-site runoff into the on-site systems, it is not typical to include off-site contributing areas in an evaluation such as this.

The required water quality volume is 16.315 ac-ft. Table 6.3 below shows the results of the analysis and the water quality provided for the ponds.

Table 6.3: Post Development Provided Water Quality.

POND - Wet Retention							
Elevation	Area	Area	Avg. Area	Δ	Volume	Σ Volume	Σ Volume
(ft)	(sf)	(acre)	(sf)	(ft)	(cf)	(cf)	(ac-ft)
0.00	915,963	21.028	0	0	0	0	0.000
1.00	1,030,203	23.650	973,083	1.0	973,083	973,083	22.339
2.00	1,143,938	26.261	1,087,070	1.0	1,087,070	2,060,153	47.295
3.00	1,443,068	33.128	1,293,503	1.0	1,293,503	3,353,656	76.989

6.1.2.3 Water Attenuation Requirements

Due to a general lack of governmental guidance, HCE has developed criteria to evaluate the water attenuation requirements for the site. It is important to note that water attenuation requirements are meant to stop the runoff from a site from flooding its downstream neighbor. This Site's downstream neighbor is the Ocean. Therefore, HCE is treating attenuation requirements in less of a pre-post requirement and more of a controlled conveyance requirement. In this case, HCE has determined that we want to control the water outflow to the sea at a rate of 2 ft/s for pond-to-pond conveyance and 5 ft/s over a weir that separates the middle and east most pond.

6.1.2.4 On-Site and Off-Site Contributing Basins

HCE has delineated and evaluated the on-site and off-site drainage basins. Exhibits 3 and 4 (EXH-3 and EXH-4) in Appendix A show the delineated basins. Table 2 and Table 3 below show the evaluation of the basins.

Table 2: Pre-Development Delineated Basins

Pre-Development			
	Basin	Area (ac)	Flowrate, Q (ft3/s)
2yr-24hr	1	59.2	0.63
	2	220.3	
	3	234.8	
	4	91.4	
50yr-24hr	1	59.2	8.24
	2	220.3	
	3	234.8	
	4	91.4	

Table 3: Post-Development Delineated Basins

Post-Development			
	Basin	Area (ac)	Flowrate, Q (ft3/s)
2yr-24hr	1	67.4	78.58
	2	46.6	54.33
	3	21.2	24.72
	4	39.7	46.29
50yr-24hr	1	67.4	415.17
	2	46.6	287.05
	3	21.2	130.59
	4	39.7	244.54

Pond and Conveyance Evaluation

The ultimate outfall for the primary ponds and conveyance system is over a weir that will be under the bridge that separates the western 2/3 of the Site from the pond on the eastern 1/3 of the Site. The water outfalls to the south through the channel entrance. Recall that an evaluation of the water that discharges directly to the eastern-most pond and out to the ocean is not a part of this evaluation.

HCE started with the ponds as shown on the provided master plans, then made some assumptions about the normal water elevation and the sloping characteristics of the ponds. Next, we made some assumptions about the conveyance between each of the ponds.

From there, HCE put together a preliminary computer model of the primary ponds and conveyance systems. The goal was to meet the requirements of the conveyance system, as shown in the sections above, while still not allowing the pond water elevation to stage up to an elevation that would endanger the surrounding structures.

Two rainfall events were modeled: the 2-year/24-hour event and the 50-year/24-hour event. The 2-year event was chosen to represent a “typical” heavy rainfall event so that HCE could evaluate the fluctuations in the ponds. The 50-year event was chosen to ensure that water could escape the system before flooding the surrounding buildings during a hurricane-style rainfall event.

2-year/24-hour Event Results
In the 2-year/24-hour rainfall event, the modeling indicates that the ponds will stage to a level of 2.25 ft.

50-year/24-hour Event Results
In the 50-year/24-hour rainfall event, the modeling indicates that the size of the control structure between the pond and the ocean should be 4 ft x 6 ft. The model also indicates that the water will stage to an elevation of 6.20 ft which is below the surrounding buildings finished floor elevation.

Exhibits 5 and 6 (EXH-5 and EXH-6) in Appendix B show the pond and conveyance systems as they were evaluated.

HCE recommends any aesthetic functions be above the elevation of 2.88 m (the stage of the water during the 50-year rainfall event).

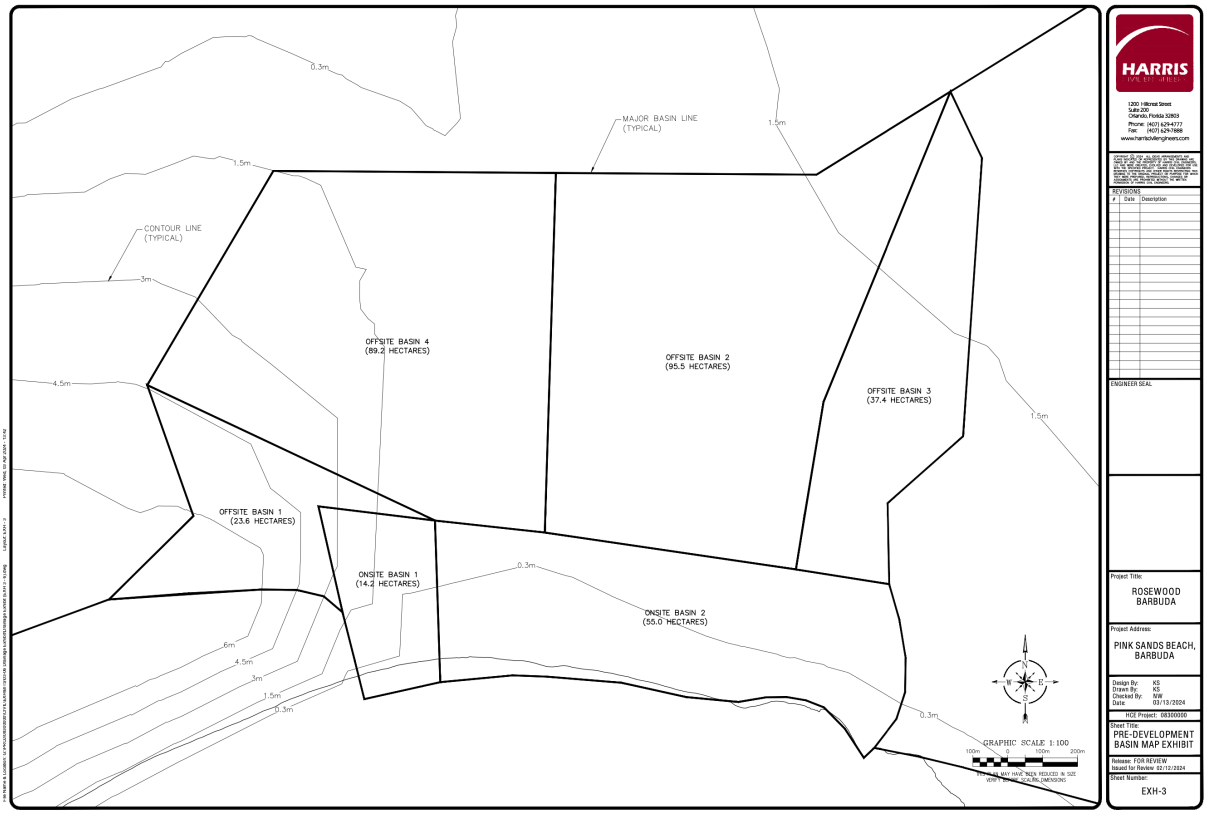


Figure 6.1 Pre-development drainage basin map (EXH-3).

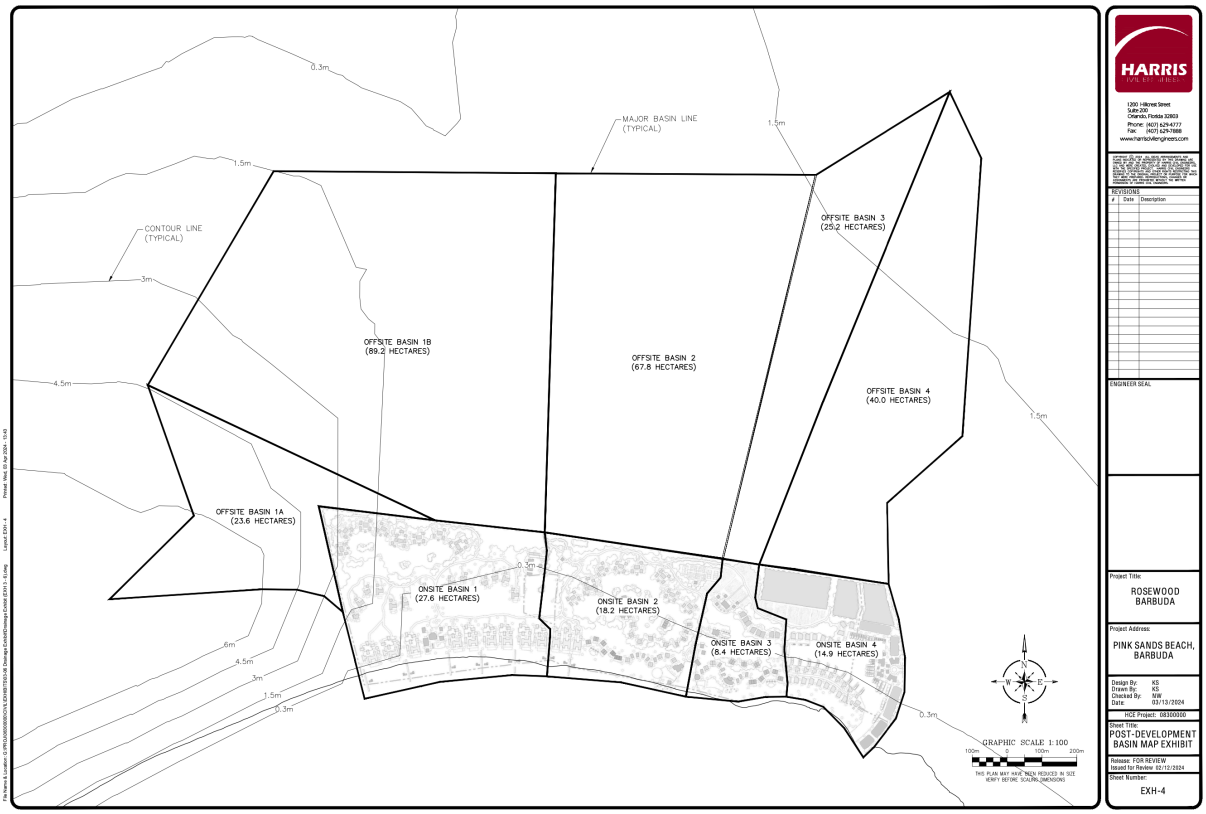


Figure 6.2: Post-development drainage basin map (EXH-4).

6.1.3 Pollution control and waste disposal

One of the key concerns with any development is the possible release of pollutants into the surrounding environment. There is potential for pollution during both the construction and operational phases of the development from solid waste from construction, municipal waste including sewage, biodegradable and recyclable waste, hazardous waste such as chemical products and e-waste. These have been assessed and will be managed with the best management practices for the earth movement, which relate to the practices and initiatives focused on minimizing waste generation in the first place and promoting sustainable disposal methods.

6.1.3.1 Solid waste

Implementation of an effective system to reduce waste has been shown to be invaluable for hotels, saving large costs in purchasing as well as cumulative water, electricity, diesel and LPG usage.

The main guidelines behind a waste management system are:

1. **Reduce the generation of waste at the source** – this is the first option as it promotes the efficient use of resources and reduces the volume of waste material that must be handled by employees and removed from the property. This is determined by the resort management, who decide the products and resources that are brought onto the property.

2. **Reuse all possible items** – all items should be reused in their original form where possible rather than being discarded. This is a best practice to avoid single use items, such as utensils and cups, items that are intended for short-term use, such as small shampoo bottles in hotel rooms, and ensure high quality of other items to enhance durability. When items cannot be reused on site, the property should investigate the possibility of donating it to employees, charitable organizations, schools, businesses or other interested parties.

3. **Recycle all possible items** – recycling consists of processing and transforming waste into new, marketable products. This should be considered if the 'Reduce' and 'Reuse' options are not applicable to the waste streams. It is the most difficult waste management option to implement in Caribbean islands that lack a strong industrial base, like Barbuda. Here, all recyclable materials would need to be transported to Antigua to be incorporated into recycling programs there.

Overall, it is critical that waste levels are monitored in some way, which may be by weight, compressed volume, number of truck loads, or some other metric. This is the only way to assess the effectiveness of waste management policies and how waste production may change over time.

In Antigua and Barbuda, general waste is disposed of at the Cooks Sanitary Landfill facility. The Antigua & Barbuda Waste Recycling Corporation (ABWREC) collects recyclable materials, then processes and exports them. ABWREC accepts and recycles plastics (PET1 & HDPE2), aluminum, steel tins, cardboard, vehicular batteries, UPS batteries, PVC cuttings, galvanize cuttings, toner cartridges and scrap metal.

Waste disposal methods

The current method for solid waste disposal for large developments in Barbuda is to collect and transport it to the municipal waste facilities in Antigua for disposal or to be recycled. This system involves on-site collection of general waste and separation of recyclable materials, storage of waste materials, transportation by boat to Antigua, and final transportation to the waste facility for disposal. This approach is perhaps the simplest logistically, but there are downsides associated with it, which include space required for waste storage prior to disposal, control of pests that may be attracted to the waste, costly transportation to Antigua, which is also an island of limited space and resources, and the final disposal of the waste in a landfill.

An innovative solution for the disposal of general solid waste would be to incorporate a commercial incinerator on-site to dispose of waste that cannot be recycled. This approach to waste management can be more sustainable for resorts in remote locations. Incinerators provide a controlled and efficient method of waste removal and the benefits include up to 90% reduction in waste volumes, recovery of heat energy that can be used for electricity and hot water, reduction in transportation costs to remove waste physically, enhanced hygiene due to not having to store waste, and versatility to dispose of a wide range of waste streams, from food and packaging waste to some hazardous materials.

The primary downsides to the incineration of general waste are the production of heat, carbon dioxide gas, particulates, and pollutants into the air, and incinerator bottom ash (IBA). In sustainable incinerator systems, the heat is repurposed for heating water on site. Of course, the combustion of waste plastics will release CO_2 gas, but this is offset by the emissions emitted to transport the waste to appropriate facilities in Antigua. Emissions of particles and pollutants into the air can be minimized using scrubbers. Finally, IBA is the residue left over after waste is burned in the incinerator. IBA can be used for construction purposes, such as bulk fill and cement, or disposed of in landfills.

To implement an efficient incineration system, Rosewood Barbuda Resort should

4. Assess the proposed volumes of waste anticipated from all different waste streams, from solid waste to food waste to recyclables.
5. Implement a waste segregation system to subsequently optimize the incineration process.
6. Train staff in proper waste management, segregation and incinerator operation practices
7. Monitor waste generation continuously to identify trends and ensure the waste management program is efficient.
8. Maintain the incinerator to ensure the equipment's sustainability and optimal performance.

Waste from construction

During the site preparation, the substrate will be excavated to facilitate the placement of pilings and create the constructed wetlands. This substrate will be used to grade the site, and it is not anticipated that any will be removed.

There are several buildings existing on the eastern side of the site that comprise the batch plant. These will be demolished during the construction phase. This solid waste should not be dumped locally and will need to be removed from the island, or if an incinerator is already in place.

Recyclable materials, such as metals, can be separated, but solid waste will likely need to go to the landfill in Antigua. If an on-site incinerator is implemented, it can be used to dispose of appropriate construction waste.

Operations

Hotels generate large volumes of solid and hazardous waste. By proactively managing these wastes, a hotel can reduce operating costs, preserve local nature attractions such as coral reefs and beaches, and reduce odors and pest infestations. Studies have shown that in some regions of the Caribbean, hotels and resorts produce more solid waste than all of the local residents combined (CAST/CTO, 1999), and this can certainly be the case in small and rural communities such as Barbuda. General waste in Barbuda goes to the local landfill. It is not feasible from social or environmental perspectives for the waste products from a resort of this size to end up in a local landfill.

Reductions in the volumes of solid waste generated result from purchasing policies and guidelines of the resort management. These policies should include:

1. Purchase of housekeeping, pool, and gardening chemicals in bulk and concentrated form, rather than small, ready-to-use containers.,
2. Purchase food and drink items in bulk rather than in single-portion packages. Packaging type, e.g. paper and cardboard versus plastic, should also be assessed.
3. Reduce the purchase of products with excessive packaging and avoid Styrofoam altogether.
4. Buy locally produced goods and fresh food where possible.

6.1.3.2 Municipal waste

Sewage

Sewage management is critical for a development of this size to ensure all sewage and grey water is contained and does not contaminate the surrounding environment. The Rosewood Barbuda Resort will install a membrane bioreactor plant (MBR), which is a combination of a suspended growth biological treatment method with membrane filtration equipment.

This type of plant accomplishes secondary to tertiary water treatment and, when used with domestic wastewater, can produce effluent of high enough quality for discharge into oceans, deep injection wells, brackish water bodies, or irrigation waterways.

To maximize water reuse and recycling, the project will use the WWTP effluent for irrigation on site. Potable water will be added to supplement the volume when and where necessary. Additionally, rainwater captured in cisterns can be used to supplement irrigation needs as well.

Management of the MBR is outlined in Section 2.1.5.3.

Biodegradable waste

Composting is the natural decomposition of organic material, such as yard waste and vegetable and fruit waste, by naturally occurring microorganisms. Composting is a simple process that requires only a modest amount of effort and can significantly reduce a property's solid waste stream and eliminate the need to purchase fertilizer or mulch. Since the Rosewood

Barbuda Resort will have an on-site kitchen garden to supply their restaurants and kitchens, this could be an invaluable resource to provide nutrients into the soil.

The key to a successful composting program is separating compostable materials (e.g., yard waste, vegetable cuttings, fruit peels) from non-compostable waste (e.g., plastics, meat and fatty food waste, and metals) as they are generated. It is much easier to keep wastes separate from the beginning than to separate them after they are mixed. There is a range of methods for composting, from simple "no-tech" methods to specialized bins that accelerate the composting process.

Generally, simpler methods are cheaper and slower, while engineered systems are faster, require less space, and afford more control over the composting process, reducing the risk of odors.

Recyclable waste

Recycling consists of processing and transforming waste into new, marketable products. This should be considered if the 'Reduce' and 'Reuse' options are not applicable to the waste streams. There are no industry to undertake recycling in Barbuda and all recyclable materials would need to be transported to Antigua to be incorporated into programs there.

Recyclable materials can be separated on site by having designated receptacles for guest use throughout the property alongside appropriate signage to educate guests and homeowners on proper disposal of recyclable materials. Staff should also be comprehensively trained in recycling so that materials from all sectors, including but not limited to housekeeping, the kitchen and bars, and groundskeeping can all dispose of materials correctly.

Grease

The proposed sanitary grease waste collection systems should be required at all restaurant facilities. The sanitary laterals for grease should be heat traced for the length of the pipe run. The plumbing engineer is to provide the grease trap and piping design. Grease traps should be cleaned on a regular basis to maintain hygiene and reduce the likelihood of attracting pests and should be done without the use of harsh chemicals.

There should be an effective program for the collection and/or recycling of cooking oil.

6.1.3.3 Hazardous waste

Chemical spills

Various chemicals will be required on site during both the construction and operational phases. These include cleaning products, pesticides, fertilizers, fuels (petrol, oil, diesel, liquified petroleum gas), swimming pool chemicals, and oil-based paints and varnishes. Careless storage and use of chemicals can pose unnecessary hazards to staff and guests and threaten the long-term health of the local environment.

To reduce the risk of spillage and contamination, the Rosewood Barbuda Resort should implement the following measures:

1. Train all staff in the safe and proper handling, use, and disposal of chemicals
2. Provide protective equipment such as gloves and eye protection where appropriate.

3. Ensure all contractors follow proper procedures when handling, using and disposing of chemicals. This will be applicable during the construction phases.
4. Ensure all chemicals are stored and handled in accordance with their Materials Safety Data Sheet (MSDS).
5. Ensure that any chemical spill is treated immediately.
6. If used, hazardous wastes should be disposed of carefully and separately from regular garbage.
7. Follow the Disaster Response protocols.

More information about managing hazardous materials in a hotel environment and creating a disaster management plan are detailed in SECTION 7.0.

E-waste

E-waste refers to the disposal of electronic devices and appliances, ranging from batteries to kitchen appliances to computers. Batteries and printer cartridges can be recycled by the ABWREC in Antigua, but none of these can be safely disposed of in Barbuda. Many of these devices cannot be incinerated as this process releases potentially toxic chemicals into the local air and physical environments. These products will need to be removed from the island for proper disposal in Antigua.

6.1.3.4 Pollution

Pollution is the contamination of the surrounding environment caused by improper waste management and/or chemical handling. Pollution can occur during site preparation and construction if excavated substrate is allowed to run off the site, if there is damage to outflow pipes or if there is chemical contamination. Pollution during the operational phase can occur from poor waste disposal practices, leaks from pipes or from chemical spills. The risk of pollution can be decreased by applying best management practices for waste disposal, as discussed in Section 6.1.3.1 above, ensuring all infrastructure is properly maintained, properly training staff, and storing and using chemicals safely.



SECTION 7.0 DISASTER MANAGEMENT PLAN

Emergency situations can take many forms and can arise from forces both internal and external to communities. External sources generally take the form of natural disasters, including hurricanes, earthquakes, tsunamis, flooding, drought, or extreme heat, while internal sources include fire, chemical spills, and health emergencies. A Disaster Management Plan (DMP) is aimed to ensure the safety of life and property during any type of emergency.

The Caribbean Disaster Emergency Management Agency (CDEMA) has developed a Comprehensive Disaster Management (CDM) Strategy and Results Framework for 2014-2024. It outlines the need to develop multi-hazard contingency and coordinated response plans to mitigate and lessen their potential impacts. In Antigua, the National Office of Disaster Service (NODS) has a disaster risk reduction plan (NODS, 2017), and ensures national hazard plans and policies are current, and provides warnings during potential hazard situations.

The five major steps of a disaster management plan are:

- **Prevention** – Actions taken to avoid an incident, including deterrence operation and surveillance.
- **Mitigation** – Refers to measures that prevent an emergency, reduce the chance of an emergency happening, or reduce the damaging effects of unavoidable emergencies. Typical mitigation measures include establishing building codes and zoning requirements, installing shutters, and constructing barriers such as levees.
- **Preparedness** – Activities that increase the ability to respond when a disaster occurs. Typical preparedness measures include training for a disaster response team, conducting disaster exercises to reinforce training and test capabilities, and presenting all-hazards education campaigns.
- **Response** – Actions carried out immediately before, during, and immediately after a hazard impact, which are aimed at saving lives, reducing economic losses, and alleviating suffering. Response actions may include activating the emergency operations center, providing mass care, emergency rescue and medical care, firefighting, and urban search and rescue.
- **Recovery** – Actions taken to return to normal or near-normal conditions, including the restoration of basic services and the repair of physical, social, and economic damages. Typical recovery actions include debris clean-up, financial assistance to individuals and governments, rebuilding of roads, buildings, and key facilities, and sustained mass care for displaced populations.

General prevention, mitigation, and preparedness protocols to allow for self-sufficiency within the development for a minimum of several days should be implemented. These include:

- Designation of a Disaster Response Team that is always represented by staff members on site.
- A thorough list of emergency contacts that is up to date.
- Ensuring there are enough emergency supplies (including dry food, water, batteries, and first aid supplies) on-site to last all staff, residents, and guests.
- Storage of all emergency supplies in locations that are easy to access and well-known to all staff and homeowners.
- Practice emergency response drills with the Disaster Response Team, all staff, and/or homeowners so that they are familiar with the actions to take during an emergency.

Disaster risks and mitigation

The disaster risks associated with the Rosewood Barbuda Resort Development prepared by Dr. Holly Trew are identified in Table 7.1, as well as the significance of the risk and any mitigation measures to be implemented.

Table 7.1: Summary of risks associated with natural hazards and mitigation measures.

	Impact	Brief Description	Risk Significance High/Medium/Low	Mitigation Measures
External origin	Extreme rainfall event/ flooding	Flooding typically results from prolonged rainfall. Soil becomes saturated and, if drainage systems are not appropriate, water collects on the surface. Generally, the highest rainfall occurs in the Barbuda highlands and flows westwards across the island on the surface or subsurface substrate towards the development site. Currently, flooding is common in the development area. Barbuda's rainy season is between June and November annually. Highest volume of rainfall is likely to coincide with tropical storms or hurricanes effecting the island.	High	• Plan efficient drainage system and implement stormwater management plan. • Construction of integrated constructed wetland systems to collect and absorb rainwater, preventing flooding in the surrounding areas.
	Extreme drought	Drought is a recurrent feature in Antigua and Barbuda which results in insufficient rainfall to meet the island's needs. Annually, Barbuda receives between 760-990 mm precipitation per year.	High	• Ensure there is enough water on site for the development's needs for potable water as well as for daily activities. • Use of water reclaimed from wastewater processing for irrigation. • The integrated constructed wetlands will also act as a rainwater sink allowing the water to seep down and replenish the groundwater, which will benefit Barbuda as a whole.

	Impact	Brief Description	Risk Significance High/Medium/Low	Mitigation Measures
	Extreme heat	Global temperatures are generally increasing, with more frequent and severe heat waves. Extreme heat can be categorized using the heat index (Figure 7.1). Barbuda's daily humidity is generally between 70-80%, so heat caution is advised from 28°C.	High	• Ensure outdoor workers are provided with appropriate personal protective equipment (PPE), hydration and breaks. • Electricity load to run AC throughout all buildings and structures in the development. • Appropriate insulation of buildings and glazing of windows and doors to maintain stable temperature inside buildings. • Extensive planting of natural areas to provide heat-absorbent surfaces and shade from vegetation. • Provide information to visitors about heat-related illnesses (heat stroke, heat exhaustion), and appropriate hydration for tropical climates. • Train staff to recognize and treat heat-related illnesses. • Make contingency plan in the event that extreme heat event is combined with loss of electricity across the development, including back-up generators.
	Hurricanes	Hurricanes are relatively common in the Caribbean and Barbuda has been impacted by 32 category 1-5 hurricanes between 1842 and 2024. The most devastating of these was Hurricane Irma in 2017. Hurricanes are often simultaneously associated with storm surge and flooding.	High	• Ensure that all buildings are up to code regarding hurricane regulations to prevent loss of roofs and structural damage. • Planned installation of hurricane shutters on all residences and buildings. • Hurricane preparedness plan (overall and residence-specific) that includes assembly and checking of emergency supplies (e.g. food, water, medical supplies), employee training, protocols for protecting vital

	Impact	Brief Description	Risk Significance High/Medium/Low	Mitigation Measures
				documents, guest security and for information dissemination to guests. The Hurricane Procedures Manual and preparedness checklist created by USAID and the OAS is included in Appendix 6. • Ability to maintain connection with weather information sources (radio, internet). • Annual tree assessment and trimming to reduce potential for damage to buildings and utilities. • Proper storage of loose items to reduce flying debris.
	Sea level rise	Sea level rise is inevitable under current climate change projections, and the IPCC predicted up to 0.25-0.30 m rise in the Caribbean before 2050. This is likely to increase the effects of storm surge and coastal erosion.	High	• Build the development with mandated setback from the sea. • Plant a boundary of vegetation between the beach and all buildings to stabilize the sand. This acts to reduce erosion and disperse wave energy from any storm surge.
	Earthquake	Antigua and Barbuda is subject to earthquakes of magnitude higher than 5.0 every few decades, and many low-magnitude earthquakes each year.	Low to Medium	• Ensure that all buildings are up to code regarding earthquake regulations. • Make an earthquake preparedness plan for employees and all residences, which includes actions to take when indoors and outdoors, the location of emergency muster points. • Ensure that the Disaster Response Team knows how to access shut off valves for all water, gas and electrical lines as they will need to be turned off if damaged.

	Impact	Brief Description	Risk Significance High/Medium/Low	Mitigation Measures
	Tsunami	The most likely source of a tsunami is from volcanic or seismic activity on Nevis and would not allow for sufficient time for a complete evacuation of the property. In the event of a tsunami of tectonic origin, which is much rarer, the warning time of would be about 60 minutes. This would allow for some evacuation away from the coastline, but there is no nearby high ground to provide refuge.	Low	• The development should install warnings and the UNESCO tsunami evacuation procedure should be implemented (Appendix 7) • Guests and staff should be educated to recognize the warning signs of tsunami such as ocean retreat and will be instructed to move quickly to a higher place. • Directional signs and fact sheets can be placed in residences. • Annual disaster response training can be provided to staff. • Monitoring the Caribbean Tsunami Warning Program (CTWP).
	Storm surge	Storm surge is a common impact resulting from tropical storms or hurricanes and waves can be 3-10 m in height. The power of the waves can destroy buildings that aren't protected in addition to water damage from the flooding. The eastern side of the development is partially protected by the ferry dock, associated breakwaters and the shallow bay, while the western side of the site's coastline is more exposed to wind and wave action.	High	• Plan efficient drainage system and implement stormwater management plan. • Plant a vegetation boundary between all building structures and the beach. • Facilitate rain absorption via the integrated constructed wetlands, and by planning as much natural garden area as possible within landscaped areas.
Internal origin	Fire	The development is comprised of many separated buildings, so there is a minor risk for a large fire. High winds can change that risk. There is a risk of fire in any of the residences from kitchen or laundry areas, and	Low to Medium	• Use non-flammable materials for construction where possible. • Designated no smoking zones around chemical storage areas, propane, and flammable gas storage.

	Impact	Brief Description	Risk Significance High/Medium/Low	Mitigation Measures
		higher risk in any restaurants and the back-of-house commercial laundry.		• Install smoke alarms, A-B-C type fire extinguishers, hydrants, and fire suppression systems, and ensure regular servicing. • Fire cistern reserve of fresh water on site. • Emergency exit signs in all buildings • Education of staff, homeowners and guests in fire response actions and emergency muster points. • Ensure proper maintenance of electrical outlets, appliances, and wiring. • Ensure proper storage of combustible materials, including cardboards, paper, and cloth.
	Chemical spills	Various chemicals will be stored on site during both construction and operational phases. These include cleaning products, pesticides, fertilizers, fuels (petrol, oil, diesel, liquified petroleum gas), swimming pool chemicals, and oil-based paints and varnishes. Guidelines for storage and use of chemicals are included in Appendix 11.	Medium	• Ensure all chemicals are stored and handled in accordance with their Safety Data Sheet (SDS). • Any chemical spill is treated immediately. • Excavate and remediate and potential contamination of groundwater.
	Health/ disease	Zoonotic, mosquito-borne diseases (e.g. dengue, zika, chikungunya) are of particular concern in Barbuda. Dengue epidemics have been reported in several islands and climate change is anticipated to increase the incidences. A future pandemic such as Covid-19 is a possible, but currently considered unlikely, scenario.	Medium from zoonotic diseases Low from other sources	• Ensure proper sanitation of laundry and guest rooms by housekeeping. • Implement strict food and beverage standards to prevent food-borne diseases. • Removal of standing, untreated water on site to prevent waterborne diseases and propagation of disease vectors (e.g. mosquitoes). This is addressed in the design

	Impact	Brief Description	Risk Significance High/Medium/Low	Mitigation Measures
		Other public health and disease outbreaks are considered to be low risk		of the integrated constructed wetlands to ensure stagnation does not occur. • Efficient air circulation and HVAC equipment. • Plan in the event of health emergencies on site, including staff first aid training, nearby clinics or hospitals, and evacuation procedures.

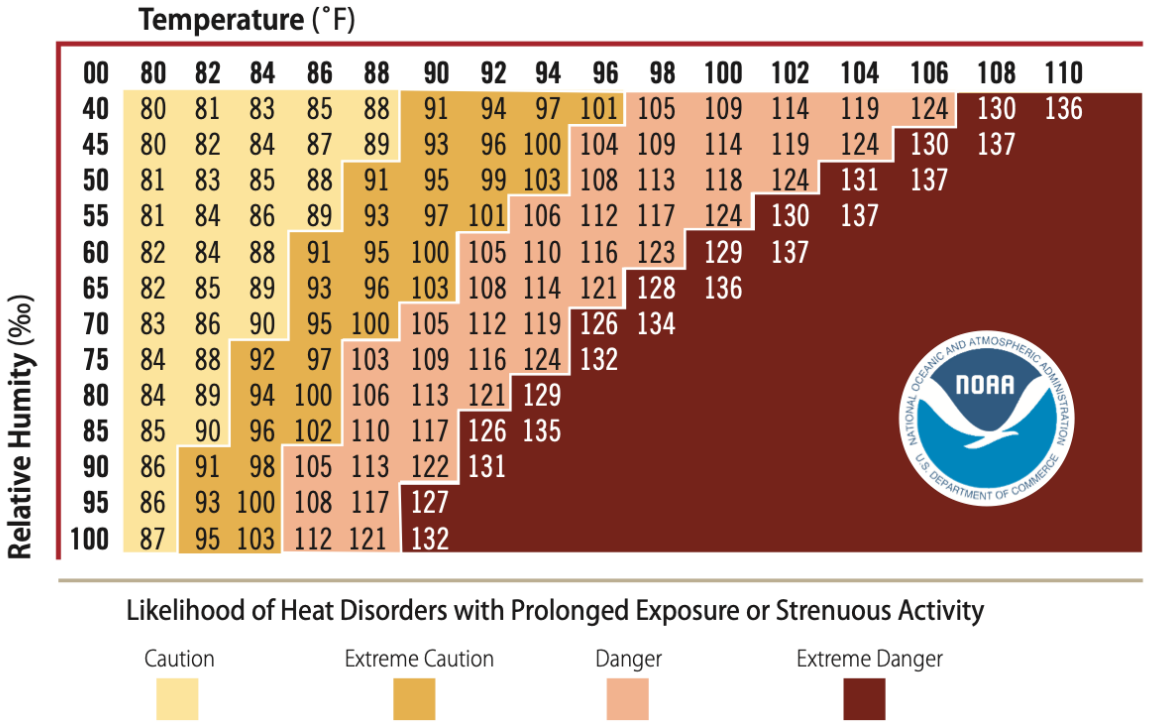


Figure 7.1: Likelihood of heat disorders with prolonged exposure or strenuous activity. Source: National Weather Service Heat Index.

Evacuation

The decision to evacuate the premises is influenced by the level of threat involved and should be made on a case-by-case basis. All evacuations will be managed by the Evacuation Officer on the Disaster Response Team. Some emergencies, including weather-related situations, chemical spills, or man-made disasters, will involve keeping staff, homeowners, and guests on site. This is known as “shelter-in-place” and requires the organization of persons on site and supplies for self-sufficiency. A central location in the development should be identified as a shelter.

Other emergencies, such as fire, flood, or extreme weather, may require evacuation or “shelter-out.” In the case of extreme weather, evacuation may occur before or after the event. Evacuation before a natural disaster may involve the movement of guests to a muster point in walking distance (e.g. the car park), where transportation to the airport or higher ground can occur. Regional shelters are designated by Antigua and Barbuda’s Director of Disaster Preparedness and Response under the Disaster Management Act (2002).



SECTION 8.0 ENVIRONMENTAL MONITORING AND MANAGEMENT PLAN

8.1 Background

Environmental monitoring is necessary to evaluate the quality of the environment and is an effective tool for the long-term management of natural and developed areas. Monitoring plans are site-specific and should comprehensively include all aspects of the area's habitats, community type, and species of interest to assess their health on an ongoing basis and determine any effects of human activities on this environment. Additionally, climate change is increasingly affecting natural resources and should be monitored to assess any impacts on the monitored site and aid in any future management decisions.

All Environmental Monitoring and Management Programs (EMMPs) begin with a baseline assessment of the site, including a review of historical information and on-site sample collections, to determine its current condition. This baseline assessment provides a standard for assessing any future changes. Subsequent monitoring should be completed at a frequency adequate to detect any changes in the parameters of interest. Here, monitoring frequency will be guided by a science-based hypothesis-driven design as well as international guidelines. Data reporting to agencies and stakeholders (e.g. Barbuda Council Environment Division, Department of Fisheries) allows data to be reviewed and, in some cases, compared to regional data. Reports should include representative photographs as well as data reporting and an interpretation of data trends and their significance to the community.

An EMMP should also implement adaptive management, which is a scientific approach to monitoring, evaluation and decision-making. This technique aims to accrue information about the system over time and cumulatively use this information to inform ongoing future monitoring. In this way, the EMMP continually aims to meet the environment and resource management goals for the site while improving the long-run management outcomes. If monitoring shows a decline in target species, variable, or natural resource, or performance standards are not being met, it is necessary to implement adaptive management strategies to rectify any issues.

The Rosewood Barbuda Resort development is required to prepare and submit an Environmental Monitoring and Management Plan. The purpose of this EMMP is to provide a framework for the management of the environmental risks identified through the Environmental and Social Impact Assessment (ESIA) process for the development. This EMMP is a condition of the Antigua and Barbuda Environmental Protection and Management Act (EPMA, 2019). Implementation of EMMP alongside the construction and operation of the development will ensure that environmental risks are reduced to as low as reasonably possible. It will ensure that all environmental obligations from legislation, regulations, conditions of approvals, permits and licenses issued to the project are met.

The EMMP contains a series of management sub-plans that address the key environmental themes that relate to the development, including biodiversity, water, erosion and sediment, socioeconomic, noise, human health and safety, and air quality sub-plans. Each sub-plan clearly articulates management objectives and performance criteria and outlines the management measures to be applied to avoid and minimize environmental impacts during the relevant phases of the project. Monitoring and reporting requirements, corrective actions, and key responsibilities are also explained.

The DoE and DCA should review the plan and further determine the priorities, requirements and frequency of submission of the elements included in this EMMP.

8.2 Roles and responsibilities for environmental management

The roles and responsibilities of the project's stakeholders in implementing the EMMP are outlined in Table 8.1.

Table 8.1: Roles and responsibilities within the EMMP

Entity	Roles and responsibility
Murbee Resorts Inc. and the Rosewood Barbuda Project	Overall developer and investor with ultimate responsibility for the project.
Project Manager (Murbee Resorts Inc.)	Overall oversight of implementation of the EMMP. Site auditing of sub-contractors on a discretionary and strategic basis. Environmental training and complaints management. Liaises with Project/Facility Environment Personnel. Notifies Environment Team and DCA of any non-compliance with EMMP.
Construction subcontractors	Report to Project Manager, implement all actions in relevant sub-plan of EMMP, including management actions and reporting. Supervise environmental performance of each task against the EMMP. Notifies Project Manager of any non-compliance with EMMP.
Development Control Authority (DCA)	Overall authority governing development. Reviews monitoring and environmental audit reports.
Department of Environment (DoE)	Environmental agency with responsibility for environmental compliance. Undertakes audits of project site as required and assesses compliance with EMMP in accordance with Government approvals. Reviews monitoring and environmental audit reports.

Entity	Roles and responsibility
Environment personnel (EP)	Trained and technically qualified personnel to conduct EMMP (may comprise consultants and/or staff) Conducts on-site monitoring and evaluation of EMMP. Works with the Project Manager to communicate any concerns and assist in developing any necessary responses or changes. Prepares and submits regular EMMP reports to Murbee and to Government.

8.2.1 Incidents and complaints

An Incident and Complaints register will be established and maintained by Developers. Any incidents of non-compliance with the EMMP will be recorded, including measures taken to address the incident, and the DCA/DoE will be notified as soon as possible. Any complaints received will be recorded in the same register. The Developers will record any complaints received as soon as possible. The register will include a record of when the complaint was received, the nature of the complaint, when it was responded to, by whom and how, and if DCA/DoE was informed.

8.2.2 Monitoring, auditing, and reporting

8.2.2.1 Monitoring

Monitoring will be undertaken to assess compliance with the ESIA approvals and the EMMP and ensure that the magnitude of any impacts is within the approved limits. Ongoing monitoring of the site will be undertaken by a qualified environment personnel member who is aware of the EMMP requirements.

The environment personnel (EP) will keep the Developers informed of all monitoring activities and results and promptly report any concerns or non-compliance. In the event of a non-compliance incident requiring a response, the EP will work with the Developers to promptly develop and implement an environmentally appropriate response and will record all measures taken. Developers and the scientist-monitor will meet periodically to review the program and activities.

The EP will be responsible for independently conducting monitoring to the appropriate scientific standards, analyzing, and synthesizing data, and creating reports for the Developers that will be used by Murbee Resorts Inc. and sent to DCA/DoE. The EP will keep copies of all raw data as well as analysis conducted.

8.2.2.2 Reporting

EMMP reports will be submitted in accordance with the timelines determined by DCA/DoE. This may include monthly, quarterly, and/or annual reports in the construction and operational phases of the project.

The reports will include:

- List of actions from the EMMP that have been implemented, including photographic evidence.
- Details of any non-compliance activity and measures taken to address it.
- Results of monitoring including e.g. marine, water quality and vegetation.
- List of any complaints received from adjoining residents.
- Any unexpected impacts to the environment that was not adequately accounted for.
- Any corrective or positive actions implemented.

8.2.2.3 Adaptive Management

Mitigation and avoidance measures have been developed as part of this EMMP that are intended to reduce the risk of the project significantly impacting the environment. In the unlikely event that the monitoring shows that the impact has exceeded the performance indicator, the proposed management actions would need to be revised. Any changes to environmental management will be proposed as part of the final quarter EMMP report and will be developed by the Developers in conjunction with the EP and appropriate Government agencies. Changes to environmental management will only be proposed if the performance indicators outlined in the EMMP are exceeded within the reporting period. Any approved changes to environmental management will be incorporated into a revised EMMP.

8.3 Biological monitoring

8.3.1 Vegetation

The biodiversity of the Rosewood Barbuda Resort development site and the adjacent coastal waters were assessed as part of this ESIA. The biodiversity value of current vegetation on the site relates to the presence of sensitive species, which are those that are re listed as threatened or endangered (IUCN Red List), regionally endemic (as determined by Pratt et al., 1997), listed in the Environmental Protection and Management Act (2019), or a key stone species, which are those that are critical to ecosystem diversity and functionality and that can enhance the landscaping environment. On the Rosewood Barbuda Resort site, the sensitive species that were identified in the vegetation surveys and are protected under the EPMA (2019) include Buttonwood (*Conocarpus erectus*), Loblolly (*Ocotea leucoxylon*), Palmetto palm (*Coccothrinax barbadensis*), Red mangrove (*Rhizophora mangle*), Royen's tree cactus (*Opuntia rubescens*), and White mangrove (*Laguncularia racemosa*). Currently, these have been assessed into a species list, but specific locations have not been recorded using GPS. The loss of these native species during construction should be minimized by conserving in place where possible or removing individual plants into a nursery environment for later outplanting. This will best ensure the protection and long-term presence of these species in Barbuda.

8.3.1.1 Integrated Wetlands

The proposed integrated constructed wetlands will form the heart of the proposed development, and their ecological health is critical to ensure they continue to perform their designed functions. Ongoing assessment of the plant species present and their growth will be an essential component of the overall assessment of the system. The wetlands will increase the proportion of wetland species in the area, with the aim of creating a thriving community with high species richness of both plants and animals. The ecosystem will also provide a case study for integrated constructed wetlands in the Caribbean. A well-designed and scientific monitoring program can provide a scientific basis for marketing the sustainability and eco-friendly components of the Resort.

8.3.2 Sand dune and beach

The western side of the development site is characterized by a gently sloping beach in a bay created by the ferry dock, while the eastern side of the site contains sand dunes that extend onto the Palmetto Peninsula. The dune system has been influenced by sand mining that has occurred across the Peninsula, altering the biological community. Vegetation in both the beach and dune areas includes species such as Buttonwoods, inkberry (*Scaevola plumieri*), wild tamarin (*Leucaena leucocephala),* Gogi (*Lycium carolinianum),* Coco plum *(Chrysobalanus spp),* saltwort (*Batis maritima*) and seagrape (*Coccoloba uvifera*). Assessing the state of vegetation cover along the coastline as well as on the sand dunes in relation to dune morphology (i.e. foredune, slope, dune crest, swale, lee slope) and proximity to the sea is useful for determining the stability of the coastal ecosystem.

In addition to monitoring vegetation, changes in dune form and location are critical for ongoing evaluation of the risks from climate change and risks to the development from storm events. Monitoring the beach width to determine erosion or accretion will provide information about

shoreline dynamics. An understanding of sediment transport will aid in maintenance of any inshore water connections throughout the constructed wetlands.

Field assessments and remote sensing (GIS) techniques will both be implemented to provide a comprehensive evaluation of these systems. Monitoring should include:

- Annual geo-referenced aerial or satellite imagery (all geo-referenced material should be in the local projection of Antigua 1943 British West Indies Grid).
- Survey data to provide locations and range of significant dune features.
- GIS mapping with survey data overlay onto aerial or satellite imagery to use as a base map for additional mapping of vegetation.
- Permanent vegetation transects (species composition and diversity). Transects should be GPS located and identified on GIS mapping.
- Areas of significant native vegetation community distribution mapped using GIS.
- Ongoing trend analysis. Multi year comparisons to identify changes in dune morphology, location and/or major changes in vegetation distribution and species composition.

8.3.3 Seagrass and coral reefs

Both seagrass and coral reef habitats are present within the shallow nearshore zone adjacent to the development site. Species commonly found include shoal grass (*Halodule wrightii*), turtle grass (*Thalassia testudinum*), and manatee grass (*Syringodium filiforme*). This habitat is important to a variety of marine species by providing shelter and nursery habitat for a variety of fish and invertebrate species and grazing for protected species such as the green turtle (*Chelonia mydas*), Hawksbill turtle (*Eretmochelys imbricate*), and Loggerhead turtle (*Caretta caretta*). Seagrass monitoring to ensure the continued health of this habitat type includes both quantitative and qualitative data collection as well as remote sensing (GIS) applications. Monitoring should include:

- Distribution of seagrass meadows mapped (photointerpretation) and field verified on annual georeferenced imagery for changes in distribution over time.
- Permanent transect monitoring using a 0.25 x 0.25 m quadrat to include species diversity, percent cover, short shoot density, stem length and epiphyte cover. Transects should be GPS-located and identified on GIS mapping, and each transect should be photographed.
- Water quality, including salinity, pH, DO, turbidity, and temperature, using a multi-parameter Sonde unit taken at each monitoring transect
- Underwater visual census (UVC) techniques are used to document observations of fish, invertebrates, sea turtles, and marine mammals. A comprehensive list of observations overtime should be reported to identify any changes in species presence and diversity.
- Observations of human impacts, such as boat scars, should be identified on seagrass mapping.
- Ongoing trends analysis of all seagrass data is necessary to identify changes over time.

8.3.4 Species of concern monitoring

Several regional species of concern utilize the coastal beach and terrestrial habitats of the development site. Endangered and protected species of sea turtles, specifically Green and Hawksbill turtles, nest on the beaches. Spiny lobsters utilize the reef patches for nursery, shelter, and foraging opportunities. The endemic Barbuda Warbler (*Setophaga subita*) is also present within the development site. Loss of habitat is an increasing issue for this species and its habitat

requirements should be considered when replanting the site. The impact on these species can be reduced by implementing Best Management Practices during the construction and operations of the development and are identified in Table 8.2.

Table 8.2: Biodiversity management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Minimize removal of native and protected species. Maintain soil, beach and dune stability provided by vegetation	Prior to construction, identify and remove or fence off any native trees or areas of vegetation to be retained. Incorporate existing trees and native species into landscaping where possible.	Ongoing monitoring by Developers	Continued growth of trees and vegetation identified for preservation
Increase wetland species and biomass	During wetland construction, careful planning of species to be incorporated and location to aid in increasing animal biodiversity	Ongoing monitoring by EP.	Increased wetland species land coverage Increased species richness Increased animal biodiversity
Beach retention	Assess beach width and dune height prior to construction. Avoid use of heavy machinery on the beach and dunes. Avoid construction of structures that increase erosion such as vertical walls in surf zones.	Annual monitoring of beach width using satellite imagery when available. Field measurements of beach width and dune hight at specific GPS locations.	No net loss of beach width or dune height associated with the development
Protect seagrass and coral reef habitats	Regular monitoring of seagrass beds in the nearshore habitat using available satellite imagery, and *in situ* surveys. Regular monitoring of coral reef patches using *in situ* surveys.	Regular monitoring of salinity and turbidity in nearshore	No net loss of seagrass or coral reef health or habitat associated with

Objective	Management actions	Monitoring	Performance indicators
	Minimize runoff	waters during construction	the development
Protection of sea turtles at sea, nesting sites, and hatchlings	Use of Best Management Practices (BMPs) in all pre-construction and construction activities. This includes use of appropriate light fixtures, light bulbs, and light orientation as to not disturb nesting female turtles and hatchlings. Use of construction barriers to prevent sea turtles and hatchlings from entering the construction zone. Cease operations if any sea turtle or hatchlings are observed within 300 ft of the construction site. Careful use of vehicles along shorelines and beaches to not crush nests and/or hatchlings emerging from nests. Disturbance/collision with sea turtles immediately reported to DB&A, Fisheries, and DoE.	Fence off any established nests Use sea-turtle friendly lights during construction Training of construction subcontractors and personnel in BMPs and recognition of nests/nesting activity	No loss of sea turtle nests or hatchlings within construction site

8.4 Physical environment monitoring

8.4.1 Water quality

The quality and quantity of coastal seawater and freshwater in wells and ponds are vital to supporting surrounding habitats and accommodating the enjoyment and recreational use of locals and visitors. The development proposes to considerably expand the scope of existing freshwater ponds on the site to create two large integrated wetlands. These will perform several functions for the resort, including stormwater control and drainage, replenishment of groundwater, biological habitat creation, and aesthetic appeal. This is detailed further in Section 5.4.3.3 of this ESIA.

The water quality of the marine and freshwater systems will require monitoring during the construction and operational phases of the development. This should be done regularly to ensure that mandated standards are maintained.

Under Schedule VII of the EMPA (2019), the coastal waters around this development are classified as Class B under the water use classifications and criteria:

1. Waters within such areas are to be used for ports, small boat harbors, industrial activities, mining, commercial and industrial shipping, compatible recreation, the support and propagation of aquatic life, and aesthetic enjoyment;

2. it is the objective for this class of water that discharge of any pollutant be controlled to the maximum extent possible and that sewage and industrial effluent receive the highest degree of treatment practicable under existing technological and economic conditions and shall be compatible with the standards established for this class;

3. the Class B designation should apply only to a limited area next to commercial or industrial facilities, and the rest of the water area in such bay or harbour shall be Class A unless given some other specific designation.

Due to the nature of the Resort, the freshwaters on-site should be maintained at a Class 2 level under the water use classifications and criteria:

1. The uses to be protected in this class of waters are bathing, swimming, the support and propagation of aquatic life, compatible recreation, and agricultural water supply;

2. It is the objective for this class of waters that their use for recreational purposes, propagation of fish and other aquatic life and agricultural and industrial water supply shall not be limited in any way;

3. Class 2 waters shall be kept clean of trash, solid waste materials and oils and shall not act as receiving waters for any effluent which has not received the highest degree of treatment or control practicable under existing technological and economic conditions, and shall be compatible with the standards established for this class;

The following are specific water quality and standards guidelines for Class B saltwater and Class 2 freshwaters as outlined in Schedule VII (Part C)(2) of the EPMA (2019):

- Microbiological requirements

  - Fecal coliform count shall not exceed a geometric mean of 200/100 ml for any 10 consecutive samples nor shall any single sample exceed 400/100 ml.
  - No *Enterococci* count requirements for Class A, B, 2, 3.
- pH Units
  - For Class B, pH variation shall be within 7.7 and 8.5 units, and for Class 2, pH variation shall not be greater than 0.5 pH units from natural conditions but not lower than a pH of 6.5 or higher than a pH of 8.5 from other than natural causes.
- Nutrient Availability
  - The ratio of total nitrogen to total phosphorus concentration shall be within: 6.1-18.1 (Class B), and 10% variation of the naturally occurring ratio (Class 2).
  - The concentration of total nitrogen and total phosphorus shall not vary by more than 10% from the natural conditions.
  - Except for concentrations attributable to natural causes, nutrient concentration shall not exceed:
    - Total Phosphorus: 0.500 mg/l as P (Class B) and 0.200 mg/l (Class 2)
    - Total Nitrogen: 0.800 mg/l as N (Class B) and 1.500 mg/l (Class 2)
- Dissolved Oxygen
  - Dissolved oxygen concentrations shall not vary by more than 25% from natural conditions.
  - Except for concentrations attributable to natural causes, dissolved oxygen concentration shall not be less than 5.0 mg/L (Class 2) and 4.5 mg/L (Class B)
- Salinity
  - Salinity changes shall be less than 5% from natural background levels (Class B) or 1,000 mg/l (Class 2).
- Temperature
  - Temperature shall not vary by more than 2 degrees Celsius from the natural conditions.
- Turbidity
  - Turbidity as measured by Nephelometric Turbidity Units (NTU) shall not be greater than 10% above natural conditions.
- Light penetration
  - The euphotic depth shall not vary by more than 10% from the natural euphotic depth.

All water quality analyses will be conducted by the Analytical Services Laboratory (ASL), in Antigua per the request of DoE. Water samples will be tested for nitrate, phosphate, salinity, pH, turbidity, Enterococci, and fecal coliform to align with the capabilities of the laboratory and the parameters required by the DoE. Temperature and dissolved oxygen will be measured *in situ* with a YSI probe, and salinity using a refractometer, by the science team. All water measurement reporting measurements and standards have been provided by the DoE. These standards require that phosphates and nitrate results be reported in mg/mL, and since the ASL reports these metrics in ppm, all results should be converted from ppm to mg/mL.

8.4.2 Stormwater management

Stormwater management is the effort to reduce runoff of rainwater that does not immediately soak into the ground. This runoff can cause flooding and erosion as it flows from one area to another or pools in low-lying areas. This is a known baseline issue for the development site, where flooding is known to occur. An appropriate drainage and stormwater management system should be built during the construction phase. This includes but is not limited to, appropriate sub-surface pipes

for drainage, drains, and soakaways, curbs to direct water flow, and water pumps to address water collection in any low-lying areas. These will help ensure that stormwater is (1) not retained on the property to cause flooding or erosion and (2) is directed to areas where it can be incorporated into the constructed wetlands, landscaping, percolate into the ground, or flow out to sea.

Water monitoring protocols are outlined in Table 8.3 below.

Table 8.3: Water quality management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Protect the health of marine and freshwater ecosystems and comply with EPMA (2019)	Maintain the health of biological communities and waters for marine life and recreational activities.	Water quality monitoring protocol in Section 5.2.3	Remedial action if water quality exceeds regulated values.
Protect marine ecosystems from increased turbidity	The marine environment appears to be subject to some turbidity from runoff and ferry activities. Consistent monitoring of water quality will allow assessment of the ongoing extent of these impacts.	Water quality monitoring protocol in Section 5.2.3	Does not exceed thresholds as per the EPMA 2015 for Class A waters.
Minimize flow of stormwater to the ocean to reduce impacts to coastal resources, and optimise retention in constructed wetlands as planned	Reduce flooding and runoff into the ocean by directing runoff water into drainage infrastructure and constructed wetlands. Design constructed wetlands to buffer stormwater runoff and allow for retention and ongoing regeneration of groundwater.	Ongoing site monitoring by developers. Water quality monitoring protocol in Section 5.2.3	Water quality does not exceed thresholds as per the EPMA 2019 for Class B, 2 waters.
Protect against chemical spills	Chemical Handling Ensure all chemicals are stored and handled in accordance with their Materials Safety Data Sheet (MSDS). Any chemical spill is treated immediately. Excavate and remediate and potential contamination of groundwater. Follow the Disaster Response protocols	Chemical and toxins storage and handling managed by Developers according to best practices.	Chemicals are stored properly, and spills are reported and treated immediately.

8.4.3 Erosion and sediment management

Land disturbance from construction accelerates erosion rates and is one of the major causes of pollution and coastal resource problems during development. Erosion increases when vegetation is removed, altered, or when land is graded or soils stockpiled. During storm events that cause stormwater runoff, any chemicals or pollutants in the soil can be transported to marine water or other sensitive locations. Controlling erosion means preventing or minimizing the amount of sediment and water runoff from the development site.

BMPs, through deliberate erosion control measures, will be used in areas near the shoreline during the construction phase of the project to prevent erosion and sediment runoff. BMPs are designed to reduce the velocity of runoff, allow rainwater to infiltrate, trap sediments, and support the establishment of vegetative cover.

During the construction phase, an appropriate drainage and stormwater management system should be built to prevent erosion and sediment runoff during the project's operational phase. Additional sediment retention structures, such as berms or swales, may also be required.

The scientist-monitor will monitor and report the specific measures as outlined in the monitoring protocol and will work with the Developers to help to facilitate successful on site-level BMP implementation.

Table 8.4: Erosion and sediment management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Minimize erosion and pollution and their impacts on humans and coastal resources	General management practices to be overseen by the Developers. They include: Secure erosion controls in place prior to construction, particularly in areas close to the shoreline Permanent soil erosion control for all channels or disturbed land areas. If permanent controls are not possible, temporary erosion controls such as planting native plants and grasses, piping or slope drains, settlement basins, artificial coverings, berms etc., should be used. Revegetation/stabilization works are to occur as early as practicable on cleared and disturbed areas.	Implementation of BMP by the Developers Dust or particle impacts on human health to be reported to the Developers	Beach width Water quality

Objective	Management actions	Monitoring	Performance indicators
	Stockpiled topsoil or sandpiles for re-use appropriately and protected from wind/runoff erosion and weed infestation. Control all traffic into and out of the site and traffic within the site to minimize erosion and dust. Maintenance and monitoring of the erosion and sediment control measures are to be applied for the full construction period. All staff working on the site need to be trained and informed of the importance of maintaining good erosion and sediment control procedures with oversight from the Developers.		
Under dry/drought conditions: limit impacts of dust and sediment pollution on human health and vegetation, and prevent transport into the marine environment	Activities that may be additionally necessary Ensure exposed soil surfaces to be kept in a moist condition. Alternatively, dust suppressants such as soil binders can be used. Promptly stabilize areas where work is completed or where stabilized through measures such as landscaping, mulching, soil binders or grassing.	Increased monitoring may be necessary TBD by scientist-monitor	No Increase In sedimentation. No impacts on human health
Under wet/flood conditions: prevent increased erosion runoff and sedimentation	Activities that may be additionally necessary Construct sediment catchment devices, typically a temporary basin. Install sediment control devices such as silt fencing, berms, and swales. Divert storm water runoff away from disturbed areas of the site	Increased monitoring may be necessary. TBD by scientist-monitor	No increase in sedimentation. No impacts on human health.

Objective	Management actions	Monitoring	Performance indicators
	and into existing intact native vegetation, sediment control devices or existing drainage systems. such as the constructed wetlands, landscaping, mulching, soil binders or grassing.		

8.4.4 Climate change

Climate change is inevitable and sea level rise is likely to negatively impact coastal developments in the Caribbean within the next two decades. It is imperative to implement monitoring for early detection of coastal changes and analyze data to determine the best methods to mitigate or adapt to the changes. The monitoring described above allows for analysis of climate change impacts and provides management tools for making informed decisions. In addition to on-site monitoring, tracking, and analyzing rainfall, temperatures, and storm activity are necessary for future decisions.

8.5 Socio-economic management

The scope of the Rosewood Barbuda Resort development makes it one of the largest in Barbuda. The engagement of the local residents and the Barbuda Council is critical for the comprehensive success of such a project. The Rosewood Barbuda Resort will add economic value to Barbuda. As a luxury hotel and home development, it will provide high-end tourists. It should directly employ local labor for both construction and operations of the resort where possible and provide training for locals to achieve the high standard of service required by the resort and to encourage new skills beyond the service industry. The developers should keep track of metrics, such as jobs created, and the EP will compile the data into quarterly or yearly reports as requested by DoE and DCA.

Education and outreach are important aspects of any monitoring program. Efforts should be made to make data available to the public and a communication program developed for local presentations can highlight the conservation efforts to the wider community. In addition, educational graphics for public viewing are effective tools to teach both locals and visitors about the ecology and importance of preserving native habitats.

Table 8.5: Socio-economic management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Maintain beach access on site	Maintain the public access around the ferry dock area	Beach access provided	Access confirmed
Enhance socio-economic wellbeing of Barbuda community	General Best Management Practices to be applied and overseen by the developer	Surveys and communication	Increased engagement and perception
On-site education for visitors	Signage and information about species and ecological importance of beaches, wetlands, etc.		Presence of signs and informational materials
Job creation and training	Job creation and training for locals. Other local outreach, such as educational talks	Quarterly/annual reporting on job creation, training, events	Number of jobs created, training provided, and events conducted

8.5.1 Noise

Construction noise quality impacts are expected to be largely temporary and mostly during the construction phase of the project. Specific noise risks during construction include workers working with loud machinery. Construction workers should be provided with appropriate noise protection equipment.

The baseline noise levels were relatively high for a rural site (Section 5.3) due to the current presence of sand mining and batch plant operations. The sand mining operation on the land adjacent to the development will continue to function during both the construction and operational phases of the development. The noise pollution from this is likely a concern for the Resort and should be assessed over time. Vegetation will be planted to provide a natural barrier and dampen this noise. There are no residential properties in the immediate vicinity of the development site.

Table 8.6: U.S. Occupational Safety and Health Act of 1970 (OSHA) standards & OSHA Hearing Conservation Program Amendment (Occupational noise exposure - 1910.95)

Duration per day (hours)	< ¼	1	1 ½	2	3	4	6	8	16	32
Sound level (db(A)) Slow Response	115	110	105	102	97	95	92	90	85	80

Noise management actions are outlined in Table 8.7 below.

Table 8.7: Noise management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Ensure the safety of all construction workers in terms of noise exposure and through the lifetime of the project.	Adopt necessary precautions in accordance with construction and operations standards as set for in “Environmental, Health, and Safety (EHS) Guidelines: Noise Management, 2007” and conform to noise standards of U.S. Occupational Safety and Health Act of 1970 (OSHA).	Ongoing site monitoring and auditing by the Health and Safety Officer, designated by the Developers	Noise exposure not to exceed standards (Table 8.6) Number of noise complaints by workers No noise-related deterioration in worker’s health
Minimize disturbances to neighbouring business	Follow standard operation guidelines including confining construction to normal working hours and avoiding weekend construction. Use temporary noise barriers or provide respite periods. Provide notice to business of any planned activities that may	Ongoing site monitoring and auditing by the Health and Safety Officer designated by the Developers.	No construction during non-designated hours Number of noise complaints

Objective	Management actions	Monitoring	Performance indicators
	exceed noise and vibration targets. Ensure that managers effectively communicate acceptable and unacceptable work practices for the site.	Complaints from residents	

8.5.2 Air quality

The air quality on the development is generally good, with some dust created from the main road and trucks carrying construction materials. However, this section of the road is fully paved so there is less resuspended dust than in other areas. Any additional air quality impacts are anticipated to occur during the construction phase. Air quality risks include:

- Use of construction materials, particularly fine sediment materials
- Use of transport vehicles (emissions and dust generation)
- Windborne dust from construction activities, as well as storage of topsoil and sand

Air quality management actions are outlined in Table 8.8 below.

Table 8.8: Air quality management sub-plan actions

Objective	Management actions	Monitoring	Performance indicators
Maintain threshold air quality by minimizing dust movement and emissions from vehicles and generators	Minimize dust creation: • Vegetation cleared in staged manner. • Sealing and/or re-vegetating disturbed areas as soon as possible after completion of each stage of construction works. • Planning haulage routes on sealed surfaces and using dust suppression on unsealed roads within construction sites. • Covering loads on public roads. • Using wind breaks. • Minimizing double-handling of materials. • Seeding, stabilizing, covering, or	Ongoing site monitoring and auditing by the Developers	Dust minimizing actions are taken. Equipment purchased is up to date and industry compliant. Nitrogen oxide, sulfur dioxide and particulate matter emissions are within recommended National Ambient Air Quality Standards.

Objective	Management actions	Monitoring	Performance indicators
	containing stockpiles where necessary. • Ensure purchase and use of modern, recent, and good working order equipment that is industry compliant		

8.6 Monitoring inspections

Suggested inspection checklist. The final version of this checklist will be determined between the GoAB, EP and the Developers.

Table 8.9: Suggested EMMP Checklist

Date	**Inspected by/company:**	**Stage(s) of development:**

✓	Monitoring action	Response/result
BIODIVERSITY		
	Are trees identified for protection still on site/ fenced off?	
	Have native plants been moved to a nursery environment?	
	Mangrove and wetland plants being grown in nursery/wetland	
	Have any nesting turtles or hatchlings been observed?	
	Have any other species of concern been identified?	
	Native plant species incorporated into landscape and dunes	
	Has seagrass and coral reef monitoring at control and impact sites been evaluated	
	Has beach width been recorded?	
	Has dune height been recorded?	
	Have all data been entered in digitally? If so, which ones and if not, why are they missing?	
WATER		
	Has water quality monitoring for all marine and freshwater sites been conducted this quarter?	
	Have the stormwater management BMPs been implemented?	
	Are all chemicals stored and handled in accordance with their MSDS?	
	Have all chemical spills been treated immediately according to disaster response protocols?	
EROSION AND SEDIMENT CONTROL		
	Have water or soil binds been applied to newly exposed soil?	
	Have exposed areas been revegetated or stabilised as soon as practicable?	
	Are any sediment catching devices in place?	
	Is storm water being diverted away from disturbed areas?	
	Are stockpiled topsoil and sand piles appropriately protected from wind/runoff erosion and weed infestation?	
	Is traffic movement into and out of the site controlled and confined to dedicated roads?	
	Any complaints from locals or workers about dust?	
	Have staff/subcontractor trainings occurred this period?	
CLIMATE CHANGE		
	Have rainfall metrics been recorded?	
	Have air and water temperatures been recorded?	
	Has any storm or hurricane activity occurred?	

SOCIAL AND ECONOMIC		
	Number of jobs created or continued	
	What trainings were provided this monitoring period	
	How many events (such as educational talks) were held this period?	
	Has beach access been preserved for the local community?	
NOISE		
	Are noise levels within acceptable levels?	
	Have there been any complaints from locals or workers about noise impacts?	
	Have any noise barriers been necessary and used?	
AIR QUALITY		
	Have there been any worker or local complaints about air quality?	
	Are traffic areas clearly delineated?	
	Has air quality been tested this period?	
COMMENTS		
Any further comments or any communication with referral/regulatory authorities about potential breached of the EMMP.		



SECTION 9.0 SUMMARY AND CONCLUSIONS

Murbee Resorts Inc. proposes to build the Rosewood Barbuda Resort on the southwest coast of Barbuda. It aims to create a luxury resort and residences that deliver an exquisite and unrivalled guest experience. The development will be constructed on a 160.48-acre plot in four phases. It will include 50 keys/suites, guest pools, an organic farm, restaurants, a spa and fitness facility, a kids club, sports courts, employee housing, and a house area. The development site is zoned for industry and tourism. It will provide local jobs and financially benefit Barbudan businesses, including suppliers, restaurants, vendors, and taxi operators. It will be a significant financial investment into Barbuda and aims to provide environmental, social and economic benefits.

The ESIA provides a comprehensive assessment based on the Terms of Reference provided by the Department of Environment for this project. The ESIA assessments included environmental, ecological, geotechnical, water quality, noise, hydrology, drainage, coastal vulnerability and climate change, socio-economic, archaeological, and utilities.

The project will provide benefits to Antigua and Barbuda as a high-end luxury resort, creating new job training. There will also be opportunities including in non-traditional hospitality sectors such as environmental management and stewardship, and local business opportunities. The project will also impact the traditional lifestyle of Barbuda- one that is currently undergoing an unprecedented and rapid transformation without much if any socio-cultural assistance to the community. The project has an opportunity and an obligation to engage with the community in a transparent way to create a sustainable and more equitable project. Communication and the engagement of a local community liaison officer can help to build trust and dialogue.

Most of the project is located in areas that have been heavily impacted including by industry. Some of the western side lies within Ramsar and CLNP designations. As a result, the ecology has been disrupted. However, the project has committed to building with nature and using nature based solutions to climate, flooding and water management are a center-piece to the development. Wetland creation, mangrove protection, and a native plant nursery are key features. Incorporating coral reef gardens and a Barbuda warbler conservation and education program will help to enhance and protect critical habitats and biodiversity.

A natural hazard disaster risk reduction plan along with a key impacts mitigation plan and an ongoing Environmental Monitoring and Management Plan is included with this ESIA to guide the project towards a sustainable and low impact effort that if implemented can help to sustain the environment and provide benefit to the community and project.



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ANNEX 1. DISCLOSURE OF CONSULTANTS ENGAGED

Curriculum Vitae

Deborah Brosnan, Ph.D.

Overview

Dr. Deborah Brosnan Dr. Deborah Brosnan is a globally recognized marine scientist, environmental entrepreneur, and climate-risk expert with over 25 years of experience in environmental risk reduction, innovation and problem-solving. As the founder and president of Deborah Brosnan & Associates, she has led groundbreaking projects across the globe, particularly focusing on marine resilience, disaster risk reduction, and ecosystem restoration. Dr. Brosnan has been at the forefront of numerous high-stakes environmental initiatives, including the pioneering OceanShot coral reef restoration project in partnership with John Paul DeJoria. She is known for being a pioneering leader, her ability to engaging diverse stakeholders to solve pressing issues, and her mentorship.

Her career is marked by her ability to blend cutting-edge science with practical solutions, having played a critical role in the recovery efforts following natural disasters such as the Montserrat volcanic eruption and the Southeast Asian tsunami. Dr. Brosnan's work is not only academic—she has held positions at top institutions like Virginia Tech, Stanford University, and the Smithsonian—but also deeply practical, influencing policy at the highest levels, including testimony before the U.S. Congress and representation at the United Nations.

Her subject matter expertise is regularly featured on CNN, BBC and other major media. She has been a featured speaker at SXSW, TEDx, WebSummit, Collision Conference, The Doha Forum, and Davos Global Risk Forum, EarthX among others. She is the recipient of a Red Cross Humanitarian Award and Ireland-America Lifetime Award for Life Sciences and was inducted into the Ireland 100 for her services to US and Irish higher education.

Deborah Brosnan Ph.D. President, Deborah Brosnan & Associates.

Mailing Address:

Office: 1725 DeSales St NW Ste 806, Washington, D.C. 20036 USA
Tel Office: 1 202 578 2348
Tel Mobile 1 503 869 5769
Email: brosnan@deborahbrosnan.com
Website: www.deborahbrosnan.com
Linked-in: https://www.linkedin.com/in/deborahbrosnan/

Academic Credentials

Ph.D., Oregon State University: Dissertation - Effect of extreme events on marine ecosystem dynamics - (1994). Advisors Jane Lubchenco and Bruce Menge.
M.S., National University of Ireland, Fisheries Science (Research Thesis) - (1982).
B.Sc., University College Galway, Honors in Zoology and Botany - (1978).

Appointments. Private and NGO Sectors

President and Founder, Deborah Brosnan & Associates - (from 2014)

A highly-regarded company that finds and implements solutions to pressing environmental challenges and risks from resilience to climate change and working with discerning clients from around the world. Headquartered in Washington, D.C., with offices established in Antigua and Barbuda and St. Barthelemy. As CEO of the company, I manage strategy, partnerships, and the suite of CEO duties. Key projects developed nature-based solutions and OceanShot.

Founder and CEO, Sustainable Ecosystems Institute - (1994-2011)

A non-profit organization that integrated science and carried out scientific research to address environmental problems throughout the USA. Established and grew the organization - recruiting a key team of 1,000 peer-nominated scientists who formally signed up to provide peer reviews for environmental matters affecting national policy decisions

Appointments: Academic

Professor of Biology, and the Global Forum for Urban and Regional Resilience, Virginia Tech. (2012- Present, now Adjunct).
Faculty Member, Global Climate Change, Virginia Tech. (2017-Present).
Environment and Policy Fellow One Health Institute, University of California Davis. (2011- 2015).
Visiting Scholar, Department of Biology, Stanford University. (2009-2010 and 2002- 2003).
Senior Visiting Researcher, Smithsonian Institution. (2013-2016).
Visiting Professor, Environment and Law, Northwestern School of Law (co-teaching science/law).

Boards of Directors and Advisory Boards

President of the Board of Trustees, Ireland America Science Forum. (current)
Board of Directors, PADI AWARE Foundation, a global SCUBA diving conservation organization (current)
Board of Trustees and Past Chair- University of California Davis, Wildlife Health Center, SeaDoc Society. (2000-currently emeritus).
Commissioner, IUCN Commission on Ecosystems. (current).
Joint USA- Italy Commission on hazards and disasters. (2015-2019)
American Society of Civil Engineers. Member of Committee on Sustainability. (2016-2022).
National Courts and Sciences Institute. Science Board Member. (2014- 2020).
American Academy of Arts and Sciences Committee on “Science During Crisis” (2017).
Global Risk Forum, Davos, Board of Advisors. (2012- 2016).
Science Advisor, Environmental Agency, St. Barthelemy FWI. (2013- 2018).
Conservation Committee, American Ornithological Society. (2014-2017).
BBC The World, Science Advisor. (2006-2012).
State Appointed Public Trustee, Board of Directors, College of Forestry, OSU.

Other Professional Activities

Science Advisor to the Government of Antigua and Barbuda representing the Nation at the UN General Assembly and UN Climate Summit (New York, September 2019).
Government Delegate to UNSIDS 2024.May 2024
CoP26 Delegate Antigua and Barbuda Government (2021)
Provided testimony before U.S. Senate and House Committee on science and environmental matters.
Chair for Scientific Code of Ethics for the U.S. Department of Interior that was adopted to ensure high-standards and the integrity of science.
Hold Memorandum of Understanding with U.S. Government's Geological Survey as an on-call advisor and provider of technical assistance during hazards and extreme events.
Delegate to UN Sendai Negotiations and Treaty Completion for Disaster Risk Reduction Sendai Japan 2015.
Science in the Courtroom: Developed and taught "Science in the Courtroom" to U.S. State Supreme Court Justices, Washington (several).
Founded Tsunami Reef Fund (2005), linking international scientists and professional divers with local communities affected by the tsunami. Provided economic and scientific assistance locally in marine debris clean-up and reef recovery. Traveled throughout the affected region in SE Asia to establish the program and additional long-term linkages and projects.

Awards, Fellowships, Memberships

Fellow The Explorers Club, New York
Member The Cosmos Club Washington DC.
Invited Member of the Global Citizen Forum
Top 50. Ireland-America Lifetime achievement award for services to Life Sciences and Health. (2019).
Inducted into "Ireland 100" for services to U.S. higher education and learning. (2015).
Science-Artist in Residence, Cill Rialig, Ireland. (August 2015).
Senior Whiteley Fellow, University of Washington. (2010).
Red Cross Hero's award for saving lives in a jetliner crash.

Examples of Invited In-Person Presentations (from 2016)

Sun Valley Forum 2024
United Nations SIDS Conference May 2024
Economist Ocean Summit Speaker 2024, 2022
Institute of Banking Keynote on Blue Economy 2024; Keynote on Environment 2023
WebSummit Lisbon Planet Tech Keynotes 2024, 2022, 2021
Cosmos Club Climate and Science Group March 2024
Collision Conference Toronto June 2024, 2023 2022
EarthX Conference May 2022
World Ocean Week Presentation with Prince Albert Foundation and Andrew Revkin 2023
Climate Week New York 2022 Convened Presentation with Global Citizens Forum and PADI
World Ocean Week- June Explorers Club 2022
SXSW Featured Speaker (South By Southwest, Austin Texas) 2022
Doha Forum 2022
Convened first ever underwater panel discussion beamed back to the main stage at the Global

Citizen Forum November 2023
GCF Keynote November 2021
WebSummit November 2021
UN Climate Change Summit New York (2019).
UN General Assembly. (2019).
American Society Advancement of Science "Science During Crisis" – Invited. (2018).
TedX: How Nature is Key To Resilience 2018
World Ocean Society Ports, Environment and Disasters: The Netherlands. (2017).
American Society of Civil Engineers: Sustainable Infrastructure: New York. (2017).
United Nations Natural Hazards Conference: Geneva – Invited. (2016)
Davos Risk Forum (several presentations and sessions organized).
American Geophysical Union Annual Meeting Organized several sessions including science during disaster sessions. (2015, 2016).
Building Resilience International Conference Virginia Tech. (2016).

Presentations on several major podcast venues including:
May 2024- A sea of climate solutions with Bruce Langford (Mindfulness Mode Podcast Program (405 million downloads): Conservation Conversation: Sustain What (A. Revkin); David Meltzer-The Playbook 2024. Sustainability Champions, Bullseye Financial Reports, the AI Journal and others.

Multi-Sector Partners

A key part of my work and mission is to engage partners from a diverse sectors to work together, some of my established partnerships include:

Private Sector (Individuals and Entities): I have established partnerships with private, government and NGO sectors to advance our collective mission for solutions that support planet, people, and ecosystems. Partnerships Include: King Charles SMI; John Paul DeJoria, Ann Bass, Pivot Investors. Pelekos Investments, Discovery Land Company, Champagne Hospitality, Rosewood Group, Ayre Group, G-iii, Calabash Group. Sustainable Hospitality Alliance: **Governments**: U.S. Geological Survey, U.S. Department of Interior, U.S. Fish and Wildlife, U.S. Army Corps of Engineers, National Aeronautics and Space Agency (NASA), NW Indian Commission, Government of St. Barthelemy, France, Government of Antigua and Barbuda, EU Commission, Organization of Eastern Caribbean States, **NGO**: The Nature Conservancy, Family Forestry, Telluride Citizen Group, The David and Lucile Packard Foundation, The Gordon and Betty Moore Foundation.

Media and OpEds

Regularly featured as a Subject Matter Expert on CNN, BBC NBC and also appeared as a subject matter expert and commentator on FOX, Scripps, CCTV, I have had features on my work on CNN, ABC, NBC CCTV and popular publications. Published several featured OpEds for the Hill, Washington Post. Fair Observer, Green Biz, Huffington Post, Sustainable Brands and others.

Publications and Presentations - Selected Examples Only

Academic Publications – Books
The Disaster Resilience Challenge- Transforming Theory into Action. J. Bohland, J Harrald, D

Brosnan 2018 C. Thomas Publishers 252 pages.
Extreme Geohazards: Reducing the Disaster Risk and Increasing Resilience, Hans-Peter Plag, S. Brocklebank, D. Brosnan, P. Campus, S. Cloetingh, S.J.-Plag, S. Stein, 2015 European Science Foundation.
Peer Reviewed Academic Publications and Reports c 50 publications (full list available online)

Languages

English, French

Key Program/Project Examples

Below is a refined list highlighting projects where I provided leadership, innovation, and implementation management to drive impactful projects in conservation, government, the private sector, and community building:

1. **OceanShot and Innovation Lab**: Spearheaded the multi-million-dollar program to restore reefs at scale and start an innovation lab. Key Partner is John Paul DeJoria and program is in collaboration with Government of Antigua and Barbuda. Established key partnerships including with King Charles III SMI Initiative; PADI, AWARE, University of West Indies, Sustainable Hospitality and others
2. **Sustainable Development in the Caribbean**: Led a $450 million sustainable development effort integrating nature-based solutions to protect against hurricanes and climate change, currently rebuilding 7 miles of dunes with native vegetation to restore biodiversity.
3. **Disaster and Crisis Management in Montserrat**: Conducted critical marine surveys during the Montserrat volcanic crisis, leading to successful marine environment preservation and the first coral reef relocation in the region.
4. **Marine Reserve Establishment in St. Barthelemy**: Directed research and collaboration with government and NGOs to establish a national marine reserve, and provided ongoing assistance.
5. **National Hazard Risk Assessment**: Key member of a U.S. Government leadership team evaluating tsunami risks in California, leading environmental, fisheries, and ports research.
6. **NASA & The Nature Conservancy Collaboration**: Co-developed a GIS-based tool for assessing and mitigating sea-level rise and hurricanes, integrating data on community impacts and ecosystem restoration and creating a series of management options.
7. **Training Caribbean Leaders for EU**: Organized and oversaw delivery a 5-day workshop on integrating environmental, natural hazard, and policy considerations for 11 Eastern Caribbean States.
8. **Innovative Coastal Protection**: Led research and advocacy for dune restoration over seawall construction, resulting in coastal protection against multiple hurricanes and saving properties worth hundreds of millions of dollars.
9. **SE Asia Tsunami Response**: Mobilized scientists and divers to aid communities in ocean clean-up and coral reef restoration post-tsunami across Sri Lanka, Thailand, and the Maldives.
10. **Pivot Investment Group Advisor**: Provided strategic planning and analysis for social-impact investments.

11. **Colorado Wetlands Conservation**: Led a 34-scientist team in biological surveys that facilitated the conservation of the largest tract of Colorado wetlands.
12. **US Government Peer-Review Process**: Developed and managed a public peer-review process used extensively by the U.S. Government, overseeing $50 million in contracts and 32 national projects.
13. **S. Florida Restoration Project**: Facilitated resolution of complex environmental and regulatory challenges in a $5.8 billion government investment, overcoming litigation deadlocks.
14. **Endangered Species Science-Based Conflict Resolution**: Mediated an 11-year dispute over endangered species and economic interests in the Pacific Northwest, achieving a consensus plan that protected jobs and species and was approved by all stakeholders, ending litigation.
15. **Chaired Committee for US Government to develop scientific ethic.** Helped to restore trust between agency scientists and government entity following several science-based challenges

Dr. Holly Trew, *B.Sc., Ph.D.*

Barbados West Indies

Nationality	Barbadian, UK
Languages	English
Home Base	UK (London), Barbados

EDUCATION

Doctor of Philosophy (Ph.D.) in Ecology, University of the West Indies, Cave Hill, Barbados**.** High Commendation. Thesis title: Abundance, distribution and growth of the excavating sponge *Cliona delitrix* in Barbados — 2015–2021

Bachelor of Science (B.Sc.) in Marine Biology, minor in Ocean Sciences, Dalhousie University, NS, Canada. Grade: First Class Honours. Thesis title: Habitat complexity, fish abundance and species richness in a tropical patch reef system — 2011–2014

RELEVANT PROFESSIONAL EXPERIENCE

Project Manager– Marine Scientist- Deborah Brosnan & Associates. — June 2022–present

Project Management for EIA and ESIA. Several projects in Antigua and Barbuda. Marine surveys, water quality analysis, EIA writing, client meetings and all aspects associated with completing and submitting EIA

Marine Biologist, Director – Azublu Ltd. — Sep 2021–2022

Contract marine consultancy, including field work and data collection, data entry, statistical analysis and report writing. Recent projects include baseline surveys for coastal construction and pipeline monitoring, as well as ecological research:

- Barbados Lionfish Project (2021-22): Underwater surveys and identification of lionfish and reef fish.
- Barbados Reef Survey Programme (2022): Transect surveys and identification of benthic organisms (corals, algae, sponges etc.) and substrate types on 43 reefs.

MMO/PSO (International) — Sep 2021–present

Monitoring for the presence of protected species, implementing mitigation procedures, and gathering environmental and operations data. Short-term contract work, current experience includes Marine 3D Seismic and Controlled Source Electromagnetic (CSEM) surveys.

Lecturer – University of the West Indies, Cave Hill — Sep 2020–Apr 2021

Co-lecturer for third-year courses 'Biology and Ecology of Coral Reefs' and 'Statistics for Ecologists'. Involved giving lectures in person and over Zoom, organizing the field-based research project, supervising field sessions, setting and marking assignments.

Teaching Assistant – University of the West Indies, Cave Hill — Sep 2016–Apr 2021

Involved supervising and working with university students in laboratory and fieldwork settings for several courses: 'Preliminary Biology', 'Essentials of Ecology', 'Marine Biota', 'Coral Reef Ecology', and 'Statistics for Ecologists'.

PhD Candidate – University of the West Indies, Cave Hill — Oct 2015–Mar 2021

Involved conceptualization of my research theme, experimental design, marine data collection and surveys using snorkel and SCUBA, training research assistants in marine species identification and survey methods, entering and maintaining datasets in MS Excel, statistical analysis of data in R, giving scientific presentations, writing scientific reports, launching, haul-out and driving powerboats, balancing a budget, and mentoring undergraduate students.

Visiting Scholar – Florida Atlantic University – Harbor Branch Oceanographic Institute — Jun–Aug 2019

Molecular ecology work on the population genetics of the excavating sponge *C. delitrix* for my PhD research.

TRAINING COURSES & CERTIFICATES

- **Computer skills**: competent in Windows and Apple software including Microsoft Office. Use of statistical software Minitab and R, and GIS mapping softwares ESRI ArcMap and QGIS.
- CARICOM Skills Certificate
- JNCC Marine Mammal Observer course (Intelligent Ocean) 05 Apr 2022
- BOEM Protected Species Observer course (EPI Group) 22 Mar 2022
- An Introduction to Integrating QGIS and R for Spatial Analysis (GIS for Ecologists) Mar 2022
- Introduction to GIS for Biologists (GIS for Ecologists) Mar 2022
- OPITO BOSIET with CA-EBS training 12 Oct 2021
- Oil and Gas UK (OGUK) Physical examination. Medically fit for Unrestricted Offshore Work. 12 Oct 2021
- Completion of 'Introduction to Python' course (Transmitting Science) Aug 2020
- Introduction to Mixed Models for Biologists (PR Statistics) May 2018
- Multivariate Analysis of Spatial Ecological Data using R (PR Statistics) May 2018
- PADI Divemaster. Status: Active. 1100 open water dives 2012
- Barbados driving license 2008

VOLUNTEER & OTHER EXPEREINCE

- **UN Sustainable Development Goals Youth Advocacy Campaign Short Film** featured my graduate research. Presented at the regional Conference on the SDGs in Kingston, Jamaica, June 28-30, 2017 2017
- **Executive Secretary** for the Barbados J/24 Club 2016–2021
- **Executive Secretary** for the Coral Reef Restoration Alliance (CORALL), Barbados 2016–2019
- Barbados' representative at the UNESCO World Heritage Youth Project on Marine Biodiversity and Climate Change, 25-29 January 2016, Panama 2016
- **Environmental Officer** on the committee of the Barbados Divers' Association 2015–2016
- **Executive Secretary** for the Barbados Sailing Association 2015–present
- **Guest speaker** on "Marine Careers" for Career Day at Bay Primary School, Barbados. 30 October. 2015
- **Sailing:** Royal Yachting Association Day Skipper (2012)**;** Barbados National Sailing Team (2002 – 2018); Tallship sailing: coastal sailing and two Atlantic crossings. Stavros S Niarchos (2008), Sorlandet (2010-2011, 2013), Pelican of London (2012). Yacht sailing and racing: extensive experience in coastal racing and multi-day deliveries between Caribbean islands. J24, Volvo 60, Volvo 70, TP52, J121, First 40. 2002–present

SUCCESSFUL FUNDING APPLICATIONS & AWARDS

- 'Best Presentation' in Environment and Ecosystems at the Caribbean Academy of Sciences 22nd Biennial Conference 2021
- Recipient of Student Travel Award from the International Coral Reef Society 2020
- Recipient of the University of the West Indies Graduate Research Award 2020
- 1st place, 'Best Student Presentation' at the 39th Scientific Conference of the Association of Marine Laboratories of the Caribbean (AMLC), 2019 2019
- 2nd place, 'Best Student Presentation' at the 4th Caribaea Initiative Research & Conservation Conference 2019 2019
- 'Best Research Paper' at the University of the West Indies 70th Anniversary Student Research Symposium 2018 2019
- Recipient of the University of the West Indies Graduate Research Award 2019
- Recipient of the University of the West Indies Graduate Research Award 2017
- Recipient of the University of the West Indies Graduate Research Award 2017
- Recipient of Student Travel Award from the Assoc. of Marine Laboratories of the Caribbean (AMLC) 2017
- Recipient of the Women Divers' Hall of Fame Marine Conservation Scholarship 2016
- Recipient of the University of the West Indies Graduate Research Award 2016

PUBLICATIONS, REPORTS, CONFERENCE PRESENTATIONS & NON-SCIENTIFIC ARTICLES

ALANNA WALDMAN CARROW, M.Sc.

Batchelors of Science in Environmental Science, University of Southern California 2016

Master of Science in Marine Biology, Nova Southeastern University 2019

Mrs. Waldman Carrow has a strong background in environmental research and reporting. She has worked on marine ecosystems to compile and analyze data to inform coastal and marine resource management projects in Florida and throughout the Caribbean. Specifically, this research has focused on coral reef restoration, assessment, and monitoring to inform conservation efforts, beach renourishment projects, marine protected area management, mitigation of invasive species impacts and ESIAs. She has also designed and managed programs for dune restoration, mangrove rehabilitation, sea turtle monitoring and protection, and sensitive vegetation mitigation.

Through her experience in research and outreach, she has worked with U.S. federal, state, and non-governmental agencies on best practices for coral restoration and management. Mrs. Waldman Carrow has conducted field work collecting data on fishes, stony corals, macroalgae, sponges, water quality, and beach renourishment and port development impacts on coastal ecosystems. She has extensive experience in project and program management with research and nonprofit organizations.

Kendall Young, M.Sc.
Master of Professional Science in Coastal Zone Management, University of Miami, Rosenstiel School of Marine, Atmospheric, and Earth Science, 2021
Bachelor of Science in Marine, Estuarine, and Freshwater Biology, University of New Hampshire, 2017

Ms. Kendall Young is an accomplished environmental specialist with extensive experience in marine and coastal ecosystem management. She specializes in environmental permitting, mitigation monitoring, wildlife assessments, biological impact evaluations, and regulatory compliance. Ms. Young has contributed to various high-profile infrastructure and environmental restoration projects throughout Florida, including the Tamiami Trail Phase 2 Design-Build and the Miami Wilds Project.

Throughout her career, Ms. Young has worked with U.S. federal, state, and local agencies, as well as non-governmental organizations, to ensure environmentally sensitive habitats are preserved and effectively managed. Her expertise includes navigating complex permitting processes for large-scale infrastructure developments, preparing various environmental documentation, and developing best management practices for sustainable development in sensitive habitats. Her dedication to environmental stewardship and her ability to collaborate across disciplines make her a key contributor to advancing sustainable solutions in coastal and marine resource management.

KENDALL YOUNG, MPS

Ksyoung13@gmail.com | (231) 642-1764 | LinkedIn

PROFESSIONAL EXPERIENCE

Deborah Brosnan and Associates | Washington, D.C. November 2024 – Present

Project Manager, Environmental Scientist *(2024-present)*

Leverage expertise in ecosystems, marine processes, and climate-change risks to design and implement nature-based solutions for tropical marine and coastal ecosystems. Manage interdisciplinary teams, conduct Environmental and Socio-Economic Impact Assessments (EIA/ESIA), and collaborate with stakeholders to integrate environmental strategies into development projects while ensuring timely and budget-conscious execution.

Davis Environmental Solutions LLC | Miami, FL November 2020 – November 2024

Environmental Scientist II *(2023-2024)/* ***Environmental Scientist*** *(2020-2023)*

Experienced in environmental permitting, compliance monitoring, and biological assessments, specializing in wildlife surveys, wetland and mangrove restoration, and mitigation planning. Skilled in managing large-scale projects, such as coral relocation, Everglades restoration, and marine species conservation, ensuring regulatory compliance and sustainable outcomes. Proficient in technical writing, GIS applications, and delivering environmental solutions for diverse clients.

Miami Waterkeeper with The City of Miami | Miami, FL June 2020 – October 2020

Fertilizer Ordinance Outreach Campaign Masters Internship

Developed and implemented an educational campaign for the City of Miami fertilizer ordinance, increasing community awareness and compliance through targeted training seminars, visually engaging flyers, and digital outreach materials. Collaborated with stakeholders, including Homeowners Associations and City officials, to disseminate ordinance guidelines effectively. Monitored online engagement metrics to evaluate campaign success and optimize outreach strategies.

New Hampshire Community Seafood | Portsmouth, NH May 2017 – January 2019

Assistant Manager

Expanded business presence and clientele through strategic marketing and event initiatives, including promoting CSF and RSF programs and organizing Under-Utilized Fish Dinners. Managed operations efficiently by overseeing orders, deliveries, and client interactions while cultivating strong stakeholder and customer relationships. Leveraged marketing and graphic design skills to enhance social media presence and boost brand visibility across platforms.

Brian E. Doyle Marine Extension Fellowship | Durham, NH Summer 2016

NH Sea Grant & UNH Cooperative Extension Fellow; Focus: Healthy Coastal Ecosystems

Collaborated with NH Sea Grant to support New Hampshire's coastal communities in making informed decisions about marine resources. Designed and implemented public outreach programs, facilitated community education on dune restoration, and conducted monitoring for American Eel populations. Assisted Sagamore-Hampton Golf Course in achieving Audubon Cooperative Sanctuary certification through water quality monitoring and stream buffer planting to protect Great Bay.

ADDITIONAL EXPERIENCE / RESEARCH

- Florida Chamber's Annual Environmental Permitting Summer School, Attendee (Summer 2022)
- New Hampshire Sea Grant Quadrennial Site Review, Guest speaker: Value of the Doyle Fellowship; Poster: Community-based dune restoration and research on the New Hampshire Seacoast (October 2018)
- New Hampshire Sea Grant Biennial Research Symposium, Poster: Community-based dune restoration and research on the New Hampshire Seacoast (February 2017)
- UNH Ocean Discovery Day at Chase Ocean Engineering Laboratory, Exhibitor: Nudibranch and Invertebrate Ecology (October 2015, September 2016)

EDUCATION

The University of Miami, RSMAS May 2021

M.P.S in Coastal Zone Management, Advisor: Maria Estevanez

The University of New Hampshire, Durham, NH May 2017

B.S. in Marine, Estuarine, and Freshwater Biology

- UNH Sailing Team (Team Captain); UNH Sustainable Fisheries & Aquaculture Club (Vice President); UNH Chapter of Women in Science (Member)

CERTIFICATIONS

PADI Advanced and Enriched Air (Nitrox) Diver | Florida Department of Environmental Protection Advanced Hydric Soils Workshop Training | Offshore Safety at Sea, USSA | Comfort at sea and in remote field locations

Cristina Esteban M.A.

Senior Social Analyst

Social expert specialized in social analysis and research from a comprehensive perspective. With solid experience leading multidisciplinary work groups and managing high-impact projects (transport, water and sanitation, architecture, hospitality, electricity, renewable energy, among others) with international financing. Experience in the application of national and international regulations, policies and safeguards and good practices in socio-environmental matters.

In my professional career, I stand out for the preparation, evaluation and monitoring of Environmental and Social Impact Studies, Environmental and Social Management Plans, Stakeholder Participation Processes, Indigenous Peoples Plans, Involuntary Resettlement Plans, Cultural Heritage Protection Plans, Gender Equality Plans, working conditions and human rights.

Relevant Experience

Senior Social Specialist Consultant with Federico Scodelaro:

Consultant to Deborah Brosnan & Associates for ESIA impact studies

Feb 2023- Present

Senior Social Consultant Federal Regional Infrastructure Trust Fund

Full-time · 5 yrs

Head of Project Evaluation Department

Jul 2023 - Apr 2024 ·

On site Argentina ·

- Lead and coordinate a multidisciplinary team of professionals (economists, architects, engineers, Lic. in environmental sciences and Lic. in sociology)

- Coordinate analysis and review of public infrastructure projects, in their economic, legal, technical and socio-environmental aspects.

- Advise executing units, in order to recommend improvements and ensure compliance with internal, national and international regulations.

- Communication with multilateral credit organizations (IDB, CAF and Fonplata).

- Review and preparation of feasibility, technical and socio-environmental reports.- Lead and coordinate a multidisciplinary team of professionals (economists, architects, engineers, Lic. in environmental sciences and Lic. in sociology) - Coordinate analysis and review of public infrastructure projects, in their economic, legal, technical and socio-environmental aspects. -

Advising executing units in order to recommend improvements and ensure compliance with internal, national and international regulations. - Communication with multilateral credit agencies (IDB, CAF and Fonplata). - Review and preparation of feasibility, technical and socio-environmental reports.

Social Specialist of the Socio-Environmental Department

May 2019 - Feb 2024

- Socio-environmental evaluation of infrastructure projects.

- Planning, advice to executing units

- Monitoring of Significant Consultation processes, of the Indigenous Peoples Plan and of the Involuntary Resettlement Plan and of the Asset Allocation Plan

- Review of Environmental and Social Technical Specifications.

- Environmental and social audit of works in progress.

- Development of management systems and procedures for the Department. - Socio-environmental assessment of infrastructure projects. - Planning, advice to executing units. - Monitoring of Significant Consultation processes, of the Indigenous Peoples Plan and of the Involuntary Resettlement Plan and of the Asset Allocation Plan. - Review of Environmental and Social Technical Specifications. - Environmental and social audit of works in progress. - Development of management systems and procedures for the Department

Quilmes Municipality logo Project Leader in the Department of Anthropology and Urban Sociology

Mar 2018 - May 2019 ·

- Socio-urban diagnoses, technical, environmental, demographic and sociological evaluations for public works projects

- Qualitative and quantitative social analysis with territorial insertion in formal and informal city

- Coordination of field work

- Development of public opinion studies- Socio-urban diagnoses, technical, environmental, demographic and sociological evaluations for public works projects - Qualitative and quantitative social analysis with territorial insertion in formal and informal city - Coordination of field work - Elaboration of public opinion studies

Urban History UBACyT Student/ Researcher

Apr 2015 - Dec 2017 ·

Gino Germani Research Institute (IIGG- UBA)Gino Germani Research Institute (IIGG- UBA)

Director: Arq. Celia Guevara Research project accredited and funded by the UBA (UBACyT) based at the Gino Germani Research Institute. The project consists of research on the ways in which different social sectors interact in a fragmented urban area of the Metropolitan Region of Buenos Aires. The methodology used is qualitative through periodic visits to the research field, using in-depth interviews.

Education

Masters in Sociology and Economics:

Institue of Higher Education (Instituto de Altos Estudios Sociales) 2020

National University of Tres de Febrero

Licenses & Certifications

- 

  Advanced Level
  Cambridge International Education

- 

  IGCSE, Merit Award
  Cambridge International Education

Federico A. Scodelaro

Washington D.C. SUMMARY

International environmental and sustainability consultant with over 16 years of experience in 26 countries in North, Central, and South America, Caribbean, Africa, Asia, and Pacific regions.

B.S., M.S. in Chemical Engineering, licensed Professional Engineer. Specialized in sustainability and environmental management in infrastructure projects – particularly in the Water and Sanitation, Solid Waste, Energy, Transport and Urban Development sectors.

Experience carrying out Environmental Impact Assessments for large infrastructure projects and programs (US$ 320m), and in Environmental Safeguards Supervision for infrastructure projects (US$ 1.5bn).

Consultant for **Deborah Brosnan & Associates UNDP**, **Inter-American Development Bank**, **CAF, and The World Bank**. Has previously consulted also for IDB Invest, French Development Agency, UNOPS, Avina Foundation, public sector, and private firms.

PROFESSIONAL EXPERIENCE

- **Senior Social and Environmental Consultant Deborah Brosnan & Associates Jan 2004- Present**
- Proposals and Socio Environmental Assessments for ESIA : Guyana, Antigua and Barbuda Desiged and conducted ESIA socio-economic assessments, public consultations.

- **Senior Environmental and Sustainability Consultant** (Jan. 2017 – present) Multi-Nationals Providing advisory services in the environmental and sustainability fields, including development of environmental impact assessments, environmental auditing, sustainability and climate planning. Key clients include World Bank, Interamerican Development Bank, UNPD, UNOPS, IDB Invest, French Development Agency, Rina Inc., Avina Foundation, Santander Bank Argentina, public and private sector entities.
- **Interamerican Development Bank. Defined Term Consultant (Full Time).** Water and Sanitation Division & Sustainable Cities Initiative (Aug. 2011 – Dec 2016). Washington D.C., USA.
- **World Bank. Junior Professional Associate, Environment Unit (LCSEN).** Argentina, Paraguay and Uruguay Country Management Unit (Aug 2009 – Aug 2011). Buenos Aires, Argentina.

Dow Chemical Company. Improvement Engineer. Water, Environment and Utilities.

EDUCATION

- **Master of Science, Chemical Engineering,** University of Oklahoma. Norman, Oklahoma, USA (2007).
- **Bachelor of Science, Chemical Engineering,** Universidad Nacional del Sur. Bahia Blanca, Argentina (2004).

PROFESSIONAL REGISTRATIONS

- **Chartered Professional Engineer**. Professional License Nº 2740. Professional Council of Chemical Engineering, Buenos Aires, Argentina.

FIELDS OF COMPETENCE

- Socio-Economic Assessments
- Environmental Impact Assessment
- Environmental Due Diligence and Compliance
- World Bank, UNDP, IDB, IFC environmental and social performance standards
- Sustainability Strategies and Reporting

KEY INDUSTRY SECTORS

- Hospitality
- Water and Sanitation
- Solid Waste Management
- Transport
- Urban Planning and Development
- Renewable Energy

COUNTRY EXPERIENCE

Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Marshall Islands, Mexico, Mozambique, Panama, Peru, Sri Lanka, Tonga, Uruguay, USA, Zimbabwe.

LANGUAGES

- English (bilingual)
- Spanish (native)
- Portuguese (limited working proficiency)

Key Project Experience Across Variety of Sectors

Year / Country	Project Name and Description	Client	Role
2024 **2024 – in progress Antigua and Barbuda**	Social and Environmental Assessment 2 Hospitality Projects Antigua and Barbuda	**Hospitality Sector**	Socio-Economic Lead
2023 – in progress Belize	Preparation of Environmental and Social Assessment and Environmental and Social Management Framework for the Sustainable and Inclusive Urban Development Program	**IDB**	Lead Author

Year / Country	Project Name and Description	Client	Role
2023 Tonga	Preparation of Environmental and Social Management Framework for Tonga Ridge to Reef Project Phase 2	**UNDP**	Lead Author
2023 Marshall Islands	Review and Improvements to Environmental and Social Management Framework and Environmental and Social Management Plan for the Addressing Climate Vulnerability in the Water Sector (ACWA)	**UNDP**	Lead Author
2023 Bahamas	Preparation of Strategic Environmental and Social Assessment and Environmental and Social Management Plan for the Local Sustainable Productive Development of the Blue Economy in Bahamas Program ($30m operation)	**IDB**	Lead Author
4/2017 – 6/2023 Argentina	Safeguards supervision for Infrastructure portfolio [retainer]. Projects: Matanza Riachuelo Basin Sustainable Development Project (USD 963m Project, Environmental Category A) – 2017-2022; Metropolitan Buenos Aires Urban Transformation Project (USD 300m Project, Environmental Category A) – 2020 - 2023	**World Bank**	Environmental Safeguards Supervision
2021 – 2022 International	Technical Senior Analyst (Environment). Caribbean and North Brazil Shelf Large Marine Ecosystems Program	**UNOPS**	Environmental Safeguards Preparation and Supervision
2021 International	Structuring of a Blue Bond Issuance for the Latin America and Caribbean Region	**IDB Invest**	Lead Author
2022	Sustainability Consultant [retainer]. Project: Development of a Blue Bond Framework for Banco Bolivariano, Ecuador	**IDB Invest**	Sustainability Consultant
2019 – 2022 Argentina	Environmental and Social Safeguards Supervision for Housing and Urban Development Programs in Argentina (total project portfolio of USD 350m)	**Interamerican Development Bank**	Environmental Safeguards Supervision

Year / Country	Project Name and Description	Client	Role
2022 – present Tonga	Implementation of the Fanga'uta Lagoon Stewardship Plan. Preparation of safeguards package.	UNDP	Environmental and Social Safeguards (Preparation)
2022 Belize	Development of Environmental and Social Management System for Solid Waste Infrastructure (Regional Landfill, mainland Waste Transfer Stations and island Waste Transfer Stations)	Interamerican Development Bank	Lead Author
2022 – present Uruguay	Development of a Framework for Evaluation of Climate Change Opportunities in the Uruguay Operational Bank Portfolio	Interamerican Development Bank	Lead Author
2022 Regional (LAC)	Development of Guide for Alignment of Water and Sanitation Program Portfolio to Paris Agreement (Climate Change)	Interamerican Development Bank	Lead Author
2022 El Salvador	Preparation of Environmental and Social Impact Assessment (ESIA), Environmental and Social Management Plan (ESMP), Environmental and Social Management Framework (ESMF) and Environmental and Social Management System (ESMS) for Program to Strengthen the Water and Sanitation Sector in El Salvador	Interamerican Development Bank	Lead author
2022 Argentina	Preparation of Environmental and Social Analysis (ESA), Environmental and Social Management Framework (ESMF) and Environmental and Social Management System (ESMS) for Neighborhood Improvement Program	Interamerican Development Bank	Author, environmental safeguards section
2022 Argentina	Preparation of Environmental and Social Management System (ESMS) for Support Program for Small Wine Producers of Argentina II	Interamerican Development Bank	Lead author

Year / Country	Project Name and Description	Client	Role
2022 - present Argentina	Development of Environmental and Social Impact Assessment for the Federal Network of Fiber Optics Group 2 (provinces of Buenos Aires, Cordoba, Mendoza, Rio Negro and Neuquén)	Jefatura de Gabinete de Ministros, Government of Argentina	Coordinator Lead Author
2021 – present Zimbabwe	Strengthening Biodiversity and Ecosystems Management and Climate-Smart Landscapes in the Mid to Lower Zambezi Region of Zimbabwe. Preparation of ESIA/ESMP/IPP	UNDP	Preparation of ESIA/ESMP
2021 – 2022 Mozambique	Safeguards consultant for preparation of GCF Concept Note. Project: Addressing Climate Change Driven Water Security Challenges in the Greater Maputo Area	UNDP	Environmental and Social Safeguards (Preparation)
2021 – 2022 Mozambique	Safeguards screening and preparation of Environmental and Social Management Framework. Project: Scaling up local adaptation and Climate Change Risk Informed Planning for Resilient Livelihoods	UNDP	Environmental and Social Safeguards (Preparation)
2022 Sri Lanka	Safeguards package preparation and review for Project "Partnerships and Innovative Financing to Mainstream Biodiversity and Sustainable Land Management in the Wet climatic zone"	UNDP	Environmental and Social Safeguards (Preparation)
2021 Colombia	Review of Environmental and Social Management Plan for Preliminary Works under the Bogota First Metro Line project (US$ 4.4 billion project)	Metro Línea 1 S.A.S.	Environmental, Health and Safety Advisor
2021-2022 Uruguay	Preparation of Environmental and Social Impact Assessment for Montevideo Urban Sanitation Program VI (US$ 82m project)	Interamerican Development Bank	Lead author
2021 Argentina	Development of Environmental and Social Impact Assessment for the Federal Network of Fiber Optics 3.1, Tranche Mar del Plata – Bahía Blanca	Jefatura de Gabinete de Ministros, Government of Argentina	Lead author

Year / Country	Project Name and Description	Client	Role
2021 Uruguay	Preparation of Strategic Environmental and Social Assessment (SESA) for Education for Transformation Program (US$ 61m)	Interamerican Development Bank	Lead Author
2021 Argentina	Preparation of Strategic Environmental and Social Assessment (SESA) for Federal Network of Fiber Optics (US$ 100m)	Interamerican Development Bank	Lead Author
2021 – 2021 Honduras	Preparation of Environmental and Social Assessment and Environmental and Social Management Framework (ESMF) for Honduras Potable Water and Sanitation Project (US$ 40m)	Interamerican Development Bank	Lead Author
2020 Argentina	Development of Sustainable Infrastructure Case Study (using IDB´s Sustainable Infrastructure framework). Sustainability assessment for Power Transmission Line Project in Buenos Aires province.	Interamerican Development Bank	Lead author
2020 Argentina	Development of Technical Feasibility Study for Sustainable Housing Project Green Climate Fund (GCF) Proposal for Argentina's Ministry of Housing and Urban Development	Avina Foundation (Panama)	Coordinator Main Author
2020 – 2021 Argentina	Preparation/Review of Environmental and Social Management Frameworks (ESMF) for two operations (Solid Waste and Water & Sanitation) in Argentina	Interamerican Development Bank	Author
2019 Argentina	Environmental and Social Management Framework (ESMP) for Water and Sanitation Program in Santa Fe, Argentina (EUR 100m Program, Environmental Category A)	**French Development Agency (AFD)**	Author
2018 - 2019 Argentina	Preparation of Guide for Incorporating Climate Change Considerations in Provincial Infrastructure Projects	Interamerican Development Bank	Lead Author, Coordinator

Year / Country	Project Name and Description	Client	Role
2019 Argentina	Environmental and Social Impact Assessment (ESIA) for Solar PV Plant La Travesía, San Juan, Argentina	Interamerican Development Bank	Coordinator Main author, environmental assessment
2019 Argentina	Environmental and Social Impact Assessment (ESIA) for Sanitation Project in Greater San Juan, Argentina	Interamerican Development Bank	Coordinator Main author
2019 Argentina	Environmental and Social Impact Assessment (ESIA) for Retamito Water Pipeline, San Juan, Argentina	Interamerican Development Bank	Coordinator Main author
2019	Preparation of City Sustainability Action Plan for Bahia Blanca, Argentina	Interamerican Development Bank	Main author
2019 Argentina	Environmental and Social Impact Assessment (ESIA) for Integrated Sanitation and Construction of Wastewater Treatment Plant Project for Concepcion del Uruguay, Entre Rios, Argentina	Municipality of Concepcion del Uruguay, Entre Rios, Argentina	Lead author
2019 El Salvador	Preparation of environmental analysis and action plans at city level for 7 urban centers in El Salvador	Interamerican Development Bank, Washington DC	Lead author
2018 - 2019 Argentina	Environmental and Social Impact Assessment (ESIA) for Integrated Sanitation and Construction of Wastewater Treatment Plant Project for Concordia, Entre Rios, Argentina	Interamerican Development Bank	Lead author
2018 - 2019 Argentina	Environmental and Social Impact Assessment (ESIA) for Integrated Sanitation and Expansion of Wastewater Treatment Plant Project for Gualeguaychú, Entre Rios, Argentina	Interamerican Development Bank	Lead author
2018 – 2019 Argentina	Environmental and Social Management Framework (ESMF) for Sanitation Program for Coastal Cities at Rio Uruguay, Entre Rios, Argentina	Interamerican Development Bank	Lead author

Year / Country	Project Name and Description	Client	Role
2018 Uruguay	Environmental and Social Analysis and Environmental and Social Management Framework (ESA-ESMP), Ciudad del Plata Sanitation Project	Interamerican Development Bank	Lead author
2018 Uruguay	Environmental and Social Management Framework (ESMF), Ciudad del Plata Sanitation Program	Interamerican Development Bank	Lead author
2018 Uruguay	Environmental and Social Impact Assessment for Neighborhood Improvement Program III, Uruguay (USD 100m Program, Env. Cat. A)	Interamerican Development Bank	Coordinator Main author, environmental assessment
2018 Uruguay	Environmental and Social Management Framework (ESMF), Neighborhood Improvement Program III, Uruguay (USD 100m Program, Env. Cat. A)	Interamerican Development Bank	Main author
2014 - 2015 Panama	Sustainability Action Plan for the Metropolitan Area of Panama City. Implementation of the Sustainable Cities Initiative	Interamerican Development Bank	Coordinator Co-author
2014 Argentina	Sustainability Assessment for Añelo, Argentina. Implementation of the Sustainable Cities Initiative	Interamerican Development Bank	Co-author
2014 Argentina	Sustainability Assessment for Las Heras, Argentina. Implementation of the Sustainable Cities Initiative	Interamerican Development Bank	Co-author
2012 – 2013 Argentina	Sustainability Assessment for Mar del Plata. Implementation of the Sustainable Cities Initiative	Interamerican Development Bank	Coordinator Co-author
2011 – 2012 Uruguay	Sustainability Assessment for Montevideo. Implementation of the Sustainable Cities Initiative	Interamerican Development Bank	Co-author

Publications

Sustainability and Climate Change Publications

1. World Bank. **Climate Change and the Blue Economy in Africa**. PROBLUE Operational brief (2022) Link
2. Inter-American Development Bank. Incorporation of Climate Change Considerations in Provincial Infrastructure Projects. Handbook for the Identification of Resilient and Low Carbon Infrastructure Investments. 169 pp [in Spanish] (2019).

3. World Bank. Global Review of Public Infrastructure Funds. Volume II, Case Studies (2019). Link
4. World Bank. Diagnostics on Water, Sanitation and Electricity Services in 10 Provinces in Northern Argentina. 95 pp (2017).
5. Interamerican Development Bank. Panama Metropolitan Area. City Sustainability Action Plan. Implementation of the Emerging and Sustainable Cities Initiative, 287 pp (2016). Link
6. Interamerican Development Bank. Sustainable Las Heras. City Sustainability Action Plan. Implementation of the Emerging and Sustainable Cities Initiative, 164 pp (2014). Link
7. Interamerican Development Bank. Sustainable Añelo. City Sustainability Action Plan. Implementation of the Emerging and Sustainable Cities Initiative, 125 pp (2014). Link
8. Interamerican Development Bank. Emerging and Sustainable Cities Initiative. Methodological Guide. Second edition. 151 pp (2014). Link
9. Interamerican Development Bank. Sustainable Mar del Plata. City Sustainability Action Plan. Implementation of the Emerging and Sustainable Cities Initiative, 105 pp (2013). Link
10. Interamerican Development Bank. Sustainable Montevideo. City Sustainability Action Plan. Implementation of the Emerging and Sustainable Cities Initiative, 79 pp (2012). Link
11. Interamerican Development Bank. Emerging and Sustainable Cities Initiative. Methodological Guide. First edition. 172 pp (2012).

Environmental and Social Impact Assessments, Environmental Due Diligence Publications

12. Environmental and Social Assessment, Environmental and Social Management Plan. Uruguay Drinking Water Systems Improvement Program – Phase I – UR-L1189 (2023). Link
13. Environmental and Social Management Framework. Uruguay Drinking Water Systems Improvement Program – Phase I – UR-L1189 (2023). Link
14. Environmental and Social Management System. Uruguay Drinking Water Systems Improvement Program – Phase I – UR-L1189 (2023). Link
15.
16. Strategic Environmental and Social Assessment, Program to Develop the Federal Fiber Optic Network, Argentina (2021). Link
17. Strategic Environmental and Social Assessment, Education for Transformation Program, Uruguay (2021). Link
18. Environmental and Social Impact Assessment, Montevideo Urban Sanitation Program VI, Uruguay (2021). Link
19. Sustainability Action Plan for Bahia Blanca – Coronel Rosales Metropolitan Area. Interamerican Development Bank. 230 pp (2019).
20. Environmental and Social Impact Assessment (ESIA) for Integrated Sanitation and Construction of Wastewater Treatment Plant Project for Concordia, Entre Rios, Argentina.
21. Environmental and Social Impact Assessment (ESIA) for Integrated Sanitation and Expansion of Wastewater Treatment Plant Project for Gualeguaychu, Entre Rios, Argentina.
22. Environmental and Social Management Framework (ESMF) for Sanitation Program for Coastal Cities at Rio Uruguay, Entre Rios, Argentina.
23. Environmental and Social Analysis, Environmental and Social Management Plan for Ciudad del Plata Sanitation Project, Phase I (UR-L1149), Uruguay. 87 pp (2018).
24. Interamerican Development Bank. Environmental and Social Management Framework for Ciudad del Plata Sanitation Project, Phase I (UR-L1149), Uruguay. 64 pp (2018).

25. Interamerican Development Bank. Environmental and Social Impact Assessment for Neighborhood Improvement Program III (UR-L1146), Uruguay. 474 pp (2018). Link
26. Interamerican Development Bank. Environmental and Social Management Framework, Neighborhood Improvement Program III (UR-L1146), Uruguay. 95 pp (2018).

Resume

Arthur Reginald (Reg) Murphy, MBE., GOH., Ph.D. MA

Ph.D. (U. of Calgary),

MA (Trent University*), (Diploma in Construction Management*
George Brown College and Ryerson University, Toronto, Ontario)

Falmouth Harbor
Antigua and Barbuda

Associate: Archaeology Consultant for ESIA/EIA and related work
Deborah Brosnan& Associates
2020-Present
Conducted several assessments and report for development projects in Antigua and Barbuda

Specialist: - Archaeology (Caribbean area)
- Forensic archaeology
- General building construction, site management, planning
- Restoration and stabilization of historical structures and sites
- UNESCO: World Heritage Dossier etc…
- Professor of Archaeology

Area of Specialities

- Archaeologist: 32 years experience
  - Field research
  - Project management
  - Surveys and excavations
  - Analysis and reporting
  - Cultural Heritage Resources Management, Development and Survey
  - Periods of research: Prehistoric and Historic Periods
  - Underwater

- Heritage Sites Development and Management
  - Management and Conservation Planning
  - Museum Development
  - Interpretation and training of guides

- UNESCO World Heritage Sites
  - Dossier development
  - Tentative Listing
  - Stabilization and restoration
  - Management planning

- Cultural Resources Site Survey and Mitigation: Selection of various projects
    - Cabot St. Lucia: Resort and Golf Course Archaeological Survey, Cas en Bae (2021)
    - Sunwing Cultural Resources Management Survey, Deep Bay Antigua (2015)
    - Great George Fort Monks Hill, Antigua. CRM project for Government of Spain proposed restoration 2016.
    - Archaeological survey of Mayaguana, The Bahamas (project field director, PAL Inc., Rhode Island) (2005)
    - St. Vincent, Cross Island Road Project, Heritage Impact Assessment, I. Jackson and Assoc., EIA (2003)
    - St. Vincent, Heritage Tourism development: Planning of 20 new parks and protected areas, project consultant (I. Jackson and Associates) (2004)
    - Clarence House Restoration Project Advisor and, Trustee, Charity Commission, UK
    - St. Georges Grenada, Restoration and development of the 3 forts of St. Georges; heritage development consultant, (EU Funded Project) (2004)
    - Consultant to Montserrat National Trust, numerous projects.
    - Archaeological surveys on Tortola, BVI. (Numerous projects and sites prior to development, 2008)
    - Archaeological survey of Gray's Point, Nonsuch Bay, Antigua (2007).
    - Archaeological excavation of Galleon Beach cemetery, Antigua. (2009 and 2012)
    - Archaeological survey, McNeish Mountain Sugar Estate (2010)
    - Archaeological survey, Fountain Beach, Anguilla (2011)
    - Archaeological / Cultural survey of Rendezvous Bay, Antigua (2011-12)

Active Projects and Activities (Voluntary)

- Chairman of the World Heritage Committee, Antigua, 2013 to current.
- **Currently** gathering data to draft a second nomination of 17th century Coastal Fortifications, Antigua and Barbuda … in progress.
- Forensics: assistance to the Royal Antigua Barbuda Police Force Criminal Investigation Department with recovery and forensic analysis, numerous cases annually, of human skeletal remains; assisting voluntarily since 2006 to current
- **Currently** drafting Management Plans and Preparation of a restoration program for the restoration of Forts James, and Barrington, 17th century coastal fortifications Antigua. 2019
- Stabilization and Improvements of Betty's Hope Estate (17th century sugar estate) and,
    - Upgrading exhibits for Museum of Antigua
    - Coastal Survey of Archaeological and historical sites Antigua and Barbuda for mitigation activities sea level change.

Professor of Archaeology

- Adjunct Status: The University of Nebraska, Lincoln, School of Global Integrative Studies and Anthropology
- Affiliated Status, The Graduate Center, City University New York.
- Member: Advisory Board Graduate Student Selection for Caribbean research, Department of Archaeology, Leiden University.

Four graduate students currently under my supervision.

Contact

www.linkedin.com/in/david-taylor-22686814 (LinkedIn)

Top Skills

Project Management
Land Development

David Taylor

Vice President/Project Manager at Harris Civil Engineers, LLC
Orlando, Florida, United States

Summary

I've spent 25 years at Harris Civil Engineers, LLC where I started out of college and worked my way up through learning the art and science of civil engineering. I am currently serve in Vice President and Team Principal roles and have an outstanding group of individuals under my supervision that continually make me and HCE look good. I have been taught by some of the best engineers I've known including Howard Jewett, Steve Dieter and, of course, Joe Harris. I am extremely blessed to be surrounded by top quality people both above and below me.

My skills include most aspects civil engineering for land development, including utilities design, driveway/roadway/parking design, storm water design, master planning assistance, etc. my skills allow me to take a project from conceptual design all the way through construction administration.

Experience

Harris Civil Engineers, LLC
25 years

Vice President/Project Manager
June 2021 - Present (3 years 7 months)

Project Manager
2010 - Present (14 years)

Project Engineer
1999 - 2010 (11 years)

Education

University of Central Florida
Master of Business Administration - MBA · (June 2023 - May 2025)

Florida Institute of Technology

BS, Civil Engineering · (1997 - 1999)

MANUEL CASTAÑO - BIO:

Manuel Castaño leads a variety of coastal engineering projects focusing on the design and master planning of waterfront infrastructure, including shoreline protection structures, living shorelines, marinas, boat ramps, piers, dredging, or beach enhancement. He has been involved in projects in the U.S. and the Caribbean from the preliminary and feasibility analyses phase to complete design and construction. Manuel's experience includes hydrodynamic and wave propagation numerical modeling; coastal vulnerability studies; navigation analyses; mooring and berthing studies; marina market analyses; and design of waterfront structures.

Manuel completed PIANC's Marina Designers Training Program and has been involved in the planning and design of numerous waterfront projects in the Caribbean. Manuel is also a WEDG certified professional, and he was one of the co-authors of PIANC's WG 168 Guidelines on Single Point Yacht Moorings and is currently involved on PIANC's Working Group 222 (Floating Breakwaters), PIANC's Working Group 149 (Guidelines for Marina Design), and with ASCE's Sea Level Change Task Committee.

Manuel Castaño is adept at managing complex waterfront development projects, and has vast experience during the feasibility and masterplanning stages. As an engineer focused on waterfront projects, Manuel works with a multi-disciplinary team of coastal, structural and utilities engineers that understand the complexity of a project like this one and is committed to its success.

MANUEL CASTAÑO - RESUME:

EDUCATION

MS, Civil Engineering, Oregon State University

MS, Civil Engineering, University of Cantabria, Santander, Spain

BSc, Civil Engineering, University of Cantabria, Santander, Spain

REGISTRATION

Professional Engineer (PE):

Florida, #86926

California, #87649

Puerto Rico, #29160

Waterfront Edge Design Guidelines (WEDG) Professional.

AFFILIATIONS

American Society of Civil Engineers (ASCE)

Coasts, Oceans, Ports, and Rivers Institute (COPRI) – Corporate Member

World Association for Waterborne Transport Infrastructure (PIANC) -Corporate Member

The Waterfront Alliance - Waterfront Edge Design Guidelines Institute

REPRESENTATIVE PROJECT EXPERIENCE

New Cruise Pier at St. John's, Antigua. Assistant project manager and project engineer in charge of the mooring and berthing studies performed as part of the design-build project of a new cruise pier ant St. John's, Antigua. Mooring and berthing analyses were performed for the design vessels (RCCL's Quantum and Oasis Class vessels), and mooring arrangements were developed for smaller class vessels (Freedom, Sovereign, Voyager and Vison Class) to assure that the proposed pier configuration can also accommodate smaller vessels. Served as a reviewer for the real-time navigation simulation, dredging package, MetOcean conditions modeling, revetment design, project specifications and material quantities take off.

Channelside District Flood Risk Analysis and Resiliency Concepts, Tampa, Florida. Project engineer in charge of the evaluation of flood risk analysis and resiliency strategies/concepts for a waterfront development in downtown Tampa. M&N collected and reviewed data related to historical

and predicted flooding and Sea Level Change rates. Data included FEMA Flood Insurance Study, historic flood and storm reports, local academic research and M&N's local project knowledge.

Kakona Development, Bahamas. Coastal engineer involved in the master planning and the coastal numerical modeling for the waterside features of a residential resort in Bahamas. These elements included a marina with capabilities and amenities for small crafts and megayachts, artificial canals systems, development of a system of breakwaters and flushing improvements.

City of New Orleans Municipal Yacht Harbor Marina Market Feasibility Study and Design, New Orleans, LA. Project engineer involved the marina market feasibility study for the City of New Orleans when planning the redevelopment of the New Orleans Municipal Yacht Harbor (MYH). This report included a thorough analysis on economic and boating trends for the Lake Pontchartrain marina market. Following the completion of the market analysis, Manuel was involved in the design development for the floating dock marina and construction support services.

Six Senses Grand Bahama, Grand Bahama, Bahamas. Project engineer in charge of the analysis and design of the in-water elements for the Six Sense Residences Grand Bahama development. This project includes a small marina, private slips, the enhancement of 2,500 LF of a dune and beach system (including headlands and groins) and approximately 3,500 LF of seawall replacement.

Sarasota Bayfront Master Plan, Sarasota, FL. Coastal engineer involved in the master planning efforts for the "Sarasota The Bay" project, for the redevelopment of approximately one mile of waterfront in downtown Sarasota. This project includes several piers, relocation of the existing boat ramp, dredging to the existing bayou and a kayak dock. Moffatt & Nichol continued its involvement with the project for the completion of design for the marine elements in Phase 1 (southernmost portion of the shoreline).

Snug Harbor Development, Tampa, FL. Project engineer involved in the design and construction of a waterfront development that included a 130-slip marina (floating docks and dry stack), replacement of approximately 3,000 ft. of existing seawall, dredging, and creation of a living shoreline and mangrove planter. M&N also supported the client developing a marina market analysis, developed dock layout alternatives, secured environmental permits and evaluated coastal vulnerability of the site, securing a Conditional Letter of Map Revision from FEMA.

National Park Service Cruz Bay Ferry Pier, St. John, USVI. Project manager and project engineer for the design and construction of a new ferry pier for the National Park Service Visitor Center in St. John, which included repairs for approximately 500 LF of existing seawall, and maintenance dredging. M&N was involved during the design and the construction phases of the project, which was completed in 2024.

Westshore Marina District, Tampa, FL. Project engineer who supported the client by developing preliminary layouts, progressing design, and assisting during the bid and construction processes for a 150-slip marina project in Tampa, FL. The project also included dredging of the existing marina basin, and design and construction of approximately 1,400 ft. of rip rap shoreline and 250 ft. of living shoreline.



ANNEX 2. DECLARATION OF COMPLETENESS AND AUTHENTICITY

Mr. Frederick Southwell
Chief Town and Country Planner
Development Control Authority
St. Johns, Antigua
30th December 2024

Dear Mr. Southwell,

Deborah Brosnan & Associates is pleased to submit this ESIA for the proposed Murbee Resorts Inc. development of the Rosewood Barbuda. Plan Application #G05-2024.

This ESIA is submitted according to the review and Terms of Reference provided to Deborah Brosnan & Associates on May 13, 2024. We confirm that this work was completed by Deborah Brosnan & Associates. This document has been prepared based on technical and other information and assessments supplied to us by the client and the clients technical/engineering, architectural and other professional teams. We have not verified all of this information but taken it at face value against known factors and international standards where possible. Where such information does not provide details yet to be finalised such as details on the sewage treatment plant and drainage, and or other factors, we have used peer-reviewed standards and acknowledged that best practice will be implemented throughout the construction, commissioning and operation of the new development. These have been indicated in the ESIA and the information provided evaluated to the best of our professional ability.

Yours sincerely,

Deborah M. Brosnan

Deborah Brosnan Ph.D.
President,
Deborah Brosnan & Associates



ANNEX 3. ENCLOSURES

Appendix 1: Barbuda Land Lease Confirmation

Murbee Resorts Inc.
Dr. Rosa Lee Drive
Lower Gambles
St. John's
Antigua & Barbuda.

From: Purcell Bird
Shareholder, Murbee Resorts Inc.

Subject: Barbuda land lease confirmation

Date: 16 December 2023

As a Barbudan and partner in the Murbee, Dulcina/Rosewood development I can confirm the following:

The Murbee development proposed project comprises a property of 160.48 acres in Barbuda which has been leased out in sections of three different leases. The first lease encompasses a 70.02- acre parcel, the second lease a 76.55-acre parcel, and a third lease a 13.91-acre parcel.

Where applicable the leases have been fully secured after acquiring the approval from the Barbudan persons who formerly occupied those lands. All leases have the Government of Antigua & Barbuda Cabinet approval with official government lease agreements. Copies of these leases have been submitted to the DCA.

Purcell Bird

Tel. 260 562 6040 / 268 773 8551 email:murbeeresort@gmail.com

Appendix 2: Master plans for the Rosewood Barbuda Development

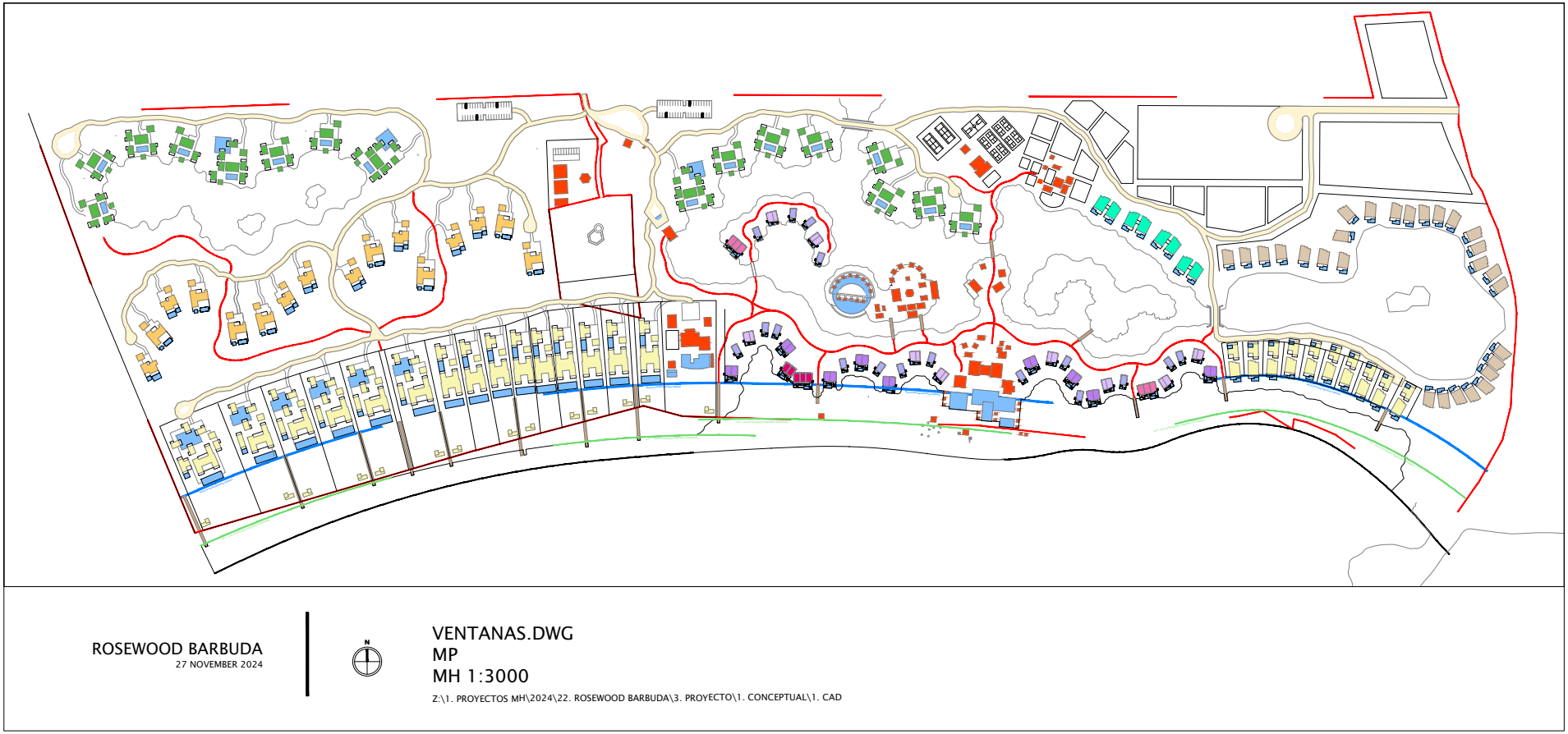

Figure 0.1: The Rosewood Barbuda master plan

ROSEWOOD BARBUDA DEVELOPMENT PHASES

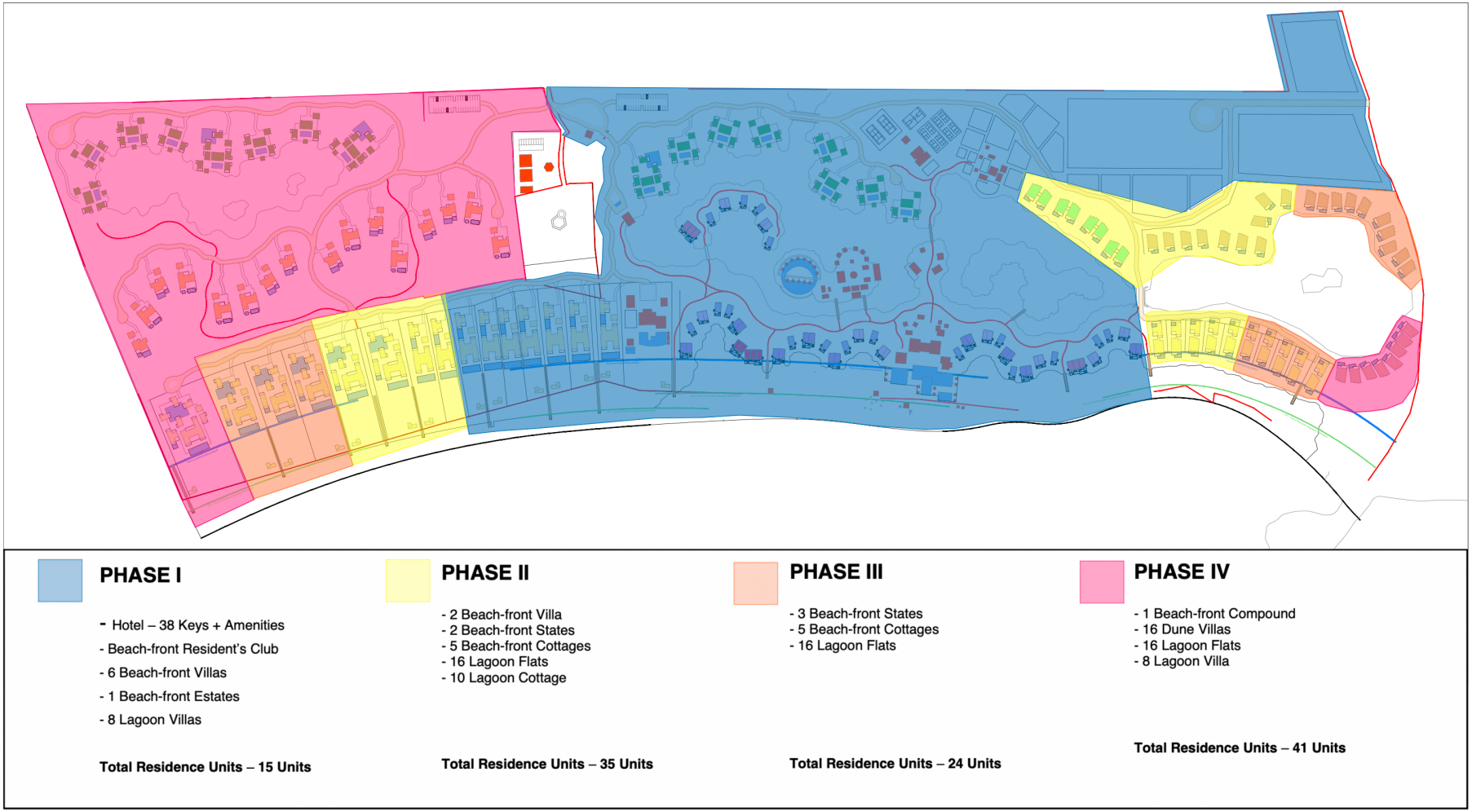

Figure 0.2: The Rosewood Barbuda master plan showing the four phases of development

Appendix 3: Water quality results

Certified by the Department of Analytical Services in Antigua

Department of Analytical Services
Friars Hill
St. John's
Antigua
T: 462-9437/462-6281
E: linroy.christian@ab.gov.ag

Certificate of Analysis

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Date of Issue	:2024-05-16
Client	:Deborah Brosnan & Associates
Report #	:DBA003
Sample Submission Date	:2024-05-08
Temperature on Arrival (°C)	:<10
Sample Type	:Environmental Water

Lab ID	Sample ID	Sample Description	Enterococci (<35) cfu/100ml	Faecal coliform (<200) mpn/100ml	pH (6.5-8.5)	Turbidity NTU	Salinity ppm	Nitrate ppm	Phosphate ppm
DBA-202405-01	Brackish	BP-Batch Plant	ND	>200	8.03	10.18	1.40×10^3	0.212	0.66
DBA-202405-02	Marine	FD1-Ferry Dock	2	ND	8.31	0.23	3.64×10^4	0.003	0.41
DBA-202405-03	Marine	ED-End of Dock	5	>200	8.31	2.12	3.63×10^4	0.002	0.19
DBA-202405-04	Marine	FD2-Ferry Dock 2	12	>200	8.28	0.28	3.64×10^4	<0.001	0.34
DBA-202405-05	Marine	MC-Middle Coast	7	ND	8.30	36.7	3.61×10^4	0.003	0.47
DBA-202405-06	Brackish	OF-Outflow	ND	>200	8.33	43.8	1.13×10^4	0.035	<0.02
DBA-202405-07	Fresh	WS-Well Sample	ND	>200	8.03	33.1	770.00	0.003	<0.02
DBA-202405-08	Fresh	EW- East Wetland	570	>200	8.14	94.0	2.61×10^3	<0.001	<0.02
DBA-202405-09	Brackish	WW- West Westland	240	>200	7.94	63.1	1.03×10^4	<0.001	<0.02
DBA-202405-10	Marine	WC-West Coast	27	>200	8.25	54.0	3.93×10^3	<0.001	0.20
DBA-202405-11	Brackish/Fresh	NW-North Wetland	8	ND	8.27	0.61	3.64×10^4	<0.001	0.12
DBA-202405-12	Brackish	SW-South Wetland	990	>200	8.45	16.9	3.46×10^3	0.002	0.04

ND-Not Detected

Approved by:

Dr Linroy Christian
Director

DEBORAH BROSNAN & ASSOCIATES

Table 0.1: Field water quality measurements taken with a YSI

Sample ID	Description	Time	Temp (°C)	ODO (mg/L)	Notes
BP	Batch Plant	4:55 am	7.1	26.9	
FD1	Ferry Dock 1	5:01 am	7.0	27.8	
ED	End of Dock	5:08 am	5.8	28.9	
FD2	Ferry Dock 2	5:13 am	4.5	29	Oil on surface of water
MC	Middle coast	5:20 am	6.7	28	
OF	Outflow	5:16 am	6.7	25.8	Cold - freshwater layer from rain likely
WS	Well sample	5:34 am	2.7	26	Fish observed
EW	East wetland	5:40 am	0.6	26.3	Frog noises
WW	West wetland	5:50 am	2.8	25.7	Frog noises
WC	West coast	5:57 am	7.6	27.9	
NW	North wetland	6:05 am	2.3	25.9	Crabs and birds
SW	South wetland	5:25 am	7.0	25.2	Crabs and birdsong

Appendix 4: Soil sampling results

Certified by the Department of Analytical Services in Antigua

Department of Analytical Services
Friars Hill
St. John's
Antigua
T: 462-9437/462-6281
E: linroy.christian@ab.gov.ag

Certificate of Analysis

This Report should not be used for purposes of advertising, publicity or litigation, nor shall it be reproduced, whether in part or in full, without the written consent of the Department of Analytical Services

Date of Issue :2024-09-05
Client :Deborah Brosnan & Associates
Report # :DBA005
Sample Submission Date :2024-08-26
Temperature on Arrival (°C) :-
Sample Type :Soil

Lab ID	Sample ID	Sample Description	pH	Potassium	Nitrate-Nitrogen	Phosphate
				ppm	ppm	ppm
DBA-202408-18	Soil	Northwest Corner Soil	7.70	600	81.6	11.8
DBA-202408-19	Soil	New Road Soil	7.42	780	117.2	14.7
DBA-202408-20	Soil	Dune Soil	7.83	240	53.5	16.1
DBA-202408-21	Soil	Ferry Dock Soil	7.63	260	69.7	14.6
DBA-202408-22	Soil	Wetland Soil	7.97	660	210.0	29.0
DBA-202408-23	Soil	Open canopy soil	7.96	600	299.7	13.0
DBA-202408-24	Soil	Farmland Soil	8.30	360	106.4	25.8
DBA-202408-25	Soil	Batch plant Soil	7.49	380	66.8	25.8
DBA-202408-26	Soil	North center Soil	7.80	560	56.2	7.6

Approved by:
Dr Linroy Christian
Director

Appendix 5: Geotechnical Investigation for Proposed Murbee Development, Barbuda (Civil Engineering & Associates Ltd.)

GEOTECH ASSOCIATES LTD.

CONSULTING CIVIL & GEOTECHNICAL ENGINEERS

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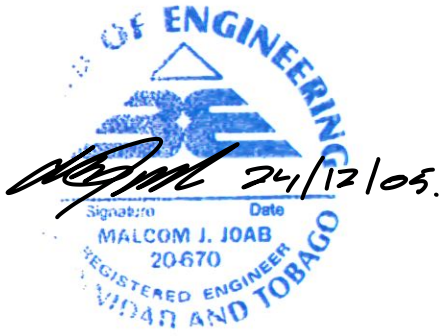
EVERON ZACHARIAH

GEOTECHNICAL INVESTIGATION FOR PROPOSED MURBEE DEVELOPMENT

BARBUDA

OUR REFERENCE: GA 24 146



24/12/05.

December 5th, 2024

Directors: Andrew Budhram (*Managing Director*) B.Sc; Malcom J. Joab (*Director*) B.Sc, M.Sc, DIC; Martin Andrews (*Executive Chairman*), B.Sc, M.Sc.

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1.0 INTRODUCTION

1.1 Terms of Reference

CIVIL ENGINEERING & ASSOCIATED SERVICES LTD. (CEAS) was commissioned by the Property Owners MURBEE RESORTS INC. to carry out a geotechnical investigation for a proposed development at River, Barbuda in accordance with the guidelines presented by their consultants Construction Management and Development (CM&D). The investigation was carried out pursuant to our proposal dated May 30, 2024.

The field investigation was carried out by CEAS LTD. while the laboratory tests were carried out by a specialized Soils Mechanics Laboratory of the Government of Antigua & Barbuda in accordance with the testing schedule prepared by CEAS. LTD. The geotechnical analyses and reporting were a collaborative effort of CEAS LTD. and our associate in Trinidad – GEOTECH ASSOCIATES LIMITED.

1.2 Objectives

This investigation was geared toward identifying the soil conditions at the site and providing specific geotechnical design input parameters for the proposed structures.

1.3 Scope

The following tasks constituted the scope of works:

- Fieldwork geared toward obtaining representative samples of the soil and necessary *in-situ* parameters,
- Laboratory testing on soil samples to determine the soil characteristics of the subsoils,
- Evaluation of the bearing capacity and settlement of shallow type foundations for the development, and
- Estimate the axial, lateral and uplift pile capacities for various driven piles.

2.0 DESCRIPTION OF SITE

2.1 Location and Site Description

The site is located at River, Barbuda. It is bounded to the south by the beach and the Caribbean Sea, to the southeast by the Barbuda Express Ferry dock, to the north and west by open lands, and to the east by an existing access road. Route 1 passes through the site. Topographically, the site may be described as flat, lying about 2 – 3 m above mean sea level. Generally, the existing vegetation consists of low grass near the beach and thick shrubbery north of Route 1.

2.2 Proposed Development

Full details of the development have not been forwarded by the Client. However, based on a review of the brief, it is understood that the proposed development would consist of an access shipping channel, a groyne, a man-made lagoon, and several villas with access to the sea via the access channel and lagoon.

3.0 FIELD INVESTIGATION

The scope of the field investigation consisted of advancing a total of twenty (20) boreholes at the approximate locations shown on *Enclosure No. 1*.

3.1 Boreholes

The boreholes were advanced to investigate four (4) main areas of the proposed development *(See Enclosure No. 1)*. The fieldwork conducted at areas are described below:

1. Area 1 – This area consisted of a total of seven (7) boreholes (B01 – B07) and it is located on the southeasternmost section of the proposed development, along the proposed dock/seawall of the marina. These boreholes were earmarked to be drilled to depths of -18.3 m (-60ft) MSL or rock whichever occurred first. Borehole B05 was advanced in the sea whereas all the others are on land. These were advanced during the period July 11, – October 21, 2024.
2. Area 2 - This consisted of a total of eleven (11) boreholes (BH1 – BH11) which were advanced along the periphery of a proposed lagoon. These were earmarked to be advanced to a depth of 10.7 m (35 ft) or rock whichever occurred first. These were advanced during the period July 22, – October 15, 2024.
3. Area 3 – In this area, two (2) special grab samples were taken (BS01 & BS02) along the shoreline and the boreholes were advanced until rock was encountered. These boreholes were advanced during the period July 18, – October 10, 2024.
4. Area 4 – This consisted of one (1) borehole (DS01) which was advanced in the sea along a proposed access channel, located near the existing passenger ferry dock.

The boreholes for this investigation were advanced using a drill rig employing wash boring drilling techniques. The borehole depths GPS coordinates and ground elevations are shown in *Table 3.1* overleaf.

Table 3.1 Summary of GPS Coordinate & Ground Elevation by Borehole

Borehole ID	GPS Coordinates		Ground Elevation (m)	Borehole Depth (m)
	Northing (m)	Easting (m)		
B01	1,945,596	624,925	1.0	15.9
B02	1,945,629	625,090	2.5	8.4
B03	1,945,561	625,170	3.5	6.1
B04	1,945,457	625,204	3.0	12.3
B05	1,945,348	625,055	0.0	11.3
B06	1,945,383	625,119	1.5	18.3
B07	1,945,524	625,075	1.5	12.2
BH1	1,945,717	624,659	1.5	14.3
BH2	1,945,599	624,749	1.5	3.5
BH3	1,945,689	624,745	1.0	8.2
BH4	1,945,677	624,501	1.5	9.6
BH5	1,945,794	624,516	1.5	8.8
BH6	1,945,729	624,351	1.1	10.7
BH7	1,945,863	623,882	1.5	10.1
BH8	1,945,910	623,713	1.5	11.0
BH10	1,945,884	623,952	1.5	11.0
BH11	1,945,717	624,659	1.5	9.4
BS01	1,945,294	625,000	0.0	7.6
BS02	1,945,351	625,106	1.0	11.4

3.1.1 *Sampling*

Soil samples were taken at intervals of 0.75 m for the first 3.0 m. Only disturbed split spoon soil samples were taken in the boreholes. The split spoon sampling procedure also entails the measurement of the Standard Penetration Resistance, or *N value* of the soil.

3.1.2 *Standard Penetration Test*

The Standard Penetration Test (SPT) was carried out in conjunction with split spoon sampling, in accordance with the method outlined on page *(vi)* of the preface. This test gives the Standard Penetration Resistance of *N value* of the soil. The *N value* is related to soil strength and density and is a useful parameter in estimating the bearing capacity of the subsoil.

3.1.3 *Groundwater Measurement*

The groundwater was observed in the boreholes while sampling, before and after casing removal and 24 hours after borehole completion.

3.1.4 *Rock Cores*

Where rock was encountered, continuous core samples of rock were taken. For the rock core runs, the rock quality designation (RQD) measurements were taken in accordance with ASTM D6032M-17.

4.0 LABORATORY TESTING

4.1 Testing

The laboratory testing consisted of the following.

- Natural moisture contents on selected recovered soil samples (ASTM D2216-19),
- Grain size analyses on selected disturbed soil samples (ASTM D422-63 (2007)),
- Unit weight on selected rock samples (ASTM D 7012-04), and
- Unconfined compressive strength and elastic modulus of rock on selected rock core samples (ASTM D7012-04).

4.2 Results

The results of the tests conducted are given in *Appendix I*.

5.0 GEOLOGICAL & GEOTECHNICAL CONDITIONS

5.1 Geotechnical & Geological Classification

A review of the Soils Map of Barbuda indicates that the surficial soils at the site are Classified as Beach Sands [1]. These sands cover most of the outer coastal fringe of Barbuda and consist of soil developed over dune sands of various ages. The largest area is at River where a succession of beaches has built up over a long period [1]. Brasier & Mather (1975) classify this area near River as part of the Palmetto Pt. Formation. This formation describes the post-Pleistocene accumulations of sand, the most extension of which is the beach ridge system of Palmetto Pt. [2].

Geologically, Brasier & Mather (1975) suggest that the Palmetto Point Formation is underlain by the Codrington Formation. Martin-Kaye (1959) describes the Pleistocene Codrington Formation Limestones as follows [3]:

1. Calcareous coral-shell sands of various ages,
2. Soft rubbly shelly limestone,
3. Moderately hard shelly limestone, massive, surface calcreted, and
4. Jointed, semi-crystalline limestone.

The rocks encountered in the boreholes would be described in terms of the Martin-Kaye (1959) classification where applicable.

Furthermore, the RQD which provides a simple and inexpensive general indication of rock mass quality was used to classify the rock quality as follows. It must be noted that the RQD does not account for joint orientation, tightness, continuity, and gouge material and it must be used in combination with other geological and geotechnical input [4]. The RQD classifications after ASTM D6032M-17 are summarized in *Table 5.1* below.

Table 5.1 Summary of Classification of Rock Quality (after ASTM D6032M-17)

RQD (%)	Classification of Rock Quality
< 25	Very Poor
25 – 50	Poor
51 – 75	Fair
76 – 90	Good
> 90	Excellent

5.2 Subsurface Conditions

Based on a review of the borehole locations and an appreciation of the proposed development, the subsurface conditions may be conveniently separated by area, viz., Area 1 (Boreholes B01 – B07), Area 2 (Boreholes BH1 – BH11), Area 3 (Borehole BS01 & BS02), and Area 4 (Borehole DS01).

The subsurface conditions encountered within the boreholes are shown on the borehole logs *(Appendix I)*.

5.2.1 Area 1 (Boreholes B01 – B07)

A review of the subsurface profile encountered on the site revealed that it consists of the following deposits in sequence:

- Loose sands,
- Dense to very dense calcareous coral-shell sands (Codrington Formation),
- Soft rubbly shelly limestone (Codrington Formation),
- Moderately hard shelly limestone, massive, surface calcreted (Codrington Formation), and
- Hard, jointed, semi-crystalline limestone (Codrington Formation).

Using the results of the soil investigation, five (5) major soil units have been identified.

Unit 1

This layer extends from the ground surface to depths ranging from 0.8 – 1.2 m below the ground surface. It consists of loose sands.

N values recorded within this unit ranged from 5 to 9.

Unit 2

This unit extends from the base of the Unit 1 to depths ranging from 3.0 – 5.3 m below the ground surface. It was not encountered in Boreholes B02 – B05. It consists of dense to very dense calcareous coral-shell sands (Codrington Formation). An isolated sub-unit of medium dense calcareous coral-shell sands was encountered in Borehole B06 at a depth ranging from 3.0 – 3.5 m below the ground surface.

N values recorded within this unit ranged from 31 to in excess of 100. A value of 27 was also recorded which correspond to the medium dense sub-unit deposit mentioned above.

Unit 3

This unit extends from the base of Unit 2 (in Boreholes B01, B06 and B07) or Unit 1 (in Borehole B02 – B05) to depths ranging from 4.6 – 7.5 m below the ground surface. It extends to the end of the borehole in Borehole B05 at a depth of 10.4 m. It was not encountered in Boreholes B01, B02 and B04. It consists of soft rubbly shelly limestone (Codrington Formation). An isolated sub-unit of very stiff clay was encountered within the unit in Borehole B07 at depths ranging from 6.8 – 7.3 m.

The RQD measured within this unit were less than 7%. Therefore, the quality of the rocks may be described as very poor.

Unit 4

This unit extends from the base of Unit 3 (in Borehole B03, B05 – B07) or Unit 1 (in Borehole B01, B02 and B04) to depths ranging from 6.1 – 12.2 m below the ground surface in Borehole B06. In Boreholes B01, B04, and B07, it extends

to the end of the borehole at depths ranging from 11.3 – 15.9 m. This unit was not encountered in Boreholes B02 and B05. It consists of moderately hard shelly limestone, massive, surface calcreted (Codrington Formation).

The RQD measured within this unit ranged from 8 – 37%. Therefore, the quality of the rocks may be described as very poor to poor.

Unit 5

This unit extends from the base of Unit 4 or the base of Unit 3 (in Borehole B02 and B05) to the end of the boreholes at depths ranging from 6.1 – 18.3 m below the ground surface. It was not encountered in Boreholes B01, B04 and B05. It consists of hard, jointed, semi-crystalline limestone (Codrington Formation).

The RQD measured within this unit generally ranged from 33 – 84%. Therefore, the quality of the rocks may be generally described as fair to good.

5.2.2 Area 2 (Boreholes BH1 – BH11)

A review of the subsurface profile encountered on the site revealed that it consists of the following deposits in sequence:

- Loose sands,
- Medium dense to very dense calcareous coral-shell sands (Codrington Formation),
- Soft rubbly shelly limestone (Codrington Formation),
- Moderately hard shelly limestone, massive, surface calcreted (Codrington Formation), and
- Hard, jointed, semi-crystalline limestone (Codrington Formation).

Using the results of the soil investigation, five (5) major soil units have been identified.

Unit 1

This layer extends from the ground surface to depths ranging from 0.8 – 1.5 m below the ground surface. It consists of loose sands.

N values recorded within this unit ranged from 2 – 10.

Unit 2

This unit extends from the base of the Unit 1 to depths ranging from 4.6 – 7.5 m below the ground surface. This unit extends to the end of Boreholes BH2 and BH8 at depths of 3.5 and 9.9 m, respectively. It consists of medium dense to very dense calcareous coral-shell sands (Codrington Formation).

N values recorded within this unit ranged from 31 to 70, averaging 37.

Unit 3

This unit extends from the base of Unit 2 to depths ranging from 4.6 – 7.5 m below the ground surface. It extends to the end of the borehole in Boreholes BH1, BH6, BH7, and BH10 at depths ranging from 10.1 – 14.3 m. It was not encountered in Boreholes BH2, BH4, BH6 – B08. It consists of soft rubbly shelly limestone (Codrington Formation).

The RQD measured within this unit were less than 7%. Therefore, the quality of the rocks may be described as very poor.

Unit 4

This unit extends from the base of Unit 3 or Unit 1 (in Borehole BH2, BH4, BH6 – BH8) to depths ranging from 6.7 – 12.2 m below the ground surface in Borehole B06. In Boreholes BH4 – BH7, it extends to the end of the borehole at depths ranging from 8.8 – 10.7 m. This unit was not encountered in Boreholes BH1, BH2, BH8 and BH10. It consists of moderately hard shelly limestone, massive, surface calcreted (Codrington Formation).

The RQD measured within this unit ranged from 15 – 35%. Therefore, the quality of the rocks may be described as very poor to poor.

Unit 5

This unit was only encountered in Boreholes BH3 and BH11, and it extends from the base of Unit 4 or the base of Unit 3 (in Borehole BH1, BH2, BH8 and

BH9) to depths ranging from 8.2 – 9.4 m below the ground surface. It consists of hard, jointed, semi-crystalline limestone (Codrington Formation).

The RQD measured within this unit generally ranged from 43 – 53%. Therefore, the quality of the rocks may be described as poor to good.

5.2.3 Area 3 (Boreholes BS01 – BS02)

A review of the subsurface profile encountered on the site revealed that it consists of the following deposits in sequence:

- Loose sands,
- Moderately hard shelly limestone, massive, surface calcreted (Codrington Formation), and
- Hard, jointed, semi-crystalline limestone (Codrington Formation).

Using the results of the soil investigation, three (3) major soil units have been identified.

Unit 1

This layer extends from the ground surface to depths ranging from 5.6 – 6.4 m below the ground surface. It consists of loose sands.

Unit 2

This unit extends from the base of Unit 1 to depths ranging from 7.6 – 9.1 m below the ground surface. It extends to the end of the borehole in Borehole BS01 at a depth 7.6 m. It consists of moderately hard shelly limestone, massive, surface calcreted (Codrington Formation).

The RQD measured within this unit was 39%. Therefore, the quality of the rocks may be described as poor.

Unit 3

This unit was only encountered in Borehole BS02, and it extends from the base of Unit 2 to the end of the borehole at a depth 11.4 m below the ground surface. It consists of hard, jointed, semi-crystalline limestone (Codrington Formation).

5.3 Groundwater Measurements

The groundwater measurements taken in boreholes at the following timeframes are summarized in *Table 5.2* below.

Table 5.2 Summary of Groundwater Measurements by Borehole

Borehole ID	Groundwater Depth (m)	
	After Borehole Completion	24 hrs after Boring
B01	0.5	Borehole Collapsed
B02	1.5	1.5
B03		Borehole Collapsed
B04	1.5	1.5
B05	2.1	2.0
B06	1.2	Borehole Collapsed
B07	0.6	0.6
BH1	0.6	0.6
BH2	Borehole Collapsed	
BH3	0.5	Borehole Collapsed
BH4	0.7	0.8
BH5	0.3	0.5
BH6	0.1	0.2
BH7	0.6	0.6
BH8	0.6	0.6
BH10	0.5	7.3
BH11	0.5	0.6
BS01	0.9	0.9
BS02	0.3	Borehole Collapsed

5.4 Engineering Properties of Soil

5.4.1 Bulk Unit Weight

The results of the unit weight measurements determined from the unconfined compression tests given in the *Appendix I* are given in *Table 5.3* below:

Table 5.3 Summary of Bulk Unit Weight Results

Area ID	Unit ID	Sample ID	Bulk Unit Weight (kN/m^3)
1	4	B01/S4	16.09
		B01/S6	16.68
		B01/S7	13.73
2	4	BH6/S6	22.65
		BH6/S8	20.50
		BH7/S8	17.26
		BH10/S7	17.75

5.4.2 Unconfined Compressive Strength

The results of the unconfined compressive (UC) strengths determined from the unconfined compression tests given in the *Appendix I* are given in *Table 5.4* below:

Table 5.4 Summary of Bulk Unit Weight Results

Area ID	Unit ID	Sample ID	UC Strength (MPa)
1	4	B01/S4	3.60
		B01/S6	1.68
		B01/S7	2.02
2	4	BH6/S6	5.73
		BH6/S8	3.91
		BH7/S8	1.95
		BH10/S7	12.28

5.4.3 *Drained Shear Strength Parameters - Soils*

The value of effective angle of internal shearing resistance, ϕ' was estimated using the results of a correlation between ϕ' and *SPT N_{60} value* for the soils [5]. Values which are considered representative for the respective units are summarized below in *Tables 5.5*.

Table 5.5 Summary of Estimated Drained Shear Strength Parameters

Area	Unit	Average N_{60} Value	ϕ' (deg)
1	1	Not measured	28*
	2	40	39
2	1	Not measured	28*
	2	37	38

* *Estimated value based on our geotechnical experience with similar deposits*

The effective cohesion intercept, c' is taken as zero for coarse-grained soils.

6.0 SITE SEISMICITY & DYNAMIC SITE CLASSIFICATION

6.1 Site Seismicity

Barbuda lies within a seismically active zone and consequently structural and geotechnical designs must take cognizance of this. Based on data published the relevant spectral acceleration for seismic designs at the subject site for a 2475-year return period is as follows [6], [7]:

Peak Ground Acceleration, pga	=	0.650g	
S_s	=	1.800	for a period of 0.2s
S_1	=	0.550	for a period of 1.0s

The relevant maps are shown on *Enclosure Nos. 2 – 4.*

6.2 Site Classification

In addition to the above, the American Society of Civil Engineers (ASCE) requires that the site be classified for the purposes of dynamic structural designs [8]. The appropriate geotechnical site class is based primarily on the shear wave velocity over a depth of 30 m *(See Table 6.1 below)*.

The determination of the shear wave velocity profile for the site was outside the scope of the investigation. However, in the absence of the determination of the average shear wave velocity over the top 30 m of soil/rock, the seismic Site Class is taken as D. It is recommended that the shear wave velocity profile be determined to confirm the seismic Site Class.

7.0 FOUNDATION ANALYSIS AND DESIGN

7.1 General

The foundation types that were evaluated can be broadly classified into two (2) types:

- Shallow Foundations, and
- Deep Foundations.

Shallow foundations, as the name suggests, are defined as having a depth of foundation less than the width of the footing. Examples of these are spread footings and raft or mat foundations.

Deep foundations are used particularly at locations where the surficial deposits are unable to sustain the foundation loads, and these loads are hence transferred to deeper, more competent deposits. These foundation types employ two (2) means by which loads are transferred. These are via a combination of:

- End bearing on the more competent deposits which have the greater bearing capacity, and
- The skin friction developed between the soil and the foundation over its length.

The evaluation of a foundation type is based on two (2) main criteria. These are:

- The allowable bearing capacity of the soil upon which the foundation is seated, and
- The maximum and differential settlement at the expected load level.

7.2 Shallow Foundations

7.2.1 Ultimate Bearing Capacity

The ultimate bearing capacity of a shallow footing may be determined by the following equation [9]:

$$q_u = cN_c s_c + qN_q s_q + 0.5\gamma B N_\gamma s_\gamma$$

Where: s = shape factors (See *Table 7.1* below)

$N_q = \exp(\pi tan\phi) tan^2\left(45^o + \frac{\phi}{2}\right)$

$N_c = (N_q - 1)cot\phi$

$N_\gamma = 1.8(N_q - 1)tan\phi$ after Hansen (1968) [10]

Table 7.1 Summary of Shape Factors

Shape Factor	Foundation Shape		
	Circular	Square	Rectangular*
s_c	1.2	1.2	$1 + 0.2\left(\frac{B}{L}\right)$
s_q	1.0	1.0	
s_γ	0.6	0.8	$1 - 0.2\left(\frac{B}{L}\right)$

** B & L are the foundation breath and length, respectively*

It is recommended that the shallow foundations would be seated at a depth of 1.0 m below the ground surface. At this depth, the geotechnical properties of the Unit 2 would dictate spread footing behaviour.

Using the above equations, the theoretical ultimate bearing capacity for a square footing at a depth of 1.0 m for a footing width of 1.5 m is 786 kPa.

7.2.2 Allowable Bearing Capacity

The allowable bearing capacity is based on the maximum safe bearing, and it also considers the anticipated foundation settlement.

(a) Maximum Safe Bearing Capacity

The maximum safe bearing capacity is the ultimate bearing capacity divided by a safety factor which is taken as 3 [11]. The maximum safe bearing capacity is taken as 250 kPa.

(b) Settlement Estimate

The settlement estimates were determined using the Schmertmann Strain Influence Factor Method [12] for the worse-case soil conditions typified by Borehole BH8.

The results of the settlement estimates are given in *Tables 7.2* below.

Table 7.2 Summary of Estimated Settlement

Column Load (kN)	Bearing Pressure (kPa)	Estimated Settlement (mm)
400	200 250	10 12
600	200 250	13 15

(c) Recommended Allowable Bearing Capacities

The allowable bearing capacity is taken as the lesser of the maximum safe bearing pressure and the bearing pressure which induces the maximum acceptable settlement. Typically, the maximum allowable settlement for buildings is taken as 25 mm. Therefore, the allowable bearing capacity may be taken as 250 kPa, for an isolated pad footing.

7.3 Deep Foundations

Based on a review of the deposits encountered in the investigation, it is our recommendation that drilled shafts be considered as the deep foundation option in lieu

of a driven pile option. The deposit encountered are generally either medium dense to very dense calcareous shell sands or intact rock and driven or displacement piles would not be capable of achieving adequate penetration without damaging the piles during installation.

Therefore, analyses were also conducted for deep foundations consisting of drilled shafts.

7.3.1 Pile Type

Two (2) types of piles were considered:

1) 400 mm diameter auger cast-in-place pile, and
2) 600 mm diameter auger cast-in-place pile.

Proprietary pile types were not considered, but guidelines and soil properties outlined in the following paragraphs may be used for estimating the capacities of such piles if they are to be considered for use.

Loose sands with shallow groundwater are also unfavorable because the potential for soil sloughing is high. Therefore, under these conditions, the control of the penetration rate during drilling and grout placement is extremely critical [13].

Given the presence of layers of loose sands encountered in the boreholes, the Client should liaise with suppliers concerning experience in installing piles in similar conditions as well as provide proof of capacity and integrity tests of piles in such conditions if this pile type is being considered for use on the project.

7.3.2 Compressive & Uplift Capacity

The analyses were done for worst-case soil conditions, in this case, typified by soil conditions encountered in Borehole BH8 which were conducted using the computer programme **SHAFT 2017 v.11** for the drilled shaft [14]. Factors of safety of 2.5 on skin friction and 3.0 on end bearing and 1.5 on skin friction and 3.0 on end bearing were used. For the uplift capacity, a factor of safety of 3.0 on the skin friction was used for all piles.



It is recommended that the piles be installed at least 1.5 m into the competent rock. Therefore, the recommended minimum pile length is 11.5 m. The results of the computations are summarized below *(Table 7.3)* and shown graphically as a function of pile embedment length *(Appendix II)*. A typical detailed output for the programme is shown in *Appendix III.*

Table 7.3 Estimated Allowable Compressive & Uplift Capacity for Single Piles – Borehole BH8

Pile Type	Pile length (m)	Allowable Compressive Pile Capacity (kN)	Allowable Uplift Capacity (kN)
0.40 m CFA pile	11.5	700	480
0.60 m CFA pile		1165	740

7.3.3 *Pile Group Capacity*

It is customary to relate the load capacity of a pile group to that of a single pile by means of an efficiency factor. The foregoing analyses have so far considered only single piles. Group efficiency depends primarily on piles spacing and soil type. For the spacings commonly used in practice (approximately 3 times the piles diameter) efficiencies of 0.7 to 0.85 are recommended. For the project site, a conservative efficiency factor of 0.8 is recommended for design.

7.3.4 *Lateral Load Capacity*

(a) *General*

Earthquake loading would induce relatively high lateral loads to the foundations. In the design of the pile foundations to resist the lateral loads adequately, two criteria must be satisfied:

viz: (i) an adequate safety factor against ultimate failure, and
(ii) an acceptable deflection at the design or working load.



(b) *Lateral Capacity and Deflection - Single Pile*

In most practical cases allowable deflection is the critical criterion in determining an allowable load.

Analyses were therefore carried out to determine the pile head deflection for a range of lateral loads. For the analyses, it was assumed that the pile head would be fixed. The modulus of subgrade reaction used in the analyses was estimated from published correlation with shear strength.

The analyses were done using the computer program **LPILE 2019 v.11** [15]. This program uses a finite difference approximation to the fourth order differential equation governing the behaviour of laterally loaded piles. The results are shown graphically on *Appendix IV*. A typical detailed output for the programme is shown in *Appendix V*. These are summarized in *Tables 7.4 & 7.5* below.

Table 7.4 Summary of Lateral Pile Analyses – 0.4 m Drilled Shaft, Borehole BH8 – 1% Steel Content

Lateral Load (kN)	Head Displacement (mm)	Max. Bending Moment (kNm)
30	1	22
40	3	29
50	5	41
60	8	54

Table 7.5 Summary of Lateral Pile Analyses – 0.6 m Drilled Shaft, Borehole BH8 – 1% Steel Content

Lateral Load (kN)	Head Displacement (mm)	Max. Bending Moment (kNm)
30	≤1	40
40		53
50		66

Lateral Load (kN)	Head Displacement (mm)	Max. Bending Moment (kNm)
60		67

The calculated deflections are not significant. However, the shear forces should be adjusted, if necessary, by the structural engineer to ensure that the maximum bending moment is less than the ultimate bending moment capacity of the pile section. The depth of fixity of the piles is 8 m.

7.3.5 Group Action

For an assumed centre to centre pile spacing of three times the pile width, we recommend P Multipliers of 0.6 for the front, and 0.4 for the middle and trailing rows. Site specific models can be examined under a separate cover when the layout, pile type, spacing and outer considerations are known.

8.0 GUIDELINES FOR SITE FILL

It is expected that the elevation of the site may be raised via filling. The following guidelines are presented and should be adhered to provide structural fill with good load bearing capabilities:

a) All loose, organic, or otherwise deleterious materials should be removed from the site as far as practicable,

b) The area should be brought up to grade using fill material which can achieve a soaked CBR of at least 10%, and

c) The fill material should have a liquid limit of no greater than 45% and a plasticity index (PI) no greater than 15%.

The fill material should be compacted in lifts not exceeding 150 mm and to a dry density of at least 97% of the modified Proctor compaction maximum dry density, excluding the first 300 mm.

9.0 PAVEMENT DESIGN CBR & SPECIFICATIONS

9.1 Pavement Design Thickness

The determination of the in-situ CBR was beyond the scope of the investigation. However, based on our geotechnical experience, a value of 3% is considered reasonable. Using this value and a cumulative traffic loading of 300,000 Equivalent Single Axle Load (ESAL's) over the *life* of the road pavement and car park, the recommended pavement for road reinstatement is given below [16]:

Asphaltic concrete	50 mm
Aggregate Base Course	150 mm
Aggregate Sub-base Course	150 mm
Capping Layer	200 mm

9.2 Pavement Specifications

9.2.1 Aggregate Base Course

Crushed stone for base shall consist of one or the other of the following materials:

- Durable crushed rock consisting of angular fragments obtained by breaking and crushing solid or shattered natural rock, or
- Durable crushed gravel stone obtained by mechanically crushing gravel boulders or stones with a minimum diameter before crushing of 200 mm.

Crushed stone shall have a maximum percentage of wear of 40% as determined by the Los Angeles Abrasion Test (AASHTO T-96).

Gradation requirements for crushed stone will be determined in accordance with AASHTO T-27 and shall conform to the grading given in *Table 9.1* below:

Table 9.1 Requirements for Granular Base Course

Sieve Designation		Percentage Passing	
Standard (mm)	Alternate No.	Grading	
		A	B
50			100
37.5			90 – 100
25		100	
19		70 – 90	50 – 85
12.5		55 – 80	
4.75	No. 4	35 – 60	25 – 45
2.36	No. 8	25 – 50	
0.600	No. 30	12 – 30	10 – 25
0.075	No. 200	5 – 10	2 – 9

The material shall also have the following properties:

- The material shall have a 10%-fines value of not less than 100 kN when tested in accordance with BS 812: Part 111. The sample shall be in a soaked condition at the time of test.
- The aggregate shall have a soundness value greater than 65 when tested in accordance with BS 812: Part 121.
- Aggregate impact value <30
- Flakiness Index < 39%
- Plasticity Index <6%
- CBR in the 4-day-soaked test of not less than 80% when compacted to 97% modified Proctor compaction.

9.2.2 *Aggregate Sub-Base Course*

Gradation requirements for sub-base course will be determined in accordance with AASHTO T-11 and T-27 and shall conform to the grading given in *Table 9.2* overleaf:

Table 9.2 Requirements for Sub-Base Course

Sieve Designation		Percentage Passing
Standard (mm)	**Alternate No.**	**Grading**
75	3 ins	100
37.5	1.4 ins	70 – 100
19	0.75 ins	50 – 85
4.75	No. 4	30 – 60
0.075	No. 200	0 – 12

The material shall also have the following properties:

- The material shall not be gap-graded, nor shall the curve of distribution of those particles sized smaller than D60 deviate by more than ±3% on any specified sieve from lying parallel with the grading envelope (D60 is the sieve size through which 60% by weight of the material passes).
- Crushed stone shall have a maximum percentage of wear of 50% as determined by the Los Angeles Abrasion Test (AASHTO T-96).
- Liquid Limit <45%
- Plasticity Index < 12%
- Linear Shrinkage <6%
- CBR in the 4-day-soaked test of not less than 30% when compacted to 97% modified Proctor compaction.
- The material shall have a 10%-fines value of not less than 50 kN when tested in accordance with BS 812: Part 111. The sample shall be in a soaked condition at the time of test.
- The aggregate shall have a soundness value greater than 65 when tested in accordance with BS 812: Part 121.

9.2.3 Select Fill

Select fill shall conform to the following given in *Table 9.3* overleaf:

Table 9.3 Requirements for Capping Layer

Property	Requirement
Rocks	Not more than 30%
Soaked CBR	Minimum 10%
Liquid Limit (LL)	Maximum 45%
Plasticity Index (PI)	Maximum 15%
Passing 0.425 mm sieve Passing 0.075 mm sieve	Max. 40% (by weight) Max. 15% (by weight)

In general, all pavement material:

d) must be free from all loose, organic, or otherwise deleterious materials should be removed from the site as far as practicable, and

e) should be compacted in lifts not exceeding 150 mm.

10.0 CONCLUSIONS & RECOMMENDATIONS

Based on a review of the previous geotechnical reports and the foregoing discussion, the following conclusions and recommendations can be made:

1. Based on a review of the borehole locations and an appreciation of the proposed development, the subsurface conditions may be conveniently separated by area, viz., Area 1 (Boreholes B01 – B07), Area 2 (Boreholes BH1 – BH11), Area 3 (Borehole BS01 & BS02), and Area 4 (Borehole DS01). Generally, the deposits encountered over the investigation area were found to be very variable.

   Area 1 – Boreholes B01 – B07

   A review of the subsurface profile encountered on the site revealed that it consists of the following deposits in sequence:

   - Loose sands,
   - Dense to very dense calcareous coral-shell sands (Codrington Formation),
   - Soft rubbly shelly limestone (Codrington Formation),
   - Moderately hard shelly limestone, massive, surface calcreted (Codrington Formation), and
   - Hard, jointed, semi-crystalline limestone (Codrington Formation).

   Using the results of the soil investigation, five (5) major soil units have been identified.

   Unit 1

   This layer extends from the ground surface to depths ranging from 0.8 – 1.2 m below the ground surface. It consists of loose sands.

   Unit 2

   This unit extends from the base of the Unit 1 to depths ranging from 3.0 – 5.3 m below the ground surface. It was not encountered in Boreholes B02 – B05. It consists of dense to very dense calcareous coral-shell sands (Codrington Formation). An isolated sub-unit of medium dense calcareous coral-shell sands was encountered in Borehole B06 at a depth ranging from 3.0 – 3.5 m below the ground surface.

Unit 3

This unit extends from the base of Unit 2 (in Boreholes B01, B06 and B07) or Unit 1 (in Borehole B02 – B05) to depths ranging from 4.6 – 7.5 m below the ground surface. It extends to the end of the borehole in Borehole B05 at a depth of 10.4 m. It was not encountered in Boreholes B01, B02 and B04. It consists of soft rubbly shelly limestone (Codrington Formation). An isolated sub-unit of very stiff clay was encountered within the unit in Borehole B07 at depths ranging from 6.8 – 7.3 m.

Unit 4

This unit extends from the base of Unit 3 (in Borehole B03, B05 – B07) or Unit 1 (in Borehole B01, B02 and B04) to depths ranging from 6.1 – 12.2 m below the ground surface in Borehole B06. In Boreholes B01, B04, and B07, it extends to the end of the borehole at depths ranging from 11.3 – 15.9 m. This unit was not encountered in Boreholes B02 and B05. It consists of moderately hard shelly limestone, massive, surface calcreted (Codrington Formation).

Unit 5

This unit extends from the base of Unit 4 or the base of Unit 3 (in Borehole B02 and B05) to the end of the boreholes at depths ranging from 6.1 – 18.3 m below the ground surface. It was not encountered in Boreholes B01, B04 and B05. It consists of hard, jointed, semi-crystalline limestone (Codrington Formation).

Area 2 – Boreholes BH1 – BH11

A review of the subsurface profile encountered on the site revealed that it consists of the following deposits in sequence:

- Loose sands,
- Medium dense to very dense calcareous coral-shell sands (Codrington Formation),
- Soft rubbly shelly limestone (Codrington Formation),
- Moderately hard shelly limestone, massive, surface calcreted (Codrington Formation), and
- Hard, jointed, semi-crystalline limestone (Codrington Formation).

Using the results of the soil investigation, five (5) major soil units have been identified.

Unit 1

This layer extends from the ground surface to depths ranging from 0.8 – 1.5 m below the ground surface. It consists of loose sands.

Unit 2

This unit extends from the base of the Unit 1 to depths ranging from 4.6 – 7.5 m below the ground surface. This unit extends to the end of Boreholes BH2 and BH8 at depths of 3.5 and 9.9 m, respectively. It consists of medium dense to very dense calcareous coral-shell sands (Codrington Formation).

Unit 3

This unit extends from the base of Unit 2 to depths ranging from 4.6 – 7.5 m below the ground surface. It extends to the end of the borehole in Boreholes BH1, BH6, BH7, and BH10 at depths ranging from 10.1 – 14.3 m. It was not encountered in Boreholes BH2, BH4, BH6 – B08. It consists of soft rubbly shelly limestone (Codrington Formation).

Unit 4

This unit extends from the base of Unit 3 or Unit 1 (in Borehole BH2, BH4, BH6 – BH8) to depths ranging from 6.7 – 12.2 m below the ground surface in Borehole B06. In Boreholes BH4 – BH7, it extends to the end of the borehole at depths ranging from 8.8 – 10.7 m. This unit was not encountered in Boreholes BH1, BH2, BH8 and BH10. It consists of moderately hard shelly limestone, massive, surface calcreted (Codrington Formation).

Unit 5

This unit was only encountered in Boreholes BH3 and BH11, and it extends from the base of Unit 4 or the base of Unit 3 (in Borehole BH1, BH2, BH8 and BH10) to depths ranging from 8.2 – 9.4 m below the ground surface. It consists of hard, jointed, semi-crystalline limestone (Codrington Formation).

Area 3 – Boreholes BS1 – BS2

A review of the subsurface profile encountered on the site revealed that it consists of the following deposits in sequence:

- Loose sands,

- Moderately hard shelly limestone, massive, surface calcreted (Codrington Formation), and
- Hard, jointed, semi-crystalline limestone (Codrington Formation).

Using the results of the soil investigation, three (3) major soil units have been identified.

Unit 1

This layer extends from the ground surface to depths ranging from 5.6 – 6.4 m below the ground surface. It consists of loose sands.

Unit 2

This unit extends from the base of Unit 1 to depths ranging from 7.6 – 9.1 m below the ground surface. It extends to the end of the borehole in Borehole BS01 at a depth 7.6 m. It consists of moderately hard shelly limestone, massive, surface calcreted (Codrington Formation).

Unit 3

This unit was only encountered in Borehole BS02, and it extends from the base of Unit 2 to the end of the borehole at a depth 11.4 m below the ground surface. It consists of hard, jointed, semi-crystalline limestone (Codrington Formation).

2. The groundwater measurements taken in boreholes at the following timeframes are summarized in *Table 10.1* below.

Table 10.1 Summary of Groundwater Measurements by Borehole

Borehole ID	Groundwater Depth (m)	
	After Borehole Completion	24 hrs after Boring
B01	0.5	Borehole Collapsed
B02	1.5	1.5
B03		Borehole Collapsed
B04	1.5	1.5
B05	2.1	2.0
B06	1.2	Borehole Collapsed
B07	0.6	0.6

Borehole ID	Groundwater Depth (m)	
	After Borehole Completion	24 hrs after Boring
BH1	0.6	0.6
BH2	Borehole Collapsed	
BH3	0.5	Borehole Collapsed
BH4	0.7	0.8
BH5	0.3	0.5
BH6	0.1	0.2
BH7	0.6	0.6
BH8	0.6	0.6
BH10	0.5	7.3
BH11	0.5	0.6
BS01	0.9	0.9
BS02	0.3	Borehole Collapsed

It must be noted that these water levels are at the time of measurement, and they do not cater for any seasonal fluctuations, flood, or tidal effects, where applicable.

3. The recommended values of effective angle of internal shearing resistance, ϕ' were estimated using the results of correlations between ϕ' and $SPT\ N_{60}$ [17]. The respective drained shear strength parameters are given in *Section 5.4.3*.

4. The recommended friction factors, tan δ between concrete and sand are 0.35 [18].

5. The relevant spectral acceleration and coefficients for dynamic design at the site are:

Peak ground acceleration (pga)	=	0.650g
S_s	=	1.800
S_1	=	0.550

This is based on a return period of 2475 years.

6. The determination of the shear wave velocity profile for the site was outside the scope of the investigation. However, in the absence of the determination of the average shear

wave velocity over the top 30 m of soil/rock, the seismic Site Class is taken as D. It is recommended that the shear wave velocity profile be determined to confirm the seismic Site Class.

7. The allowable bearing capacity is taken as the lesser of the maximum safe bearing pressure and the bearing pressure which induces the maximum acceptable settlement. Typically, the maximum allowable settlement for buildings is taken as 25 mm. Therefore, the allowable bearing capacity may be taken as 250 kPa, for an isolated pad footing.

8. The recommended allowable axial compression and lateral capacity of 400- and 600-mm diameter drilled shafts in Area 2 are given in *Section 7.3* above. The minimum recommended pile length 8 m based on fixity and worst-case soil conditions.

9. The calculated deflections are negligible. The shear forces at the pile head should however be adjusted to ensure an adequate factor of safety when compared to the ultimate bending moment capacity of the pile section.

10. The determination of the in-situ CBR was beyond the scope of the investigation. However, based on our geotechnical experience, a value of 3% is considered reasonable. Using this value and a cumulative traffic loading of 300,000 Equivalent Single Axle Load (ESAL's) over the *life* of the road pavement and car park, the recommended pavement for road reinstatement is given below [16]:

Asphaltic concrete	50 mm
Aggregate Base Course	150 mm
Aggregate Sub-base Course	150 mm
Capping Layer	200 mm

11. Minimum pavement specifications for base course, sub-base course and select fill material are given in *Section 9.2* above.

12. Measures should be put in place for pumping of water within excavation during construction. An adequate number of sumps and pumps may be used to remove the water during construction. Alternatively trenches to remove water or other suitable

methods to be determined by the Contractor must be employed to dewater the foundation bases.

13. As indicated above, the deposits were generally found to be very variable across the site. Therefore, the Client and/or designers must put the necessary contractual arrangements in place for a test pile program to verify adequacy of proposed pile size and length to support the design loading conditions within the relevant areas for the development. The test pile program will inform the designers on if pile length modification is necessary for production piling or confirm adequacy of the theoretical estimates.

14. If drilled shafts are to be installed at the site, then suitably qualified personnel must oversee the installation of such piles to evaluate whether production installations are being performed in accordance with the established pile installation criteria including monitoring of grout takes, determining pile tip elevations, observations of grout return, reinforcing steel, pump calibration, grout pressures, and other installation procedures, grout tests, and pile integrity testing.

    Accurate plots of segmental grout volume and shaft diameter versus depth must be developed for each production pile.

    Adjacent piles within four diameters on center should not be installed within about four hours of each other. This waiting time is required to minimize damage to installed piles by allowing the grout to initially set prior to placing adjacent piles.

15. Piles are expected to be embedded in competent materials. Downdrag due to pressure of new fill on subsoil is therefore not expected to be of concern.

16. All excavations for foundations should be blinded with lean concrete as soon as possible to avoid loss of shear strength of the exposed soil.

17. The subgrade must be cleared and grubbed to a maximum depth of about 0.15 m to remove any vegetation and other deleterious material. Any soft spots which are identified via “proof-rolling” must be removed and replaced with sub-base material. The minimum specifications for sub-base material are given *Section 9.2.3*.

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ENCLOSURES

ENCLOSURE No.1



File Name & Location: G:\PROJ\08300000\CIVIL\EXHIBITS\Bore Hole Locations\X-Bore Hole Locations.dwg Layout: EXH - 10 Printed: Tue, 11 Jun 2024 - 9:20

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REVISIONS

	Date	Description

ENGINEER SEAL

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Project Title: ROSEWOOD INFRASTRUCTURE PACKAGE

Project Address: PINK SANDS BEACH, BARBUDA

Design By:	KS
Drawn By:	KS
Checked By:	NW
Date:	05/01/2024

HCE Project: 08300000

Sheet Title: BORING EXHIBIT

Release: FOR REVIEW
Issued for Review 05/01/2024

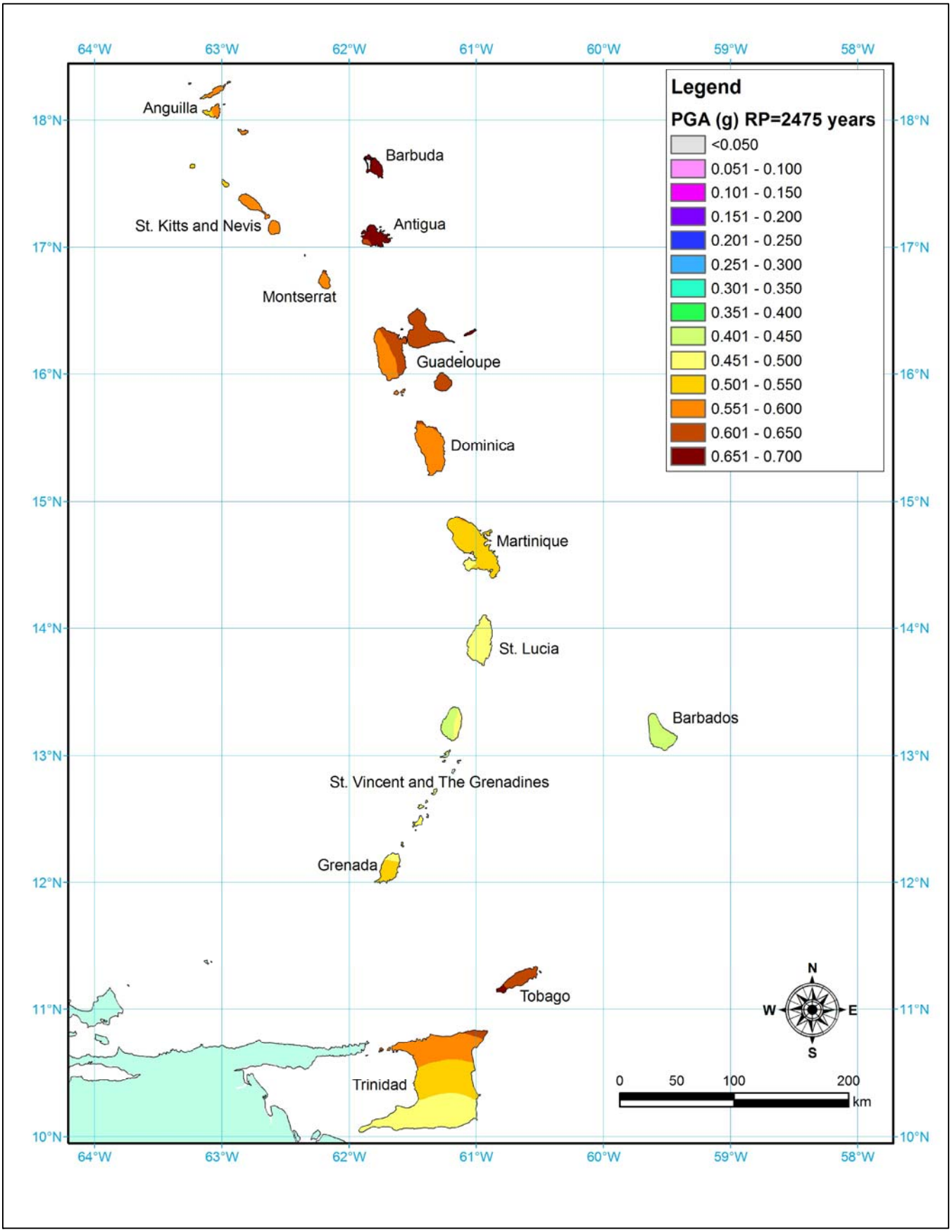
Sheet Number: EXH-10

PROJECT G.I. for Proposed Murbee Development – Barbuda

JOB NO. GA 24 206

DATE December 2024

PLAN SHOWING BOREHOLE LOCATIONS



PROJECT G.I. for Proposed Murbee Development – Barbuda

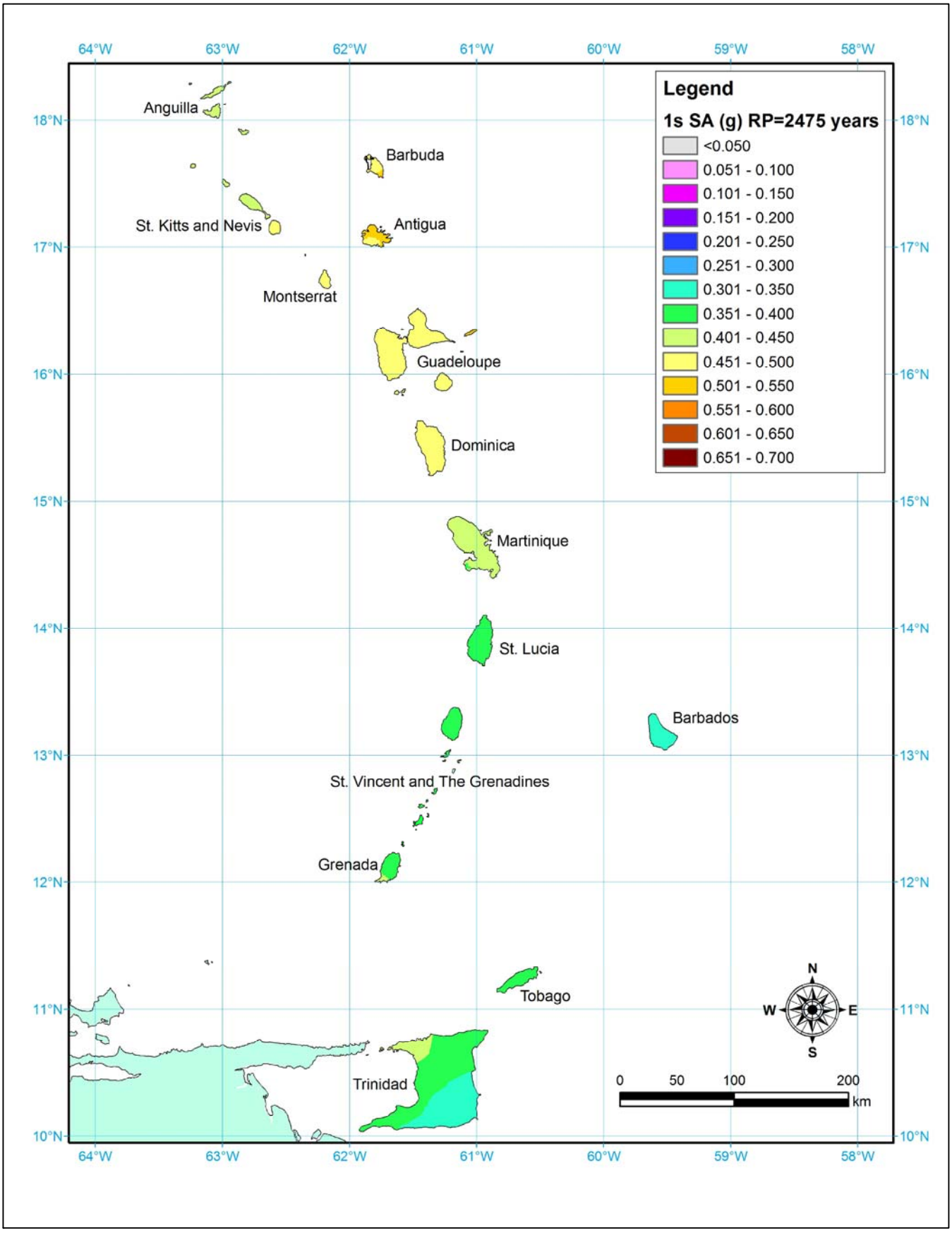
JOB NO. GA 24 146

DATE December 2024

PEAK GROUND ACCELERATION (2475 YEAR RETURN PERIOD)

Geotech Associates Limited

Tunapuna, Trinidad



PROJECT G.I. for Proposed Murbee Development – Barbuda

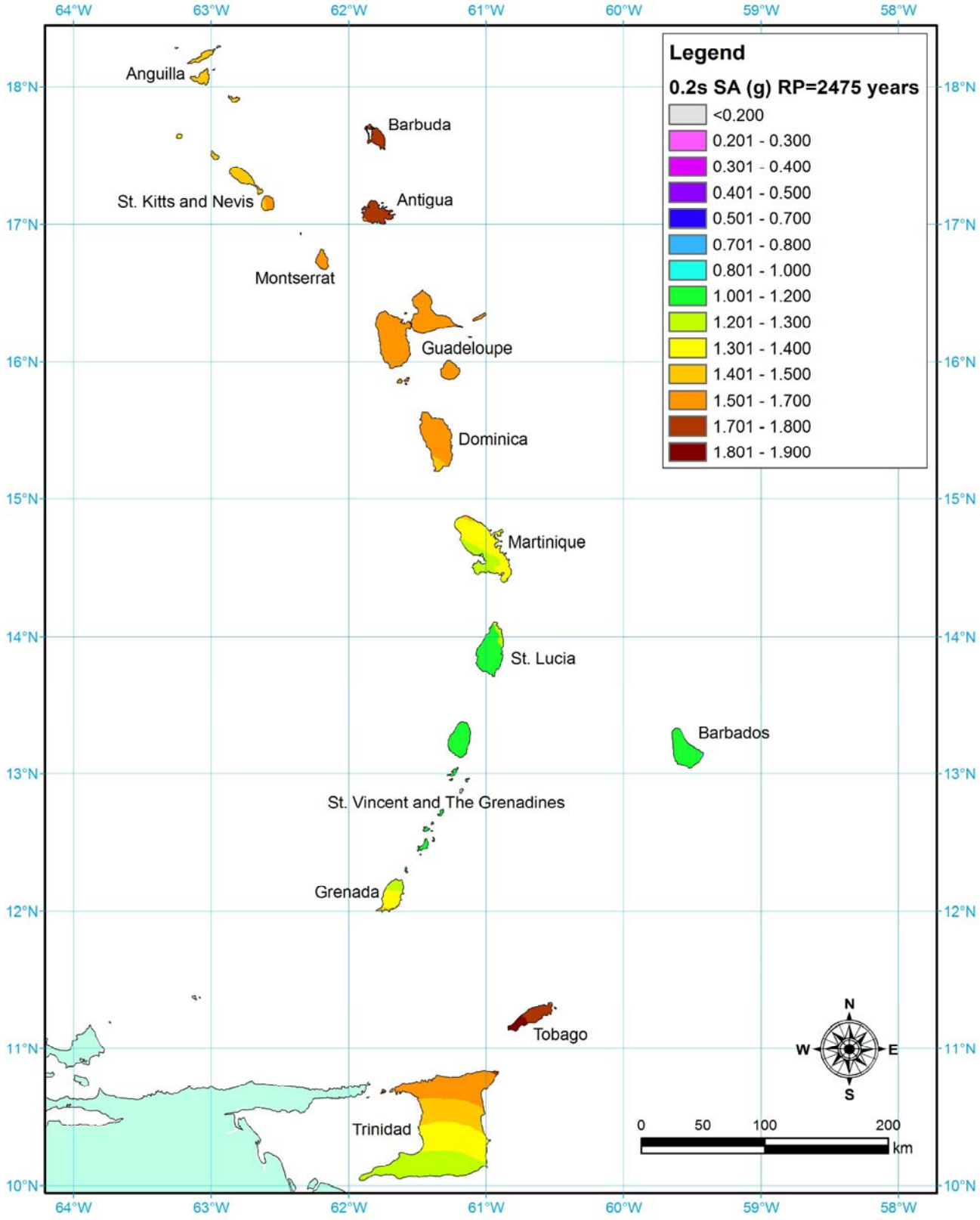
JOB NO. GA 24 146

DATE December 2024

1 SEC ACCELERATION (2475 YEAR RETURN PERIOD)

Geotech Associates Limited

Tunapuna, Trinidad



PROJECT	G.I. for Proposed Murbee Development – Barbuda	JOB NO.	GA 24 146
		DATE	December 2024

0.2 SEC ACCELERATION (2475 YEAR RETURN PERIOD)

Geotech Associates Limited
Tunapuna, Trinidad

PHOTOGRAPHS



All Samples of B01

Borehole B01





All Samples of B02

Borehole B02



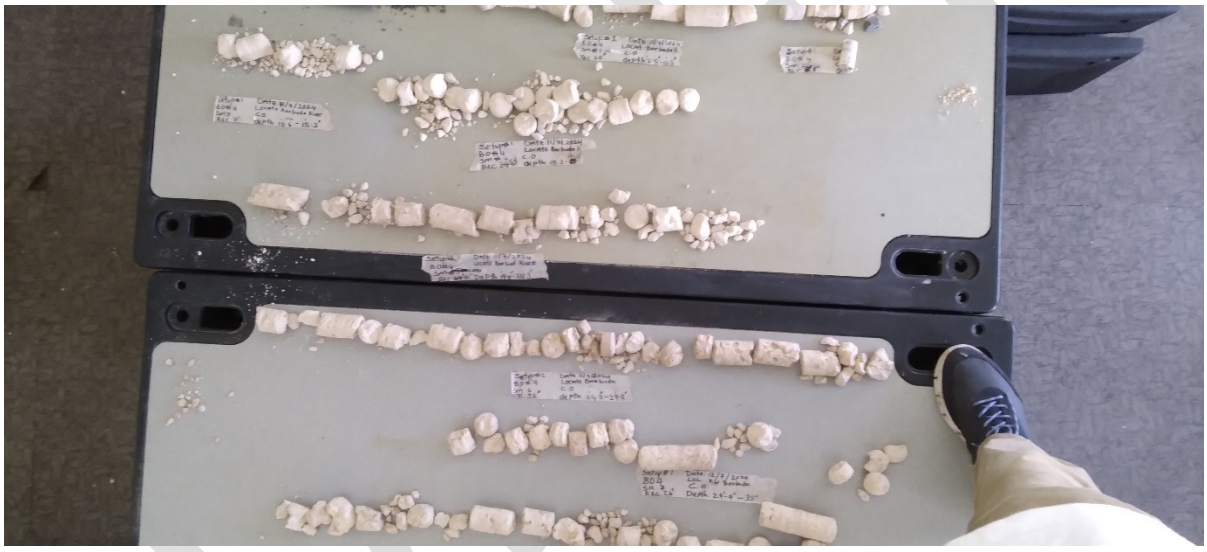
Close up Samples B03



All Samples of B03

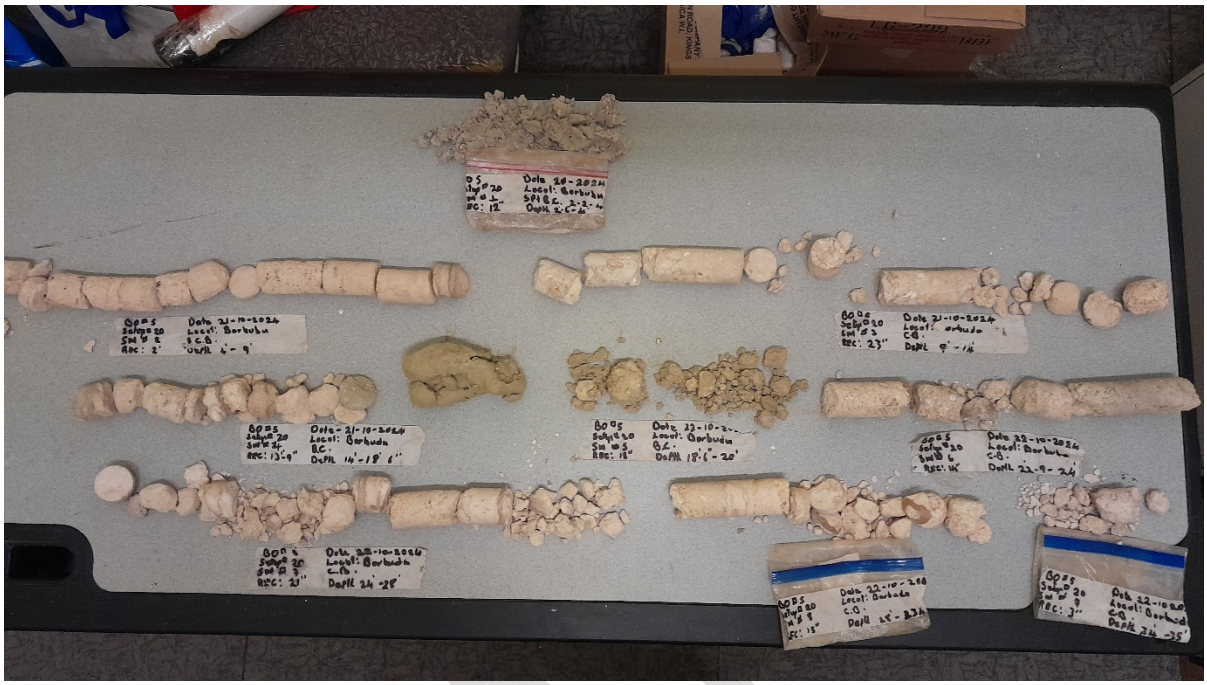
Borehole B03





All Samples of B04

Borehole B04



All Samples of B05



Close up of Samples of B05

Borehole B05



Close up of Samples



Close up of Samples B05

Borehole B05

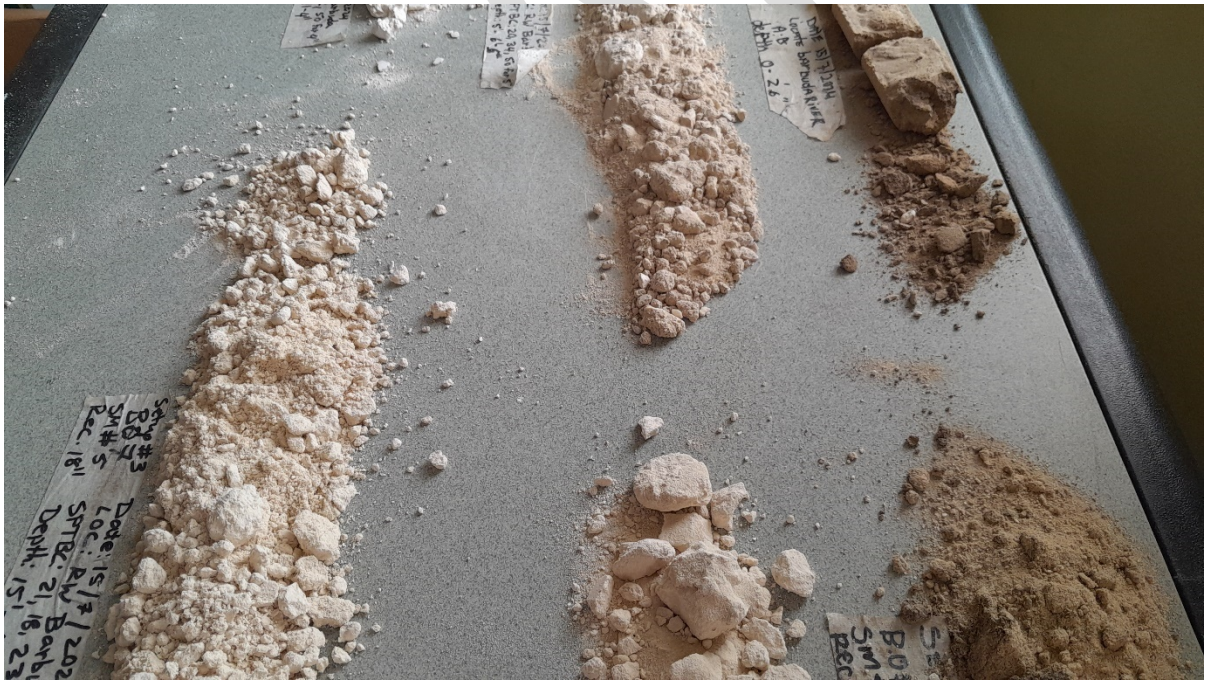




Borehole B06



Close up of Samples B07



Close up of Samples B07

Borehole B07



DRAFT

Borehole BS01



Close up of Samples BS02



Close up of Samples BS02

Borehole BS02



All Samples DS01



Close up of Samples DS01

Borehole DS01



All Samples DS01



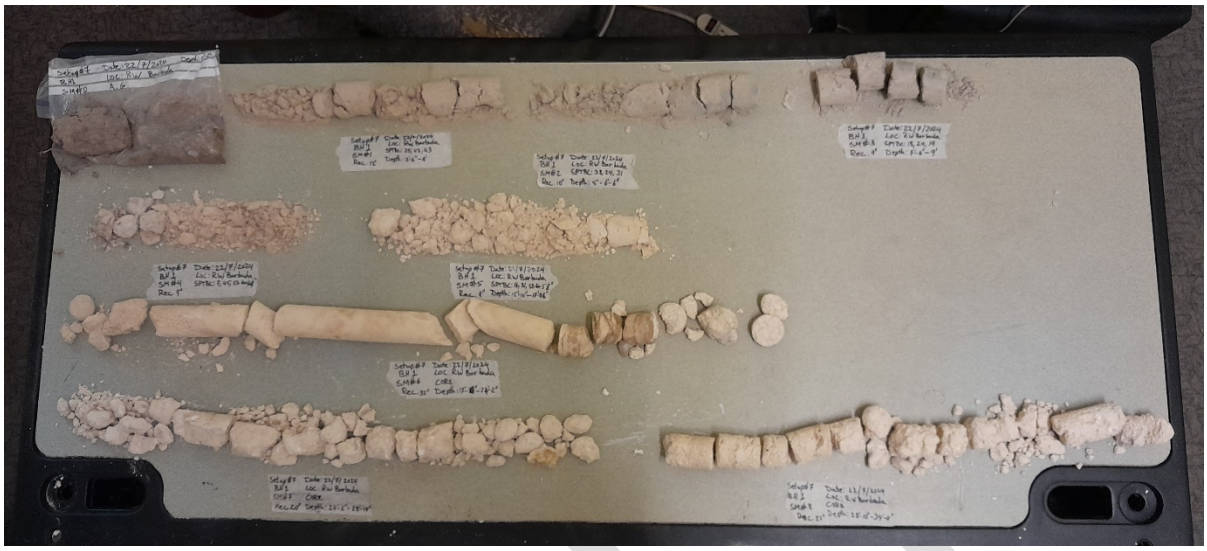
Close up of Samples DS01

Borehole DS01



All Samples BH1

Borehole BH1

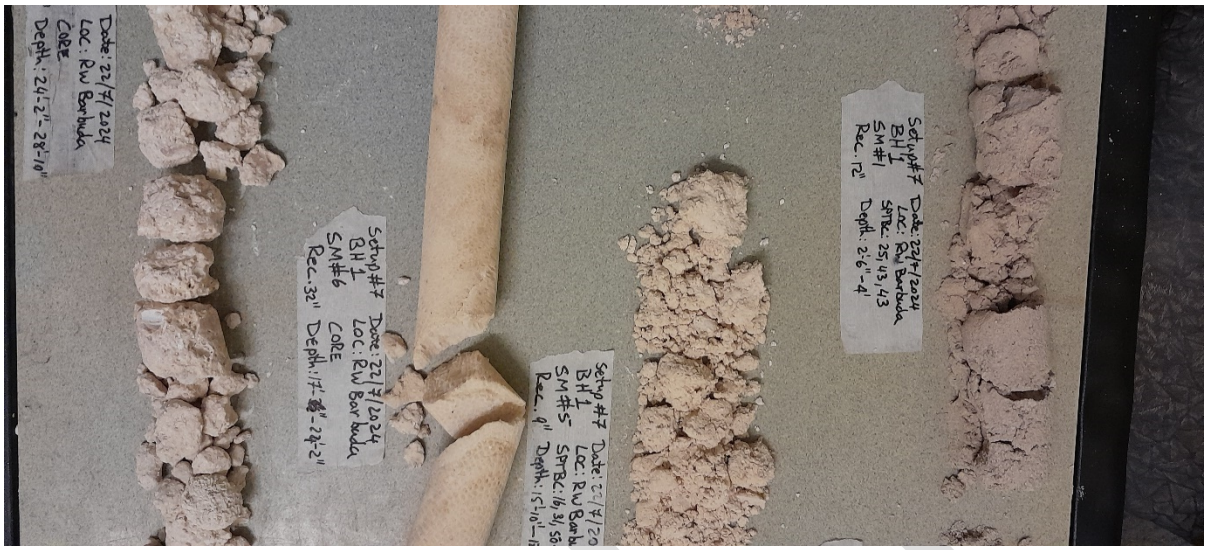


All samples BH1

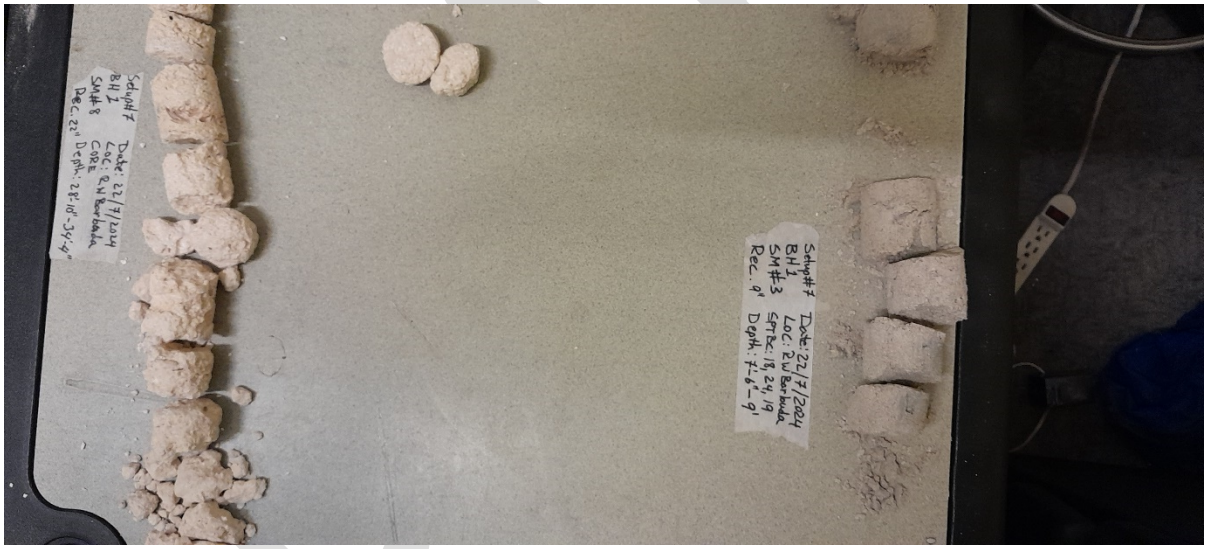


Close up of Samples BH1

Borehole BH1



Close-up of the samples

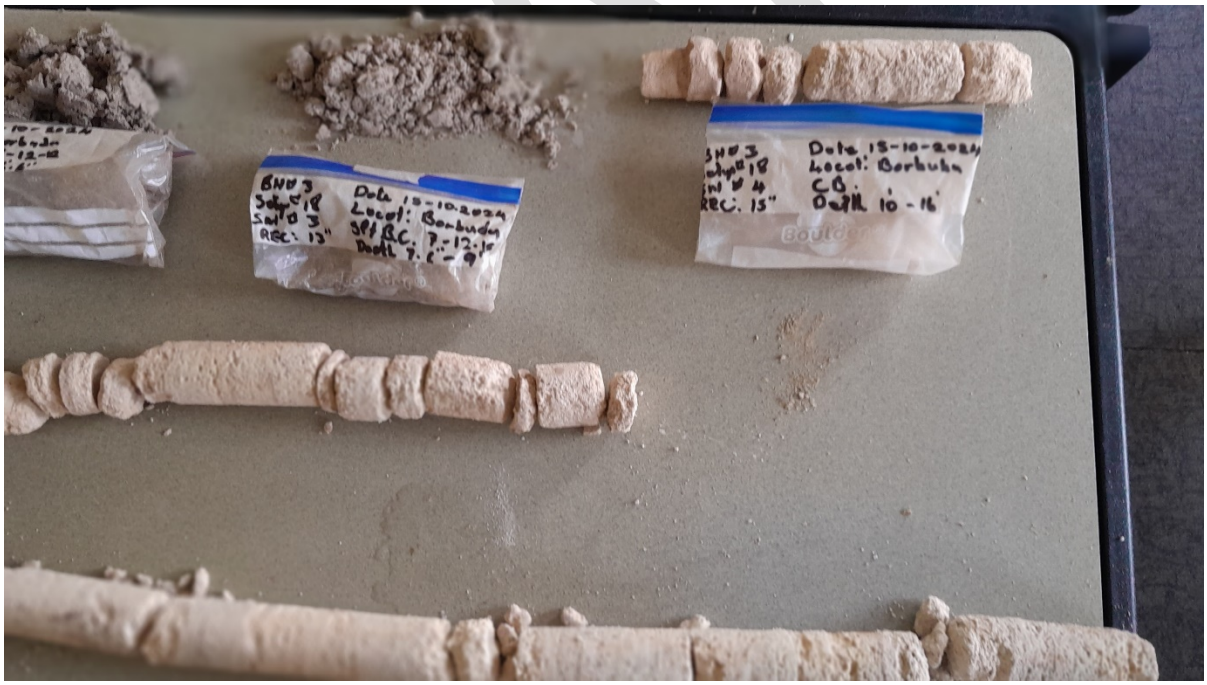


Close-up of the samples

Borehole BH1



All Samples BH3



Close up of Samples **BH3**

Borehole BH3

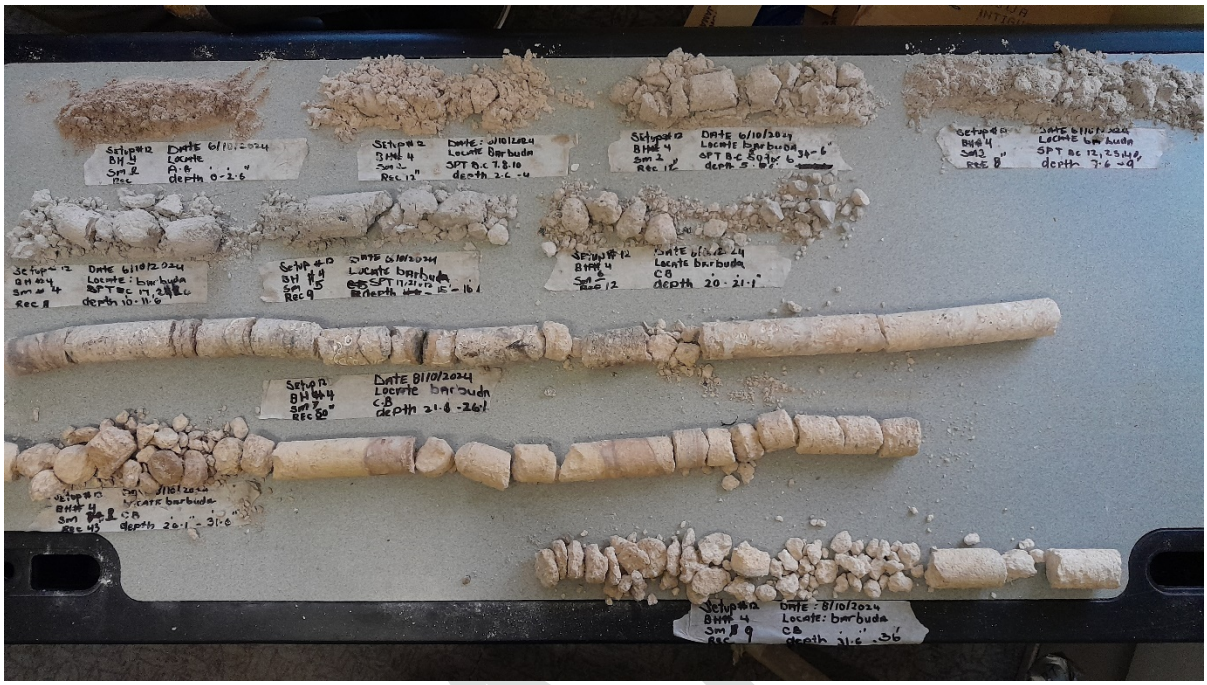


All Samples BH3



Close up of Samples

Borehole BH3



All Samples BH4

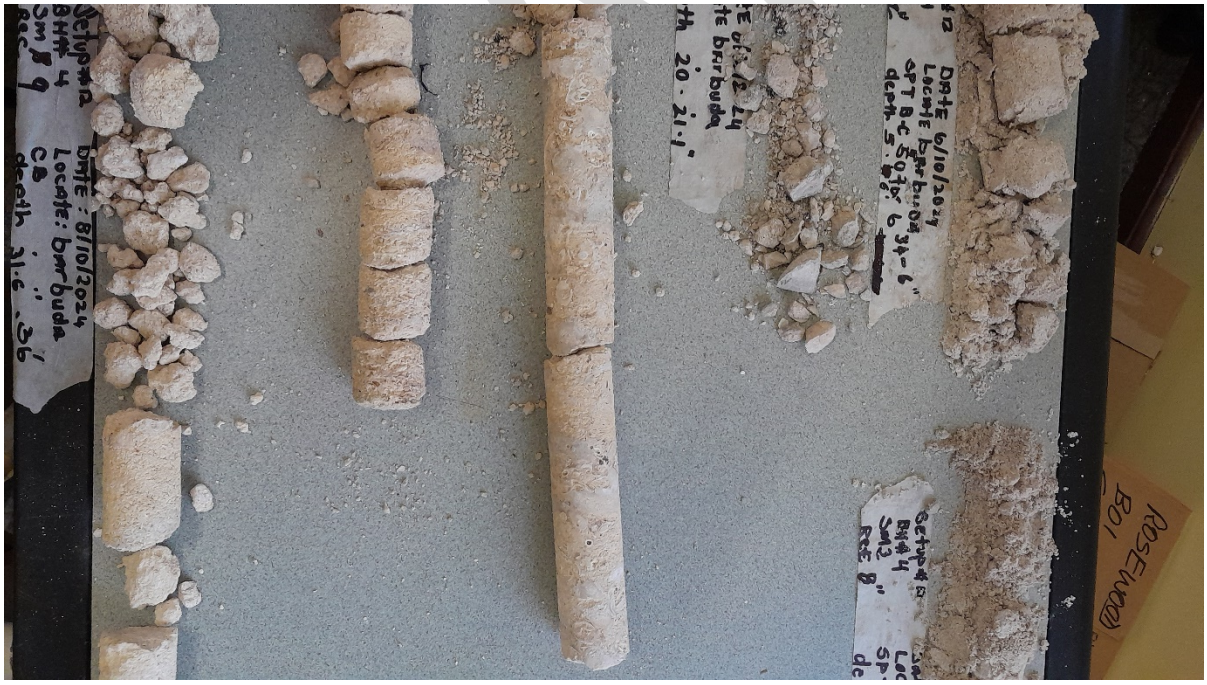


Close up of Samples BH4

Borehole BH4



Close up Samples BH4

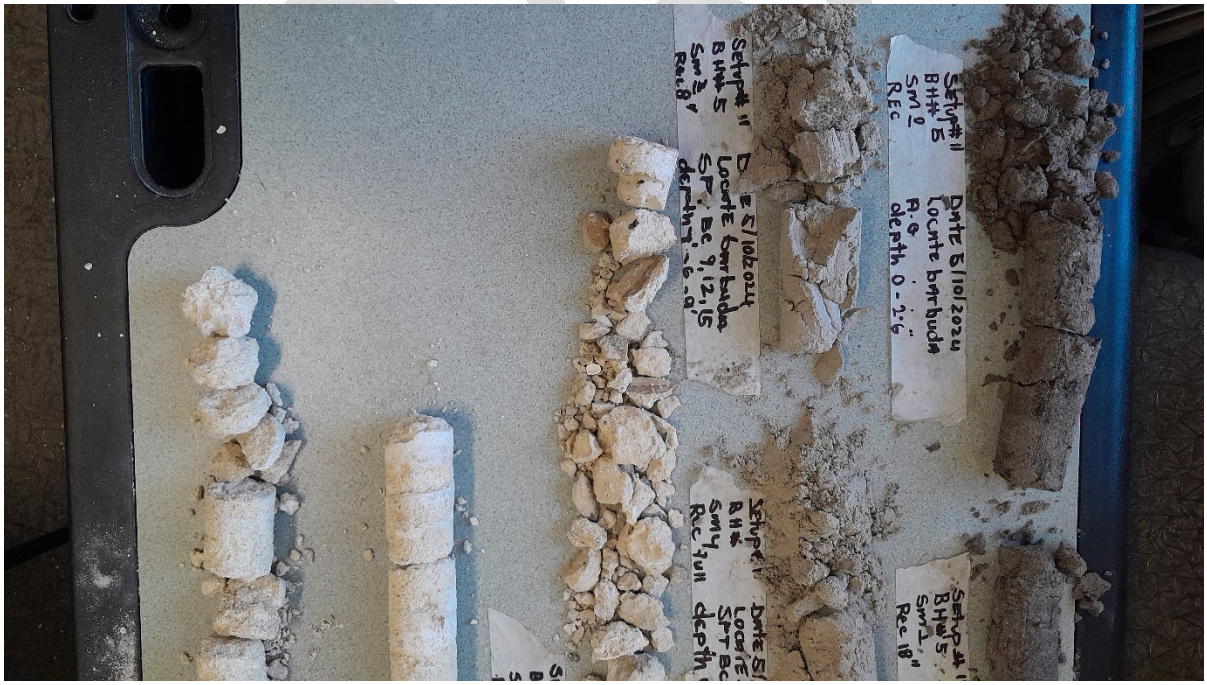


Close up of Samples BH4

Borehole BH4



All Samples BH5



Close up of Samples

Borehole BH5



Close up of Samples BH5



Close up of Samples BH5

Borehole BH5



Close up of Samples BH6



Close up of Samples BH6

Borehole BH6

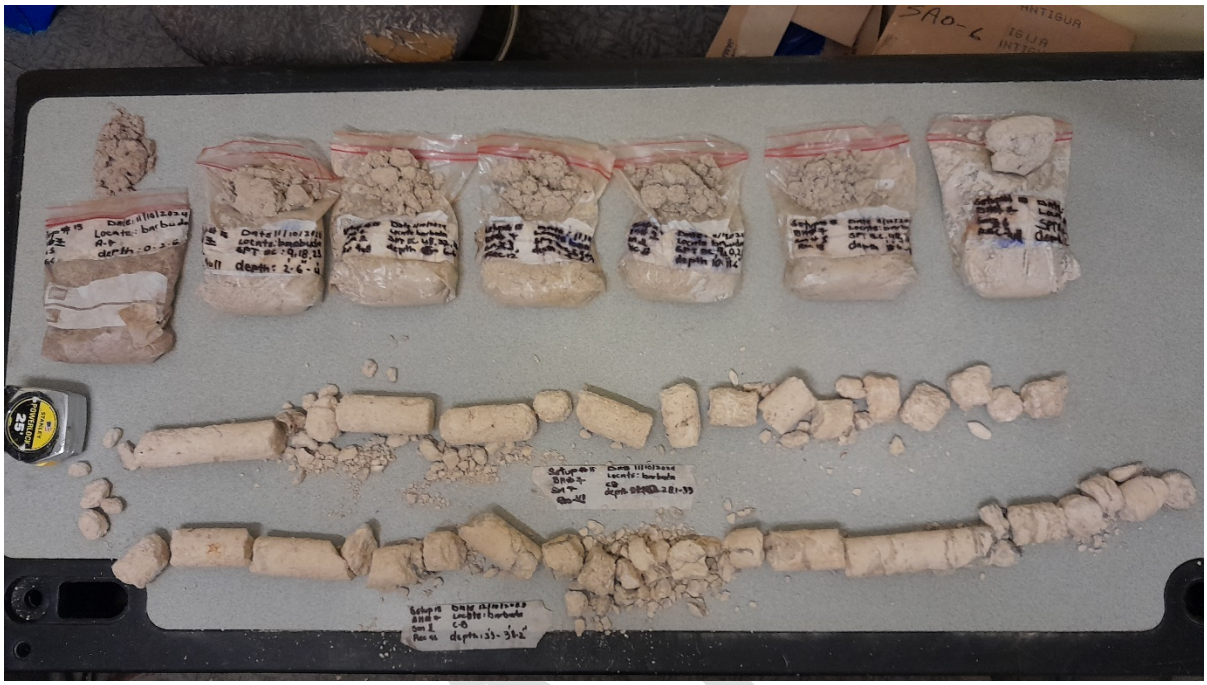


All Samples BH6



Close up of Samples BH6

Borehole BH6

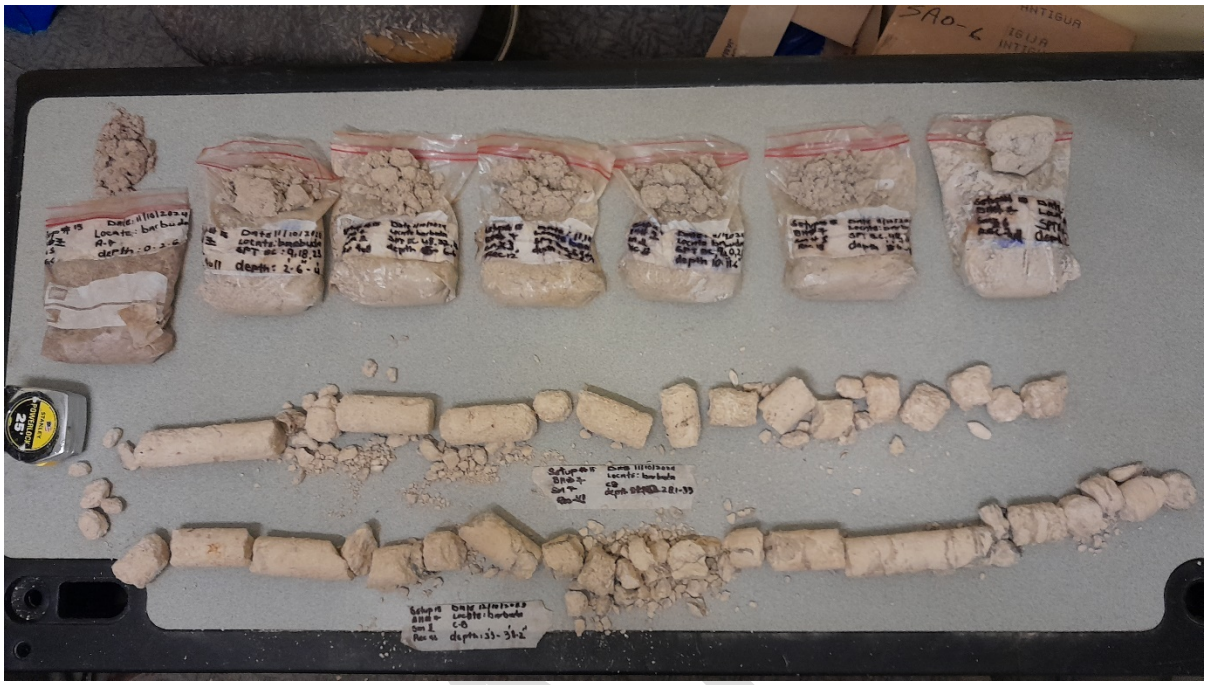


All Samples BH7



Close up of Samples BH7

Borehole BH7



All Samples BH11



Close up of Samples BH7

Borehole BH7



All Samples BH11

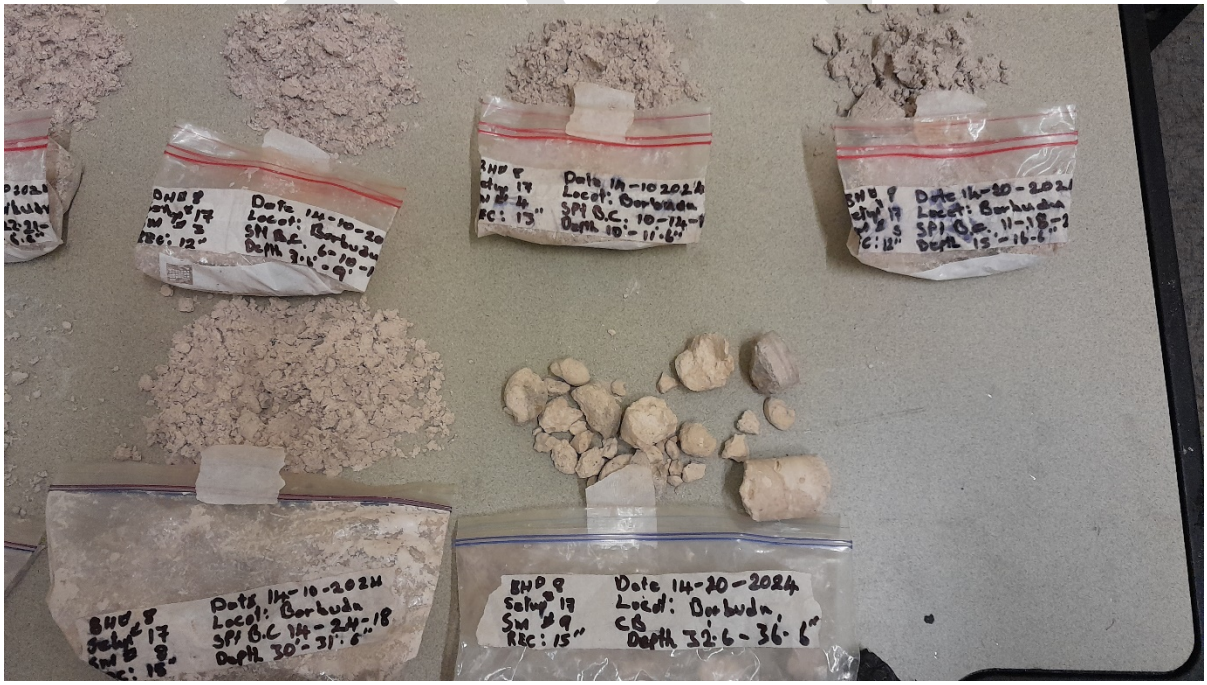


Close up of Samples BH8

Borehole BH8



All Samples BH8

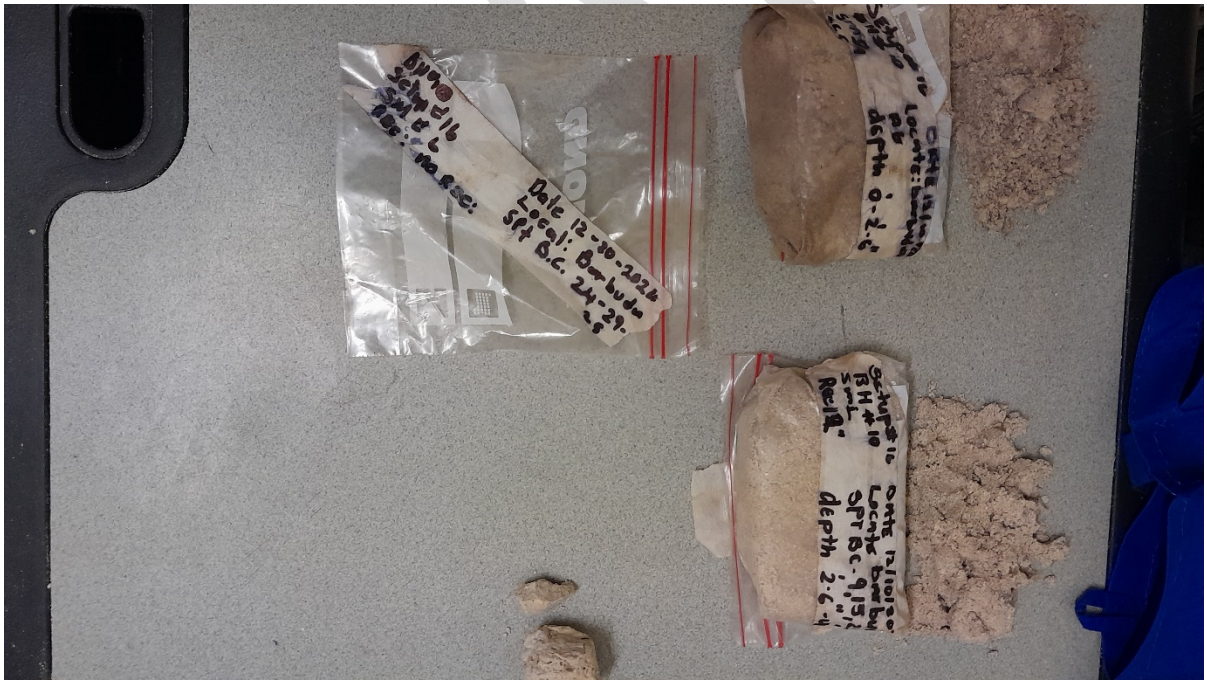


Close up of Samples BH8

Borehole BH8



All Samples BH10



Close up of Samples BH10

Borehole BH10

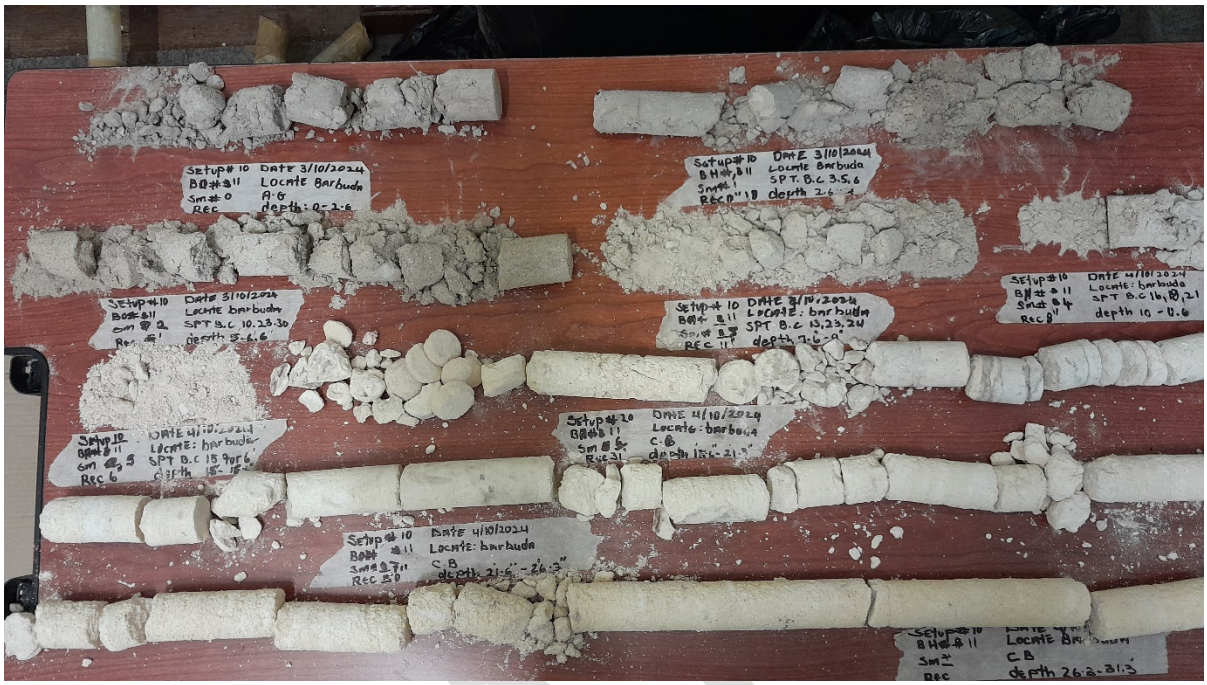


Close up of Samples BH10



Close up of Samples BH10

Borehole BH10



All Samples BH11



Close up of Samples BH11

Borehole BH11



Close up of Samples BH11



Close up of Samples BH11

Borehole BH11

APPENDIX I

LOG OF BORING No. BO1

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River, Barbuda, See Borehole Location Plan **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem Continuous Flight Auger **DATE:** 19th July 2024
DEPTH TO - WATER> INITIAL: 1.5 **AFTER 24 HOURS:** **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
0	Brownish Grey silty sand		0			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
2.5	Very dense Grey sand		1			63 →
5	Dense grey sand		2			
	Very dense greyish white fine sand		3			
10	Cemented Sand to fragmented limestone rock		4			
15	Cemented sand to fragmented limestone rock		5			
20	Cemented sand to fragmented limestone rock		6			
25	Cemented sand to fragmented limestone rock		7			
30	Fragmented limestone rock		8			
35						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BO1

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River, Barbuda, See Borehole Location Plan **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem Continuous Flight Auger **DATE:** 19th July 2024
DEPTH TO - WATER> INITIAL: ▽ 1.5 **AFTER 24 HOURS:** ▽ **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
						Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
40	Fragmented Limestone Rock		9			
45	Fragmented Limestone rock		10			
50	Fragmented Limestone rock		11			
	Boring terminated at 52 ft. Borehole terminated at 52 ft.					
55						
60						
65						
70						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. B02

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, See Borehole Location Plan **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid stem Continuous Flight Auger **DATE:** 12th July 2024
DEPTH TO - WATER> INITIAL: ▽ 5 **AFTER 24 HOURS:** ▽ 5 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
0	dark brown clayey sand		0			Plastic Limit ⊢—⊣ Liquid Limit
	2.5		1			Water Content - ●
	Cream cemented sand/ sandstone cream cemented silty sand wwith marine deposits/ Sandstone					Penetration - ▨
5 ▽			2			10 20 30 40 50
10	Cream cemented sand		3			100 →
	Cream cemented sand/ Sandstone Rock		4			
15						
	Cream cemented sand/ Sandstone Rock		5			
20						
	Cream cemented sand/ Sandstone Rock		6			
25						
	26		7			
	Cream Limestone rock					
	Boring terminated at 27.5 ft. Cream Limestone rock		8			
30						
35						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. B03

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, See Borehole Location Plan **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous Flight Auger **DATE:** 2nd August 2024
DEPTH TO - WATER> INITIAL: **AFTER 24 HOURS:** **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
0	cream Sand		0			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
		2.5				
	Dark Brownsilty clay		1			
5	Cream cemented sand & gravel rock	4	2			
10	Cream cemented sand & Gravel		3			
15	Cream cemented sand & limestone rock		4			
20		20				
	Cream limestone rock		5			
	Boring terminated at 23 ft. Borehole terminated at 28.5 ft.					
25						
30						
35						

Core Barrel stuck at bottom of hole at 28'-5"

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. B04

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, Seee Borehole location Map **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: SS continuous flight auger **DATE:** 11th july 2024
DEPTH TO - WATER> INITIAL: ▽ 5 **AFTER 24 HOURS:** ▽ 5 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200
0	Dark brown sand with silt mixed with marine deposits		0		
			1		
5 ▽	Cream cemented sand/ Sandstone Rock		2		
10	Cream cemented sand/ Sandstone Rock		3		
15	Cream cemented sand/ Sandstone Rock		4		
20	Cream cemented sand/ Sandstone Rock		5		
25	Cream limestone rock		6		
30	Cream limmestone rock		7		
35	Cream limestone rock				

2.5

24.5

TEST RESULTS
Plastic Limit ⊢——⊣ Liquid Limit
Water Content - ●
Penetration - ▨
10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. B04

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, Seee Borehole location Map **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: SS continuous flight auger **DATE:** 11th july 2024
DEPTH TO - WATER> INITIAL: ▽ 5 **AFTER 24 HOURS:** ▼ 5 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
40			8			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
	Boring terminated at 40.25 ft. Borehole Terminated at depth of 40.25 ft.					
45						
50						
55						
60						
65						
70						

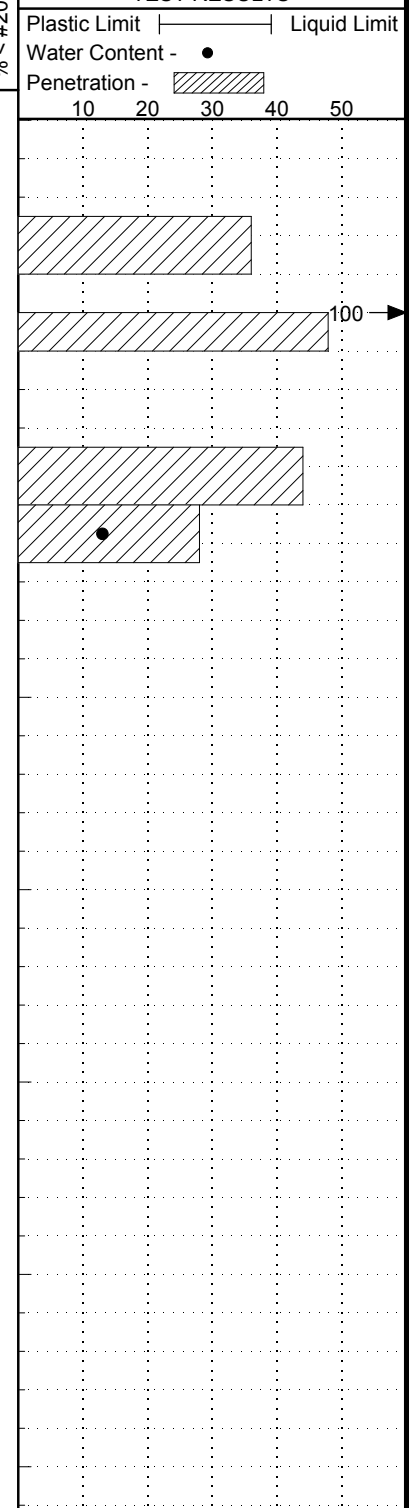
This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. B06

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, See Borehole location Map **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous flight auger **DATE:** 16-07-2024
DEPTH TO - WATER> INITIAL: 4 **AFTER 24 HOURS:** **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200
0	Creaamish Brown fine sand		a		
2.5	Dense cream sand with pockets of marine deposits		1		
5	Very dense cream sand with pockets of marine deposits		2		
8.5	Dense coarse sand		3		
10	Medium dense grey coarse sand		4		
13.5	Cream cemented sand with marine deposits/ sandstone		5		
15	Cream cemented sand with marine deposits/ sandstone		6		
20	Cream cemented sand with gravel & marine deposits/ sandstone		7		
25	Cream cemented sand with gravel & marine deposits/ sandstone		8		
30	Cream cemented sand with gravel & marine deposits/ sandstone				
35					

TEST RESULTS



This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. B06

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, See Borehole location Map **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous flight auger **DATE:** 16-07-2024
DEPTH TO - WATER> INITIAL: ▽ 4 **AFTER 24 HOURS:** ▽ **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
40			9			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
	40.0 Limestone rock		10			
45	Limestone rock		11			
50	Limestone Rock		12			
55	Borehole terminated at 60 ft.		13			
60	Boring terminated at 60 ft. Borehole terminated at 60 ft.					
65						
70						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BO7

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, See Borehole Location Map **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous flight auger **DATE:** 15th July 2027
DEPTH TO - WATER> INITIAL: 2 **AFTER 24 HOURS:** 2 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
0						Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
	Brown sand mixed with marine dposits		0			
	Dense creamish brown sand		1			
5	Very dense Cream partially cemented sand with isolated shell fragments & bits of gravel		2			84 →
	7.5					
	Very dense cream partially cemented fine sand with gravel		3			
10	Very dense cream partially cemented fine sand with gravel		4			75 →
15	Dense cream partially cemented fine sand with gravel		5			
	17.5					
	Cream fissured cemented sand / sandstone rock		6			
20						
	22.5					
	greenish brown silty clay		6B			
	24					
25	Cream cemented sand with marine desposits/ sandstone rock		7			
30	Cream cemented sand with marine desposits/ sandstone rock		8			
35	Cream cemented sand with marine desposits/ sandstone rock					

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BO7

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, See Borehole Location Map **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous flight auger **DATE:** 15th July 2027
DEPTH TO - WATER> INITIAL: ▽ 2 **AFTER 24 HOURS:** ▽ 2 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
			9			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
40	Boring terminated at 40 ft. Borehole terminated aat 40 ft.					
45						
50						
55						
60						
65						
70						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BH BO1

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454

CLIENT:

PROJECT LOCATION:

LOCATION: River, Barbuda, See Borehole LOcation Plan **ELEVATION:**

DRILLER: M White **LOGGED BY:** S James

DRILLING METHOD: Solid Stem Continuous Flight Auger **DATE:** 19th July 2024

DEPTH TO - WATER> INITIAL: ▽ 1.5 **AFTER 24 HOURS:** ▽ **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
0	Brownish Grey silty sand		0			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
						63 →
2.5	Very dense Grey sand		1			
5	Dense grey sand		2			
	Very dense greyish white fine sand		3			
10	Cemented Sand to fragmented limestone rock		4			
15	Cemented sand to fragmented limestone rock		5			
20	Cemented sand to fragmented limestone rock		6			
25	Cemented sand to fragmented limestone rock		7			
30	Fragmented limestone rock		8			
35						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BH BO1

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River, Barbuda, See Borehole LOcation Plan **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem Continuous Flight Auger **DATE:** 19th July 2024
DEPTH TO - WATER> INITIAL: ▽ 1.5 **AFTER 24 HOURS:** ▽ **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
40	Fragmented Limestone Rock		9			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
45	Fragmented Limestone rock		10			
50	Boring terminated at 47 ft. Fragmented Limestone rock		11			
55						
60						
65						
70						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING
No. BH: B02

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454

CLIENT:

PROJECT LOCATION:

LOCATION: River Barbuda, See Borehole Location Plan **ELEVATION:**

DRILLER: M White **LOGGED BY:** S James

DRILLING METHOD: Solid stem Continuous Flight Auger **DATE:** 12th July 2024

DEPTH TO - WATER> INITIAL: ▽ 5 **AFTER 24 HOURS:** ▽ 5 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
0			0			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨
			1			10 20 30 40 50; 100 →
	2.5					
	Cream cemented sand/ sandstone cream cemented silty sand wwith marine deposits/ Sandstone					
5 ▽			2			
	Cream cemented sand		3			
10						
	Cream cemented sand/ Sandstone Rock		4			
15						
	Cream cemented sand/ Sandstone Rock		5			
20						
	Cream cemented sand/ Sandstone Rock		6			
25						
	26					
	Cream Limestone rock		7			
	Boring terminated at 27.5 ft. Cream Limestone rock		8			
30						
35						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING
No. BH: B04

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454

CLIENT:

PROJECT LOCATION:

LOCATION: River Barbuda, Seee Borehole location Map **ELEVATION:**

DRILLER: M White **LOGGED BY:** S James

DRILLING METHOD: SS continuous flight auger **DATE:** 11th july 2024

DEPTH TO - WATER> INITIAL: ▽ 5 **AFTER 24 HOURS:** ▽ 5 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS: Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨ (10 20 30 40 50)
0	Dark brown sand with silt mixed with marine deposits		0			
2.5	Cream cemented sand/ Sandstone Rock		1			
5 ▽	Cream cemented sand/ Sandstone Rock		2			
10	Cream cemented sand/ Sandstone Rock		3			
15	Cream cemented sand/ Sandstone Rock		4			
20	Cream cemented sand/ Sandstone Rock		5			
24.5	Cream limestone rock		6			
30	Cream limmestone rock		7			
35	Cream limestone rock					

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING
No. BH: B04

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454

CLIENT:

PROJECT LOCATION:

LOCATION: River Barbuda, Seee Borehole location Map **ELEVATION:**

DRILLER: M White **LOGGED BY:** S James

DRILLING METHOD: SS continuous flight auger **DATE:** 11th july 2024

DEPTH TO - WATER> INITIAL: ▽ 5 **AFTER 24 HOURS:** ▼ 5 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
			8			Plastic Limit ⊢——⊣ Liquid Limit Water Content - ● Penetration - ▨ 10 20 30 40 50
40	Boring terminated at 40.25 ft. Borehole Terminated at depth of 40.25 ft.					
45						
50						
55						
60						
65						
70						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

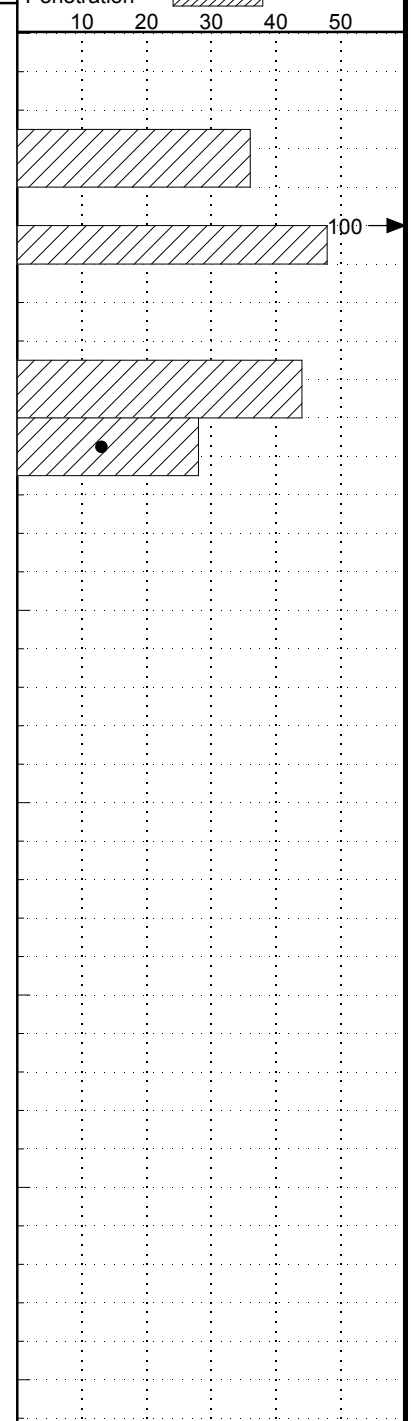
LOG OF BORING No. BH: B06

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, See Borehole location Map **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous flight auger **DATE:** 16-07-2024
DEPTH TO - WATER> INITIAL: 4 **AFTER 24 HOURS:** **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200
0	Creaamish Brown fine sand		a		
2.5	Dense cream sand with pockets of marine deposits		1		
5	Very dense cream sand with pockets of marine deposits		2		
8.5	Dense coarse sand		3		
10	Medium dense grey coarse sand		4		
13.5	Cream cemented sand with marine deposits/ sandstone		5		
15					
	Cream cemented sand with marine deposits/ sandstone		6		
20					
	Cream cemented sand with gravel & marine deposits/ sandstone		7		
25					
	Cream cemented sand with gravel & marine deposits/ sandstone		8		
30					
35	Cream cemented sand with gravel & marine deposits/ sandstone				

TEST RESULTS

Plastic Limit ├──┤ Liquid Limit
Water Content - ●
Penetration - ▨



This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BH: B06

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda, See Borehole location Map **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous flight auger **DATE:** 16-07-2024
DEPTH TO - WATER> INITIAL: ▽ 4 **AFTER 24 HOURS:** ▽ **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
			9			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
40	40.0					
	Limestone rock		10			
45	Limestone rock		11			
50	Limestone Rock		12			
55	Boring terminated at 55 ft. Limestone Rock		13			
60						
65						
70						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BH1

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda,See Borehole Location Map- Set up 7 **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem Continuous Flight Auger **DATE:** 22nd July 2024
DEPTH TO - WATER> INITIAL: ▽ 2 **AFTER 24 HOURS:** ▽ 2 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
0	Brownish Grey sand with silt & organics		0			Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨ (10 20 30 40 50)
2.5	Very dende cream sand		1			88
5	Very dense greyish cream Sand		2			
7.5	Dense greyish white sand		3			
10	whitish cream Sand with silt pockets of gravel		4			95
15						
16	Cream sand with silt and shell fragments		5			81
17.5	Cream fissured coral rock		6			
20						
25	creams fragmented limestone rock.		7			
30	Fragmented limestone rock		8			
35	Borehole termineated at 34.5 ft.					

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BH1

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River Barbuda,See Borehole Location Map- Set up 7 **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem Continuous Flight Auger **DATE:** 22nd July 2024
DEPTH TO - WATER> INITIAL: ▽ 2 **AFTER 24 HOURS:** ▽ 2 **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS: Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨ (10 20 30 40 50)
40						
45						
	Boring terminated at 47 ft. Fragmented Limestone rock		11			
50						
55						
60						
65						
70						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BSO2

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River See Borehole Location Plan **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous flight auger **DATE:** 18-07-2024
DEPTH TO - WATER> INITIAL: ▽ 1 **AFTER 24 HOURS:** ▽ **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200
0	Creaamish Brown fine sand		a		
19	Cream cemented Sand with marine deposits/ Sandstone rock		1		
25	Cream cemented Sand with marine deposits/ Sandstone rock		2		
30	Cream limestone rock		3		

TEST RESULTS
Plastic Limit ⊢——⊣ Liquid Limit
Water Content - ●
Penetration - ▨
10 20 30 40 50

This information pertains only to this boring and should not be interpreted as being indicative of the site.

LOG OF BORING No. BSO2

PROJECT: Murbee Development / Rosewood Resorts Barbuda **PROJECT NO.:** CEAS240454
CLIENT:
PROJECT LOCATION:
LOCATION: River See Borehole Location Plan **ELEVATION:**
DRILLER: M White **LOGGED BY:** S James
DRILLING METHOD: Solid Stem continuous flight auger **DATE:** 18-07-2024
DEPTH TO - WATER> INITIAL: ▽ 1 **AFTER 24 HOURS:** ▽ **CAVING>** C

Depth (feet)	Description	Graphic	Sample No.	Blow Counts	% < #200	TEST RESULTS
						Plastic Limit ⊢—⊣ Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50
	Boring terminated at 37.25 ft. Borehole terminated at 37.25					
40						
45						
50						
55						
60						
65						
70						

This information pertains only to this boring and should not be interpreted as being indicative of the site.

STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

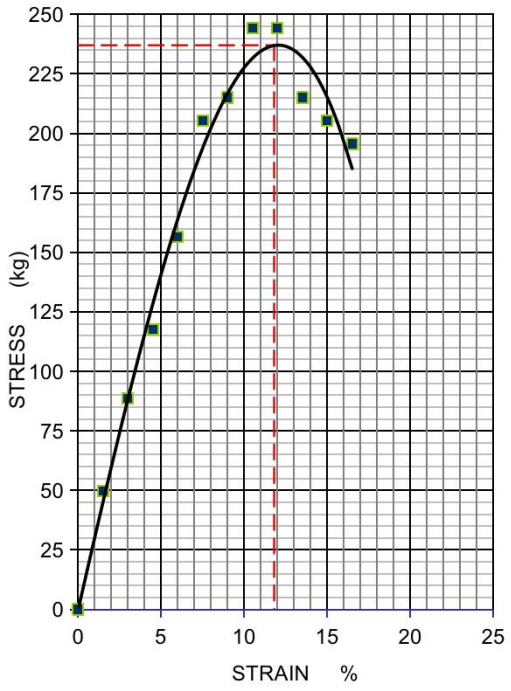
(SPECIFICATION ASTM D 2938)

CLIENT	:		LAB REPORT N°	:	A 292
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Sandy Clay stone	SAMPLE N° .	:	SM 6
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:	22'-0" to 27'-3"	DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.2	Max Load (Kg)	237
Area (cm2)	13.85		
Volume (cm3)	113.61	Stress (%)	11.80
Mass (g)	192.8		
Moisture Content (%)	2.2	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.70		
Dry Density (gr/cm3)	1.66	Strength (Kg/cm2)	**17.1**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	3	50
3.0	7	89
4.5	10	118
6.0	14	157
7.5	19	205
9.0	20	215
10.5	23	244
12.0	23	244
13.5	20	215
15.0	19	205
16.5	18	196
18.0		
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	2	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



Comments

David Willet / 17-Sep-2024
Signed by / Date

/
Checked & Approved by / Date

STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

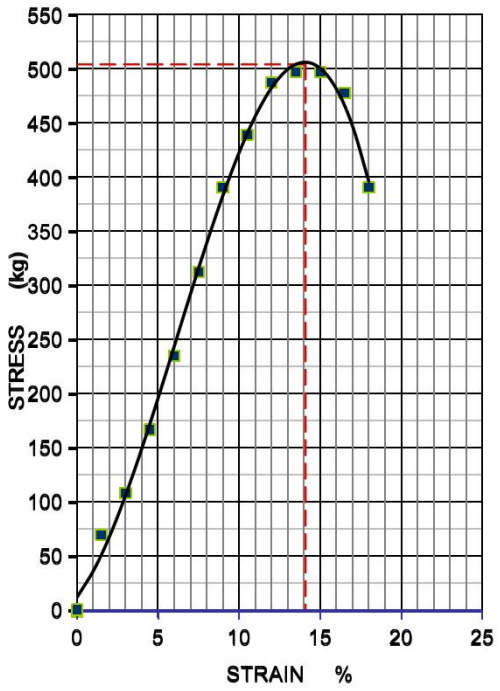
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 293
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	A11
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.0	Max Load (Kg)	504
Area (cm2)	13.85		
Volume (cm3)	110.84	Stress (%)	14.10
Mass (g)	214.0		
Moisture Content (%)	2.0	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.93		
Dry Density (gr/cm3)	1.89	Strength (Kg/cm2)	**36.4**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	5	69
3.0	9	108
4.5	15	166
6.0	22	234
7.5	30	312
9.0	38	390
10.5	43	439
12.0	48	487
13.5	49	497
15.0	49	497
16.5	47	478
18.0	38	390
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	3	
		1) Diagonal shear plane(s)
Degrees:	14	
		2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



Comments

David Willet / 17-Sep-2024
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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

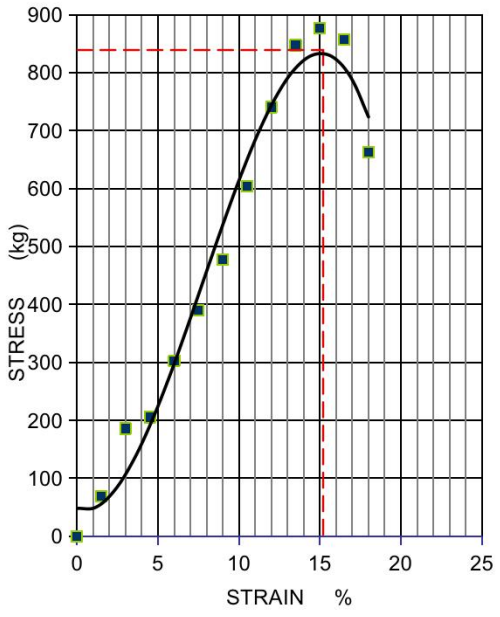
CLIENT	:		LAB REPORT N°	:	A 294
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA6
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.3	Max Load (Kg)	839
Area (cm2)	13.85		
Volume (cm3)	114.99	Stress (%)	15.20
Mass (g)	216.5		
Moisture Content (%)	2.4	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.88		
Dry Density (gr/cm3)	1.84	Strength (Kg/cm2)	**60.6**

Failure Mode		Notes
		Water content as received
Type	3	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	5	69
3.0	17	186
4.5	19	205
6.0	29	303
7.5	38	390
9.0	47	478
10.5	60	604
12.0	74	740
13.5	85	847
15.0	88	877
16.5	86	857
18.0	66	663
19.5		
21.0		
22.5		
24.0		



David Willet / 17-Sep-2024
Signed by / Date

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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

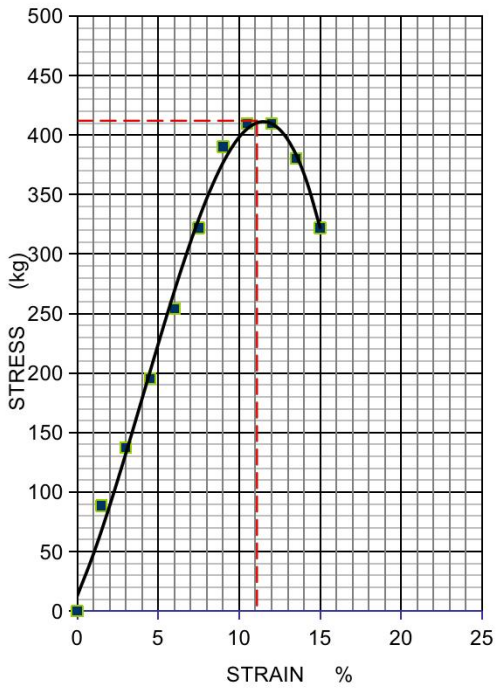
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 295
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Sandy Limestone	SAMPLE N° .	:	AS8
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.1	Max Load (Kg)	412
Area (cm2)	13.85		
Volume (cm3)	112.22	Stress (%)	11.10
Mass (g)	163.3		
Moisture Content (%)	2.5	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.46		
Dry Density (gr/cm3)	1.42	Strength (Kg/cm2)	**29.7**

Strain %	Dial (div	Stress (kg)
0.0	3	0
1.5	7	89
3.0	12	137
4.5	18	196
6.0	24	254
7.5	31	322
9.0	38	390
10.5	40	410
12.0	40	410
13.5	37	380
15.0	31	322
16.5		
18.0		
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	3	
		1) Diagonal shear plane(s)
Degrees:	14	
		2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



Comments

David Willet / 17-Sep-2024
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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

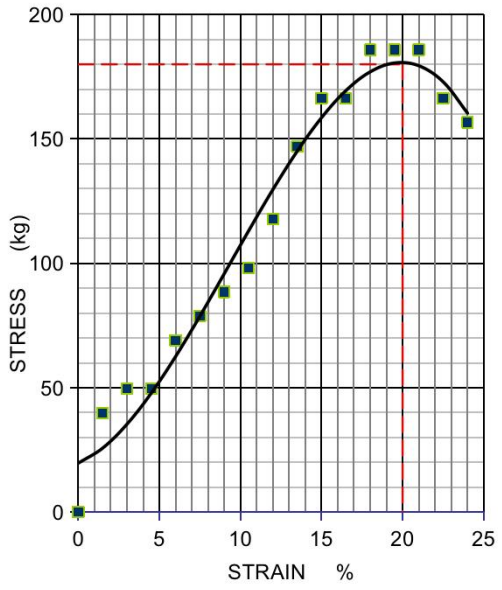
CLIENT	:		LAB REPORT N°	:	A 296
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Sandy Limestone	SAMPLE N° .	:	SA7
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.2	Max Load (Kg)	180
Area (cm2)	13.85		
Volume (cm3)	113.61	Stress (%)	20.00
Mass (g)	175.4		
Moisture Content (%)	2.5	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.54		
Dry Density (gr/cm3)	1.51	Strength (Kg/cm2)	**13.0**

Failure Mode		Notes
		Water content as received
Type	3	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	2	0
1.5	2	40
3.0	3	50
4.5	3	50
6.0	5	69
7.5	6	79
9.0	7	89
10.5	8	98
12.0	10	118
13.5	13	147
15.0	15	166
16.5	15	166
18.0	17	186
19.5	17	186
21.0	17	186
22.5	15	166
24.0	14	157
25..5		



David Willet / 17-Sep-2024
Signed by / Date

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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

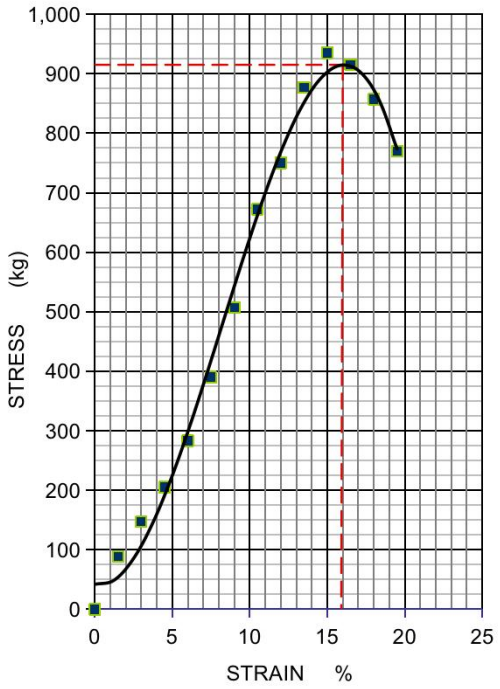
CLIENT	:		LAB REPORT N°	:	A 297
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA11
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.0	Max Load (Kg)	915
Area (cm2)	13.85		
Volume (cm3)	110.84	Stress (%)	15.90
Mass (g)	206.7		
Moisture Content (%)	1.9	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.86		
Dry Density (gr/cm3)	1.83	Strength (Kg/cm2)	**66.0**

Failure Mode		Notes
		Water content as received
Type	1	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	7	89
3.0	13	147
4.5	19	205
6.0	27	283
7.5	38	390
9.0	50	507
10.5	67	672
12.0	75	750
13.5	88	877
15.0	94	935
16.5	92	916
18.0	86	857
19.5	77	770
21.0		



David Willet / 17-Sep-2024
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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

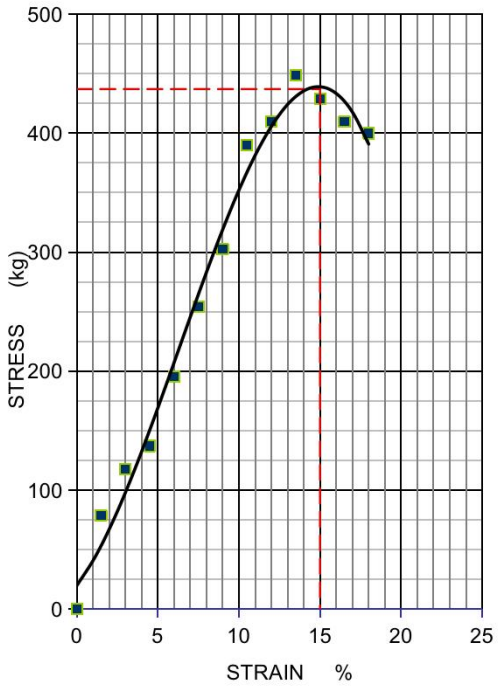
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 298
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Sandy Limestone	SAMPLE N° .	:	SA4
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.2	Max Load (Kg)	437
Area (cm2)	13.85		
Volume (cm3)	113.61	Stress (%)	15.00
Mass (g)	197.4		
Moisture Content (%)	2.2	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.74		
Dry Density (gr/cm3)	1.70	Strength (Kg/cm2)	**31.5**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	6	79
3.0	10	118
4.5	12	137
6.0	18	196
7.5	24	254
9.0	29	303
10.5	38	390
12.0	40	410
13.5	44	449
15.0	42	429
16.5	40	410
18.0	39	400
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	1	
		1) Diagonal shear plane(s)
Degrees:	14	
		2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



Comments

David Willet / 17-Sep-2024
Signed by / Date

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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

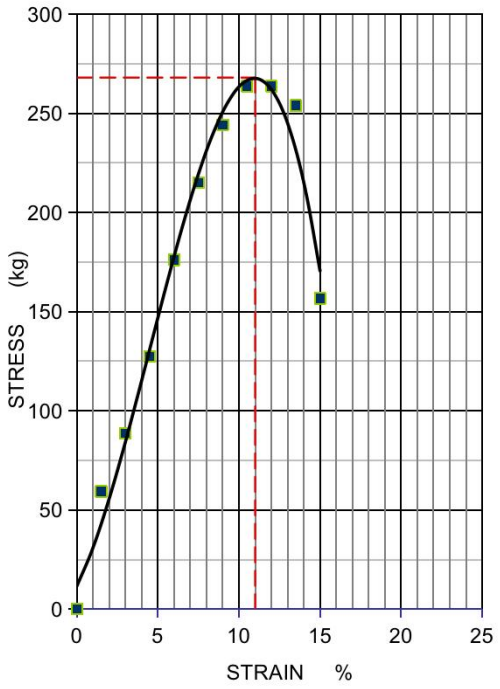
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 299
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Sandy Limestone	SAMPLE N° .	:	SA10
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.0	Max Load (Kg)	268
Area (cm2)	13.85		
Volume (cm3)	110.84	Stress (%)	11.00
Mass (g)	219.3		
Moisture Content (%)	2.4	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.98		
Dry Density (gr/cm3)	1.93	Strength (Kg/cm2)	**19.3**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	4	59
3.0	7	89
4.5	11	127
6.0	16	176
7.5	20	215
9.0	23	244
10.5	25	264
12.0	25	264
13.5	24	254
15.0	14	157
16.5		
18.0		
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	4	
		1) Diagonal shear plane(s)
Degrees:	14	
		2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



Comments

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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

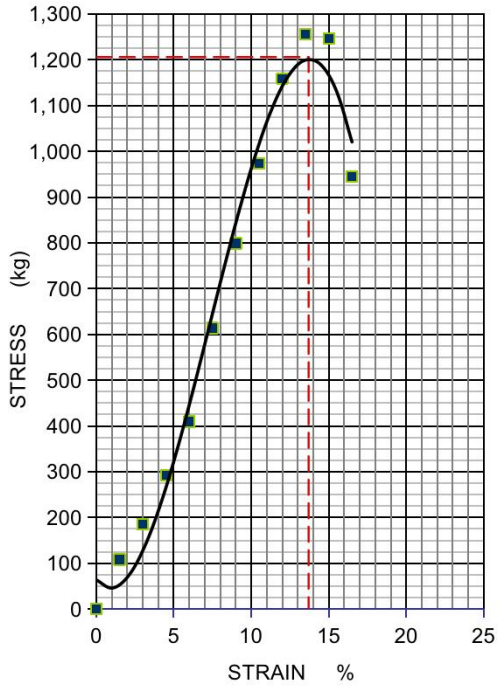
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 300
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA10
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.3	Max Load (Kg)	1206
Area (cm2)	13.85		
Volume (cm3)	114.99	Stress (%)	13.70
Mass (g)	218.3		
Moisture Content (%)	2.1	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.90		
Dry Density (gr/cm3)	1.86	Strength (Kg/cm2)	**87.0**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	9	108
3.0	17	186
4.5	28	293
6.0	40	410
7.5	61	614
9.0	80	799
10.5	98	974
12.0	117	1159
13.5	127	1256
15.0	126	1246
16.5	95	945
18.0		
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	1	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



Comments

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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

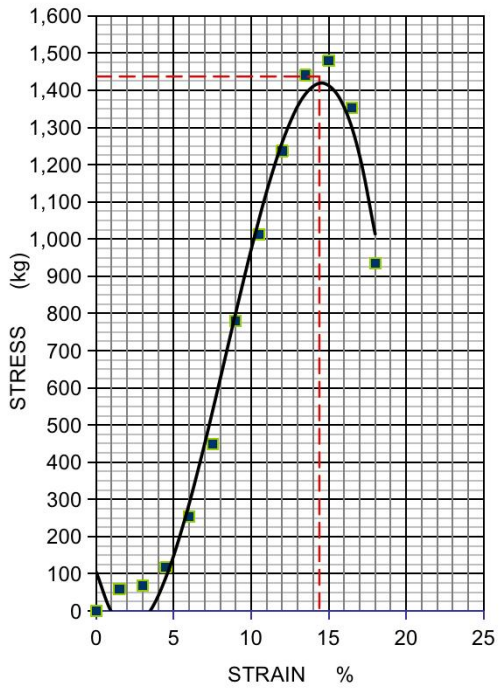
CLIENT	:		LAB REPORT N°	:	A 301
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA11
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.1	Max Load (Kg)	1437
Area (cm2)	13.85		
Volume (cm3)	112.22	Stress (%)	14.40
Mass (g)	215.6		
Moisture Content (%)	1.9	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.92		
Dry Density (gr/cm3)	1.89	Strength (Kg/cm2)	**103.7**

Failure Mode		Notes
		Water content as received
Type	2	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	4	59
3.0	5	69
4.5	10	118
6.0	24	254
7.5	44	449
9.0	78	779
10.5	102	1013
12.0	125	1237
13.5	146	1441
15.0	150	1480
16.5	137	1353
18.0	94	935
19.5		
21.0		



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

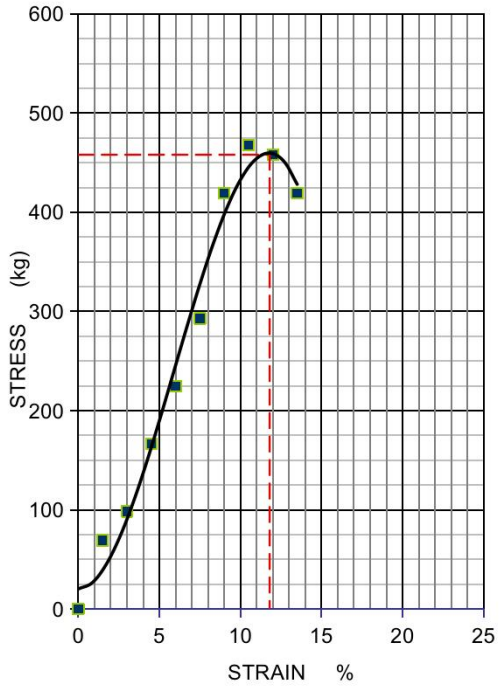
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 302
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Coral Stone	SAMPLE N° .	:	SA6
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.1	Max Load (Kg)	458
Area (cm2)	13.85		
Volume (cm3)	112.22	Stress (%)	11.80
Mass (g)	154.2		
Moisture Content (%)	2.2	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.37		
Dry Density (gr/cm3)	1.34	Strength (Kg/cm2)	**33.1**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	5	69
3.0	8	98
4.5	15	166
6.0	21	225
7.5	28	293
9.0	41	419
10.5	46	468
12.0	45	458
13.5	41	419
15.0		
16.5		
18.0		
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	2	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

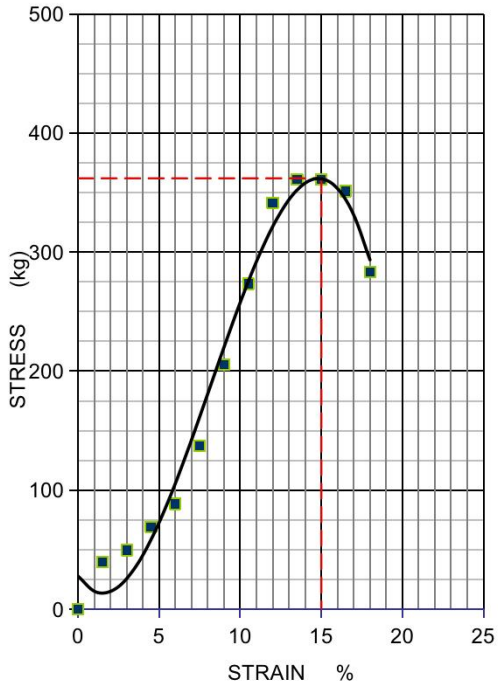
CLIENT	:		LAB REPORT N°	:	A 303
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Coral Stone	SAMPLE N° .	:	
BORE HOLE N°	:		SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:	1000D	DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.0	Max Load (Kg)	362
Area (cm2)	13.85		
Volume (cm3)	110.84	Stress (%)	15.00
Mass (g)	128.4		
Moisture Content (%)	2.3	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.16		
Dry Density (gr/cm3)	1.13	Strength (Kg/cm2)	**26.1**

Failure Mode		Notes
		Water content as received
Type	4	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	2	40
3.0	3	50
4.5	5	69
6.0	7	89
7.5	12	137
9.0	19	205
10.5	26	273
12.0	33	342
13.5	35	361
15.0	35	361
16.5	34	351
18.0	27	283
19.5		
21.0		



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

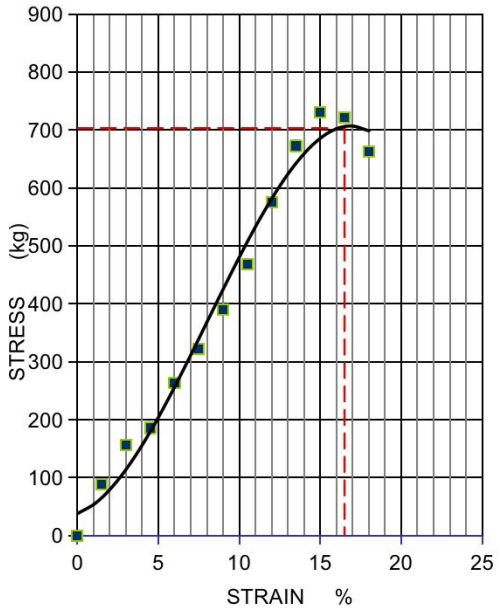
CLIENT	:		LAB REPORT N°	:	A 304
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Coral Stone	SAMPLE N° .	:	SA6
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.2	Max Load (Kg)	703
Area (cm2)	13.85		
Volume (cm3)	113.61	Stress (%)	16.50
Mass (g)	182.6		
Moisture Content (%)	2.6	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.61		
Dry Density (gr/cm3)	1.57	Strength (Kg/cm2)	**50.7**

Failure Mode		Notes
		Water content as received
Type	3	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	7	89
3.0	14	157
4.5	17	186
6.0	25	264
7.5	31	322
9.0	38	390
10.5	46	468
12.0	57	575
13.5	67	672
15.0	73	731
16.5	72	721
18.0	66	663
19.5		
21.0		
22.5		
24.0		



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

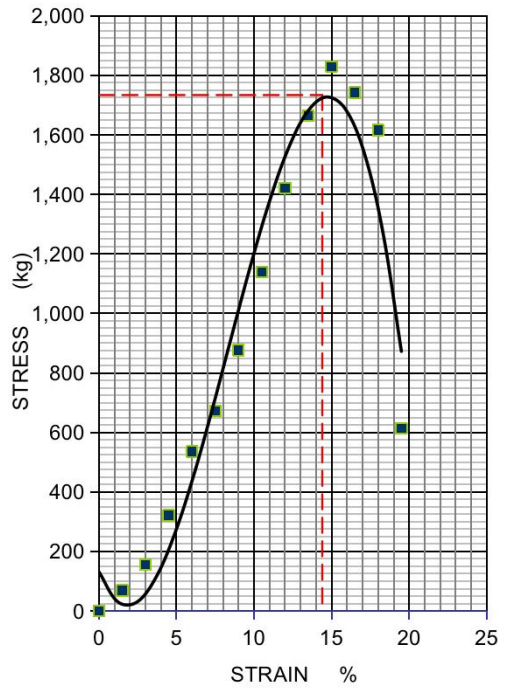
CLIENT	:		LAB REPORT N°	:	A 305
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA8
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.2	Max Load (Kg)	1734
Area (cm2)	13.85		
Volume (cm3)	113.61	Stress (%)	14.40
Mass (g)	215.9		
Moisture Content (%)	2.3	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.90		
Dry Density (gr/cm3)	1.86	Strength (Kg/cm2)	**125.2**

Failure Mode		Notes
		Water content as received
Type	2	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	5	69
3.0	14	157
4.5	31	322
6.0	53	536
7.5	67	672
9.0	88	877
10.5	115	1139
12.0	144	1422
13.5	169	1665
15.0	186	1830
16.5	177	1743
18.0	164	1616
19.5	61	614
21.0		



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

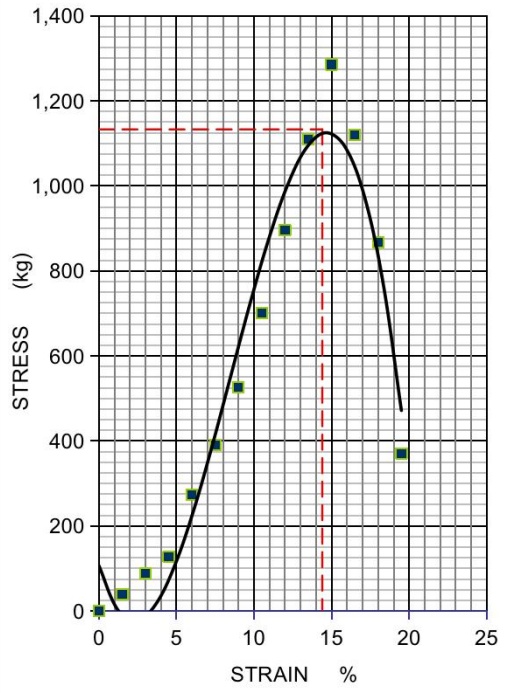
CLIENT	:		LAB REPORT N°	:	A 306
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	16-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA11
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.2	Max Load (Kg)	1133
Area (cm2)	13.85		
Volume (cm3)	113.61	Stress (%)	14.40
Mass (g)	203.5		
Moisture Content (%)	2.4	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.79		
Dry Density (gr/cm3)	1.75	Strength (Kg/cm2)	**81.8**

Failure Mode		Notes
		Water content as received
Type	1	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	2	40
3.0	7	89
4.5	11	127
6.0	26	273
7.5	38	390
9.0	52	526
10.5	70	702
12.0	90	896
13.5	112	1110
15.0	130	1285
16.5	113	1120
18.0	87	867
19.5	36	371
21.0		



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

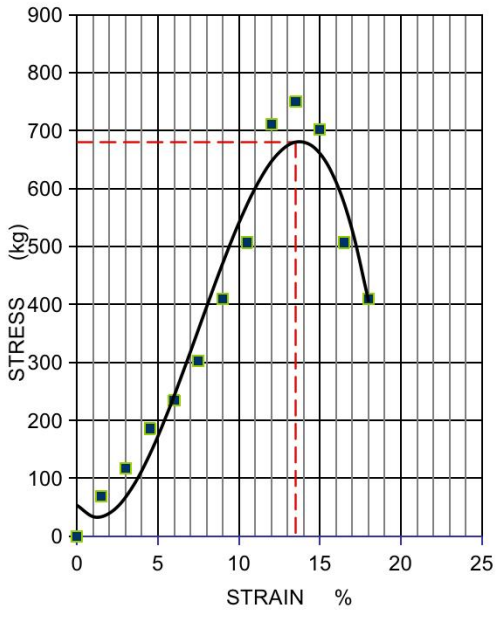
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 307
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	17-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA6
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.0	Max Load (Kg)	680
Area (cm2)	13.85		
Volume (cm3)	110.84	Stress (%)	13.50
Mass (g)	195.2		
Moisture Content (%)	3.0	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.76		
Dry Density (gr/cm3)	1.71	Strength (Kg/cm2)	**49.1**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	5	69
3.0	10	118
4.5	17	186
6.0	22	234
7.5	29	303
9.0	40	410
10.5	50	507
12.0	71	711
13.5	75	750
15.0	70	702
16.5	50	507
18.0	40	410
19.5		
21.0		
22.5		
24.0		

Failure Mode		Notes
		Water content as received
Type	3	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

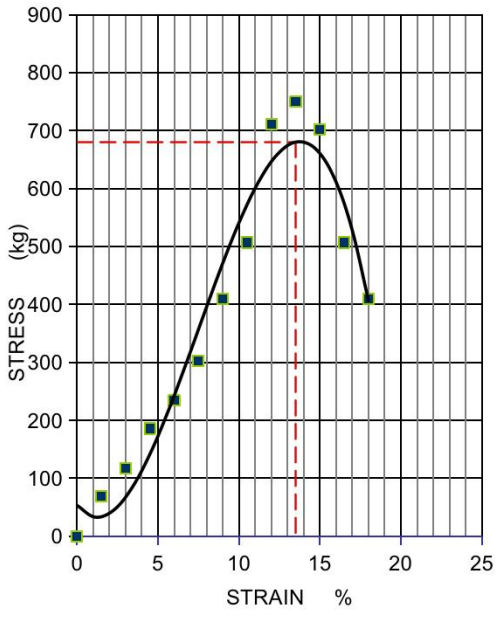
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 308
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	17-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA8
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.0	Max Load (Kg)	680
Area (cm2)	13.85		
Volume (cm3)	110.84	Stress (%)	13.50
Mass (g)	195.2		
Moisture Content (%)	3.0	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.76		
Dry Density (gr/cm3)	1.71	Strength (Kg/cm2)	**49.1**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	5	69
3.0	10	118
4.5	17	186
6.0	22	234
7.5	29	303
9.0	40	410
10.5	50	507
12.0	71	711
13.5	75	750
15.0	70	702
16.5	50	507
18.0	40	410
19.5		
21.0		
22.5		
24.0		

Failure Mode		Notes
		Water content as received
Type	1	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

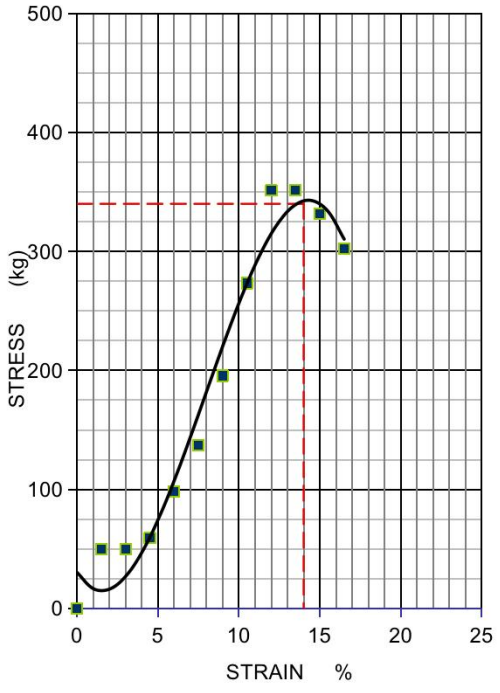
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 309
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	17-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	
BORE HOLE N°	:		SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.3	Max Load (Kg)	340
Area (cm2)	13.85		
Volume (cm3)	114.99	Stress (%)	14.00
Mass (g)	198.1		
Moisture Content (%)	2.5	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.72		
Dry Density (gr/cm3)	1.68	Strength (Kg/cm2)	**24.5**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	3	50
3.0	3	50
4.5	4	59
6.0	8	98
7.5	12	137
9.0	18	196
10.5	26	273
12.0	34	351
13.5	34	351
15.0	32	332
16.5	29	303
18.0		20
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	3	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



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STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

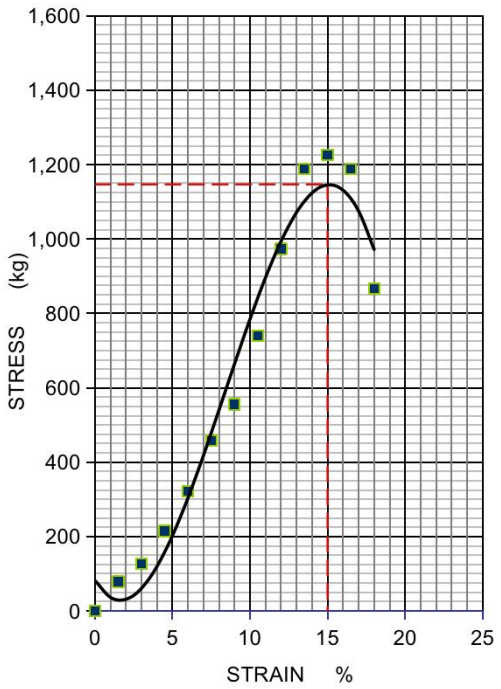
CLIENT	:		LAB REPORT N°	:	A 310
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	17-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA11
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.0	Max Load (Kg)	1147
Area (cm2)	13.85		
Volume (cm3)	110.84	Stress (%)	15.00
Mass (g)	230.4		
Moisture Content (%)	1.9	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	2.08		
Dry Density (gr/cm3)	2.04	Strength (Kg/cm2)	**82.8**

Failure Mode		Notes
		Water content as received
Type	1	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	6	79
3.0	11	127
4.5	20	215
6.0	31	322
7.5	45	458
9.0	55	556
10.5	74	740
12.0	98	974
13.5	120	1188
15.0	124	1227
16.5	120	1188
18.0	87	867
19.5		
21.0		



David Willett / 18-Sep-2024

Signed by / Date

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Checked & Approved by / Date

STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

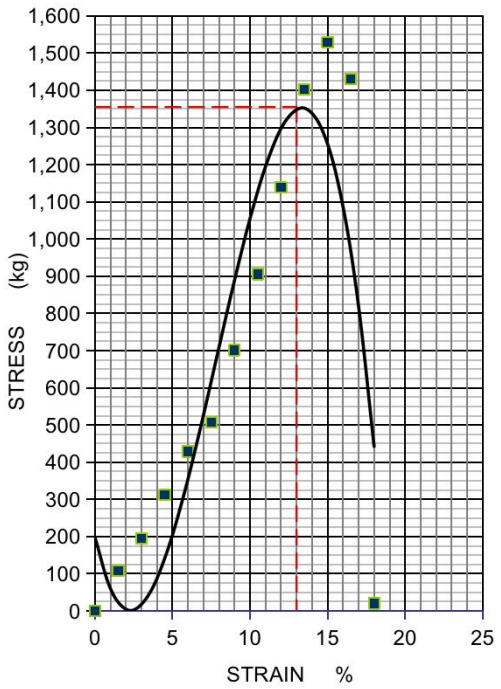
CLIENT	:		LAB REPORT N°	:	A 311
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	17-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA9
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.1	Max Load (Kg)	1355
Area (cm2)	13.85		
Volume (cm3)	112.22	Stress (%)	13.00
Mass (g)	206.1		
Moisture Content (%)	2.2	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.84		
Dry Density (gr/cm3)	1.80	Strength (Kg/cm2)	**97.8**

Failure Mode		Notes
		Water content as received
Type	2	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	9	108
3.0	18	196
4.5	30	312
6.0	42	429
7.5	50	507
9.0	70	702
10.5	91	906
12.0	115	1139
13.5	142	1402
15.0	155	1529
16.5	145	1431
18.0	0	20
19.5		
21.0		



David Willett / 18-Sep-2024

Signed by / Date

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Checked & Approved by / Date

STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

(SPECIFICATION ASTM D7012-04)

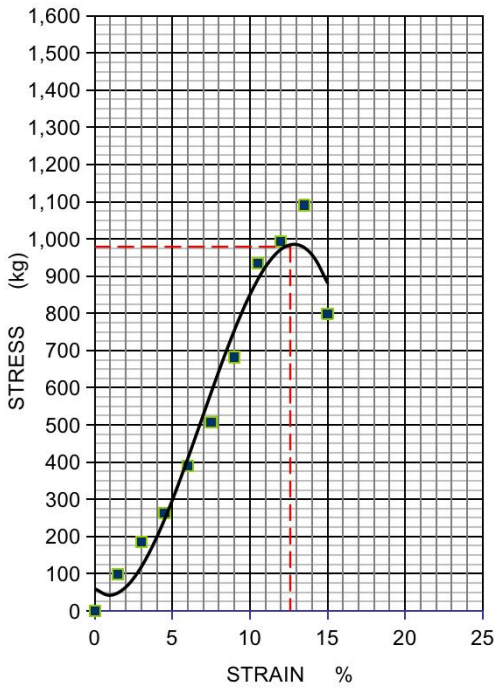
CLIENT	:		LAB REPORT N°	:	A 312
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	17-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SA 4
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:		DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.3	Max Load (Kg)	979
Area (cm2)	13.85		
Volume (cm3)	114.99	Stress (%)	12.60
Mass (g)	214.3		
Moisture Content (%)	2.3	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.86		
Dry Density (gr/cm3)	1.82	Strength (Kg/cm2)	**70.7**

Failure Mode		Notes
		Water content as received
Type	1	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

Comments

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	8	98
3.0	17	186
4.5	25	264
6.0	38	390
7.5	50	507
9.0	68	682
10.5	94	935
12.0	100	993
13.5	110	1091
15.0	80	799
16.5		
18.0		
19.5		
21.0		



David Willett / 18-Sep-2024
Signed by / Date

/
Checked & Approved by / Date

STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

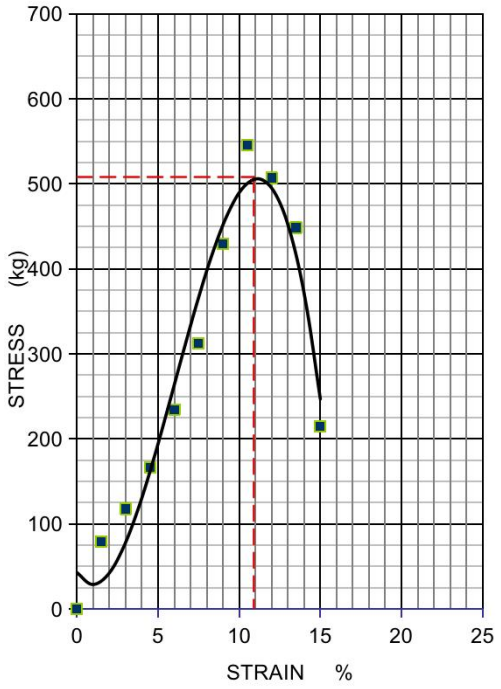
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 313
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	17-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SM 4
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:	9'-8" to 15'-0"	DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.0	Max Load (Kg)	508
Area (cm2)	13.85		
Volume (cm3)	110.84	Stress (%)	10.90
Mass (g)	181.5		
Moisture Content (%)	2.0	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.64		
Dry Density (gr/cm3)	1.61	Strength (Kg/cm2)	**36.7**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	6	79
3.0	10	118
4.5	15	166
6.0	22	234
7.5	30	312
9.0	42	429
10.5	54	546
12.0	50	507
13.5	44	449
15.0	20	215
16.5		
18.0		
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	2	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other



Comments

David Willett / 18-Sep-2024
Signed by / Date

/
Checked & Approved by / Date

STANDARD TEST METHOD FOR UNCONFINED COMPRESSIVE STRENGH OF INTACT ROCK CORE

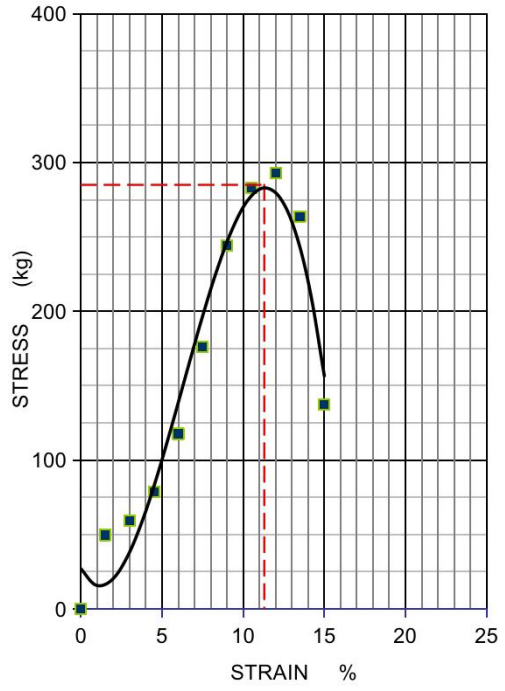
(SPECIFICATION ASTM D7012-04)

CLIENT	:		LAB REPORT N°	:	A 314
PROJECT	:		TECHNICIAN	:	David Willet
LOCATION	:	Rosewood Barbuda	DATE TESTED	:	17-Sep-2024
MATERIAL	:	Clay Sandstone	SAMPLE N° .	:	SM 7
BORE HOLE N°	:	01	SAMPLED BY	:	E. Zacharia
SANPLE DEPTH	:	27'-3" to 32'-2"	DATE SAMPLED	:	19 July 2024

Sample Measurements		Testing Results	
Diameter (cm)	4.2		
Height (cm)	8.1	Max Load (Kg)	285
Area (cm2)	13.85		
Volume (cm3)	112.22	Stress (%)	11.30
Mass (g)	156.8		
Moisture Content (%)	2.4	Pace Rate (kg/s)	1.25
Wet Density (gr/cm3)	1.40		
Dry Density (gr/cm3)	1.36	Strength (Kg/cm2)	**20.6**

Strain %	Dial (div	Stress (kg)
0.0	0	0
1.5	3	50
3.0	4	59
4.5	6	79
6.0	10	118
7.5	16	176
9.0	23	244
10.5	27	283
12.0	28	293
13.5	25	264
15.0	12	137
16.5		
18.0		
19.5		
21.0		

Failure Mode		Notes
		Water content as received
Type	3	1) Diagonal shear plane(s)
Degrees:	14	2) Vertical fracture(s)
Deformation Dial: 1 unit = 0.10mm		(3) Vertical splitting
Proving Ring No: 1155-16-20314C		4) Shear along foliation /discontinuity
Load Dial: 1 unit = 9.7299512		(5) Conical
		6) Spalling
		(7) Other

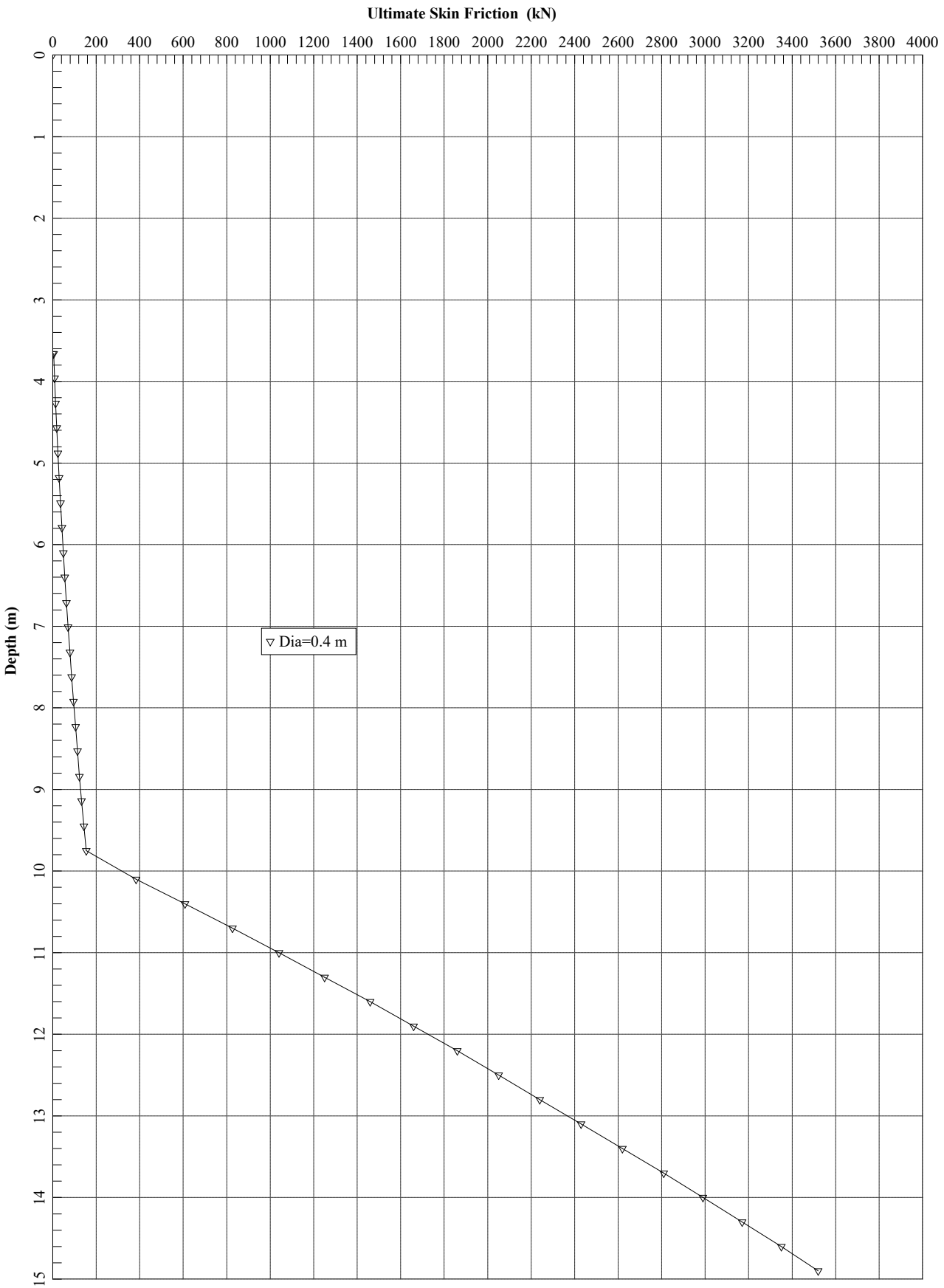


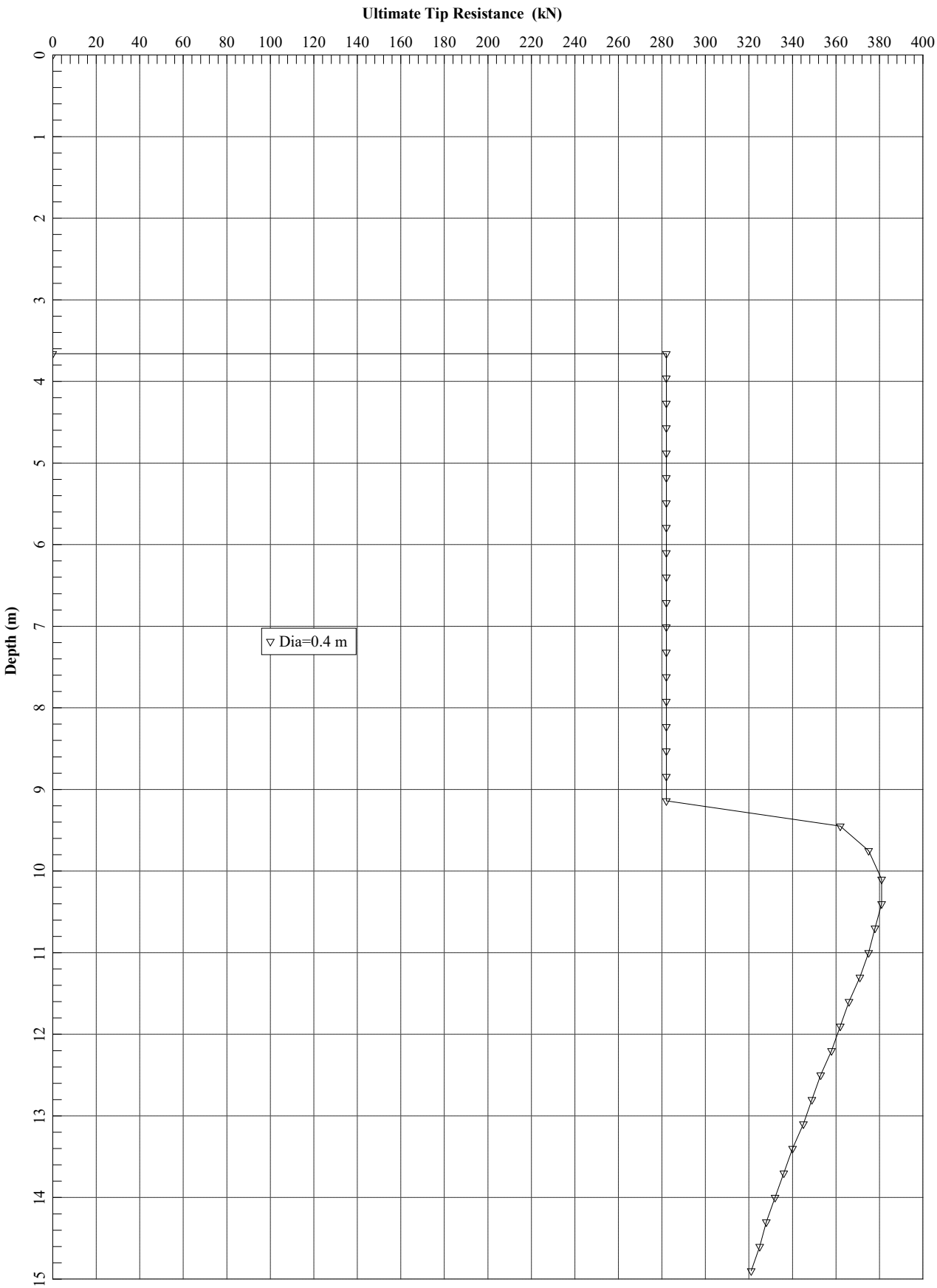
Comments

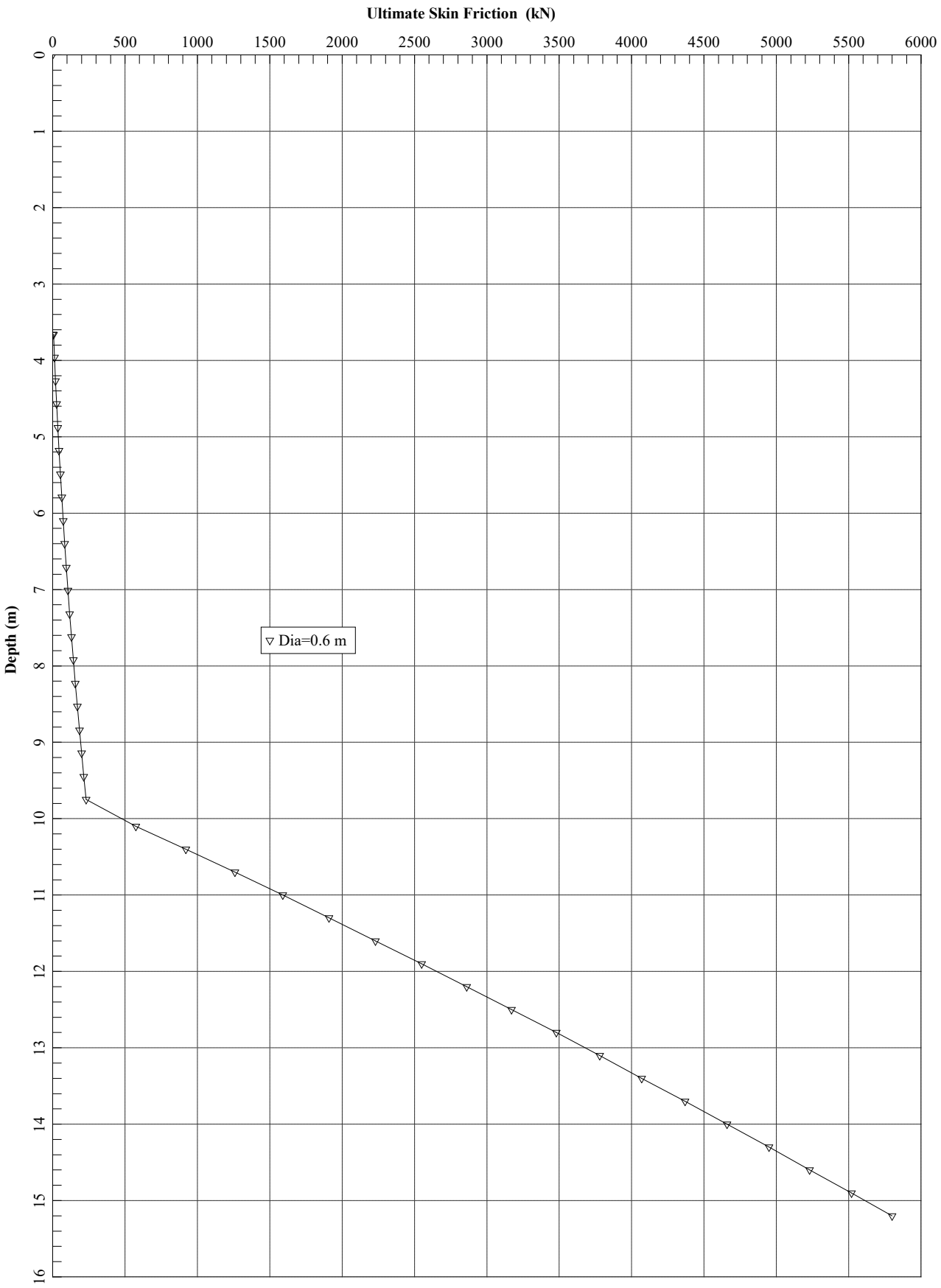
David Willett / 18-Sep-2024
Signed by / Date

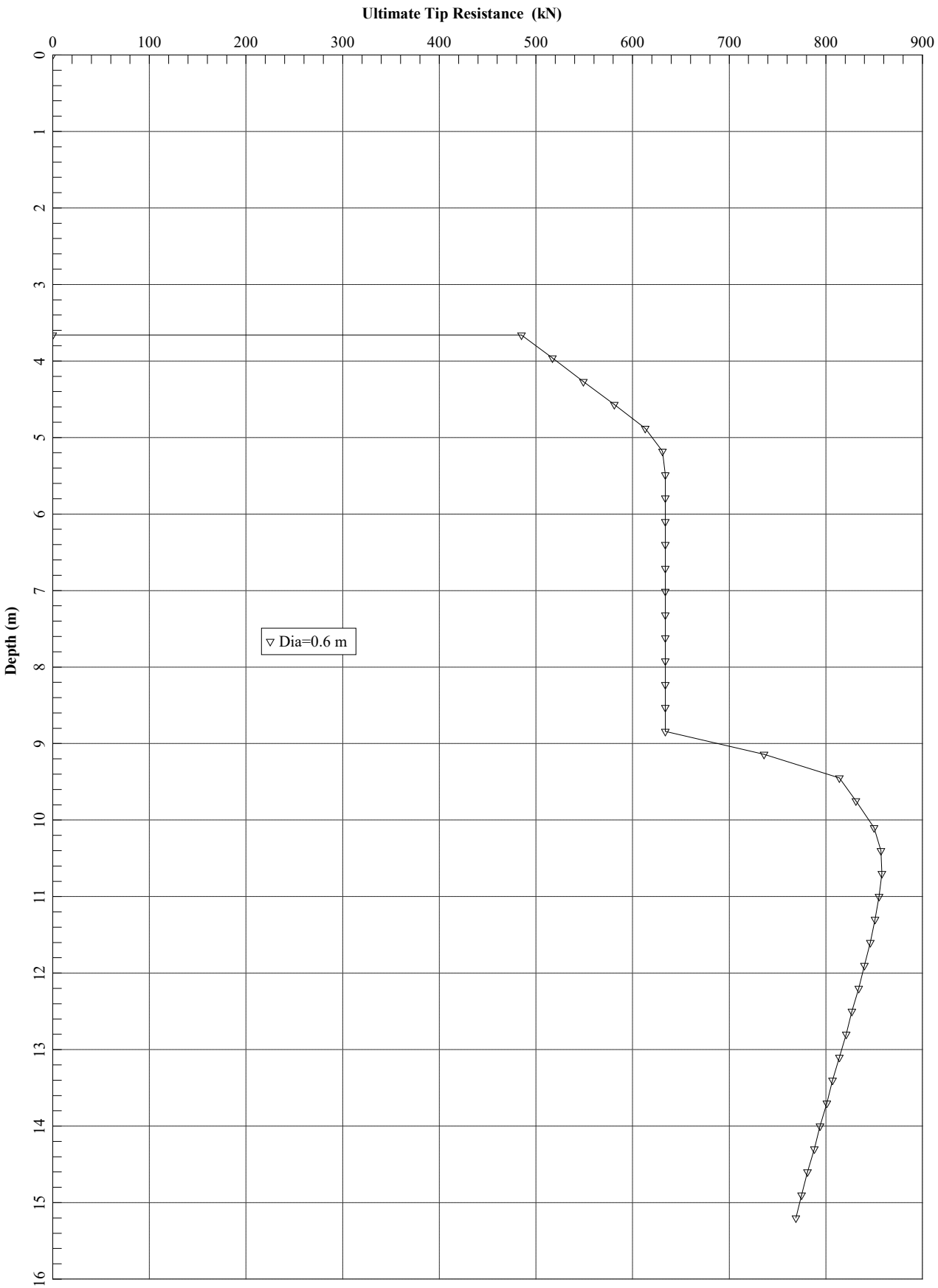
/
Checked & Approved by / Date

APPENDIX II


Ultimate Skin Friction (kN)
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Dia=0.4 m


Ultimate Tip Resistance (kN)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380
400
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Dia=0.4 m


Ultimate Skin Friction (kN)
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Dia=0.6 m


Ultimate Tip Resistance (kN)
0
100
200
300
400
500
600
700
800
900
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
Dia=0.6 m

APPENDIX III

```
=========================================================================

                  SHAFT for Windows, Version 2017.8.11

                   Serial Number :  156316401

                VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                 (c) Copyright ENSOFT, Inc., 1987-2017
                       All Rights Reserved

=========================================================================

     Path to file locations      : C:\Users\mjjoa\OneDrive\Surface Pro 3 Backup\Work
Folder\Project Files\Analysis\
     Name of input data file     : 24146 (0.6 auger).sf8d
     Name of output file         : 24146 (0.6 auger).sf8o
     Name of plot output file    : 24146 (0.6 auger).sf8p
     Name of runtime file        : 24146 (0.6 auger).sf8r

     -------------------------------------------------------------------------
                         Time and Date of Analysis
     -------------------------------------------------------------------------

               Date:  December 05, 2024     Time:  07:19:20

     GA 24 146 - Soil Investigation for Murbee Development


     PROPOSED DEPTH =      15.0 M
     ----------------


     NUMBER OF LAYERS =    2
     ------------------


     WATER TABLE DEPTH =       0.0 M
     -------------------



     FACTOR OF SAFETY APPLIED TO THE ULTIMATE SIDE FRICTION CAPACITY = 2.50
     ---------------------------------------------------------
     FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 3.00
     -----------------------------------------------------


     SOIL INFORMATION
```

LAYER NO 1----SAND

AT THE TOP

SIDE FRICTION PROCEDURE: Ko METHOD
LATERAL EARTH-PRESSURE COEFFICIENT - Ko = 0.370E+00
INTERNAL FRICTION ANGLE, DEG. = 0.450E+02 (*)
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.390E+02
SOIL UNIT WEIGHT, KN/CU M = 0.180E+02
MAXIMUM LOAD TRANSFER FOR SOIL, KN/SQ M = 0.100E+11
DEPTH, M = 0.000E+00

AT THE BOTTOM

SIDE FRICTION PROCEDURE: Ko METHOD
LATERAL EARTH-PRESSURE COEFFICIENT - Ko = 0.370E+00
INTERNAL FRICTION ANGLE, DEG. = 0.426E+02 (*)
BLOWS PER FOOT FROM STANDARD PENETRATION TEST = 0.390E+02
SOIL UNIT WEIGHT, KN/CU M = 0.180E+02
MAXIMUM LOAD TRANSFER FOR SOIL, KN/SQ M = 0.100E+11
DEPTH, M = 0.990E+01

LAYER NO 2----WEAK ROCK

AT THE TOP

DIAMETER OF SOCKET, M = 0.600E+00
SLUMP OF CONCRETE, M = 0.150E+00
ANGLE OF INTERFACE FRICTION, DEG. = 0.300E+02
UNIAXIAL COMPRESSION STRENGTH OF ROCK,KN/SQ M = 0.310E+04
ELASTIC MODULUS FOR THE INTACT ROCK, KN/SQ M = 0.350E+07
ROCK QUALITY DESIGNATION (RQD) % = 0.200E+02
DEPTH, M = 0.990E+01

AT THE BOTTOM

DIAMETER OF SOCKET, M = 0.600E+00
SLUMP OF CONCRETE, M = 0.150E+00
ANGLE OF INTERFACE FRICTION, DEG. = 0.300E+02
UNIAXIAL COMPRESSION STRENGTH OF ROCK,KN/SQ M = 0.310E+04
ELASTIC MODULUS FOR THE INTACT ROCK, KN/SQ M = 0.350E+07
ROCK QUALITY DESIGNATION (RQD) % = 0.200E+02
DEPTH, M = 0.180E+02

(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS

INPUT DRILLED SHAFT INFORMATION

 MINIMUM SHAFT DIAMETER   =   0.600 M
 MAXIMUM SHAFT DIAMETER   =   0.600 M
 RATIO BASE/SHAFT DIAMETER =   0.000 M
 ANGLE OF BELL   =   0.000 DEG.
 IGNORED TOP PORTION   =   3.500 M
 IGNORED BOTTOM PORTION   =   0.000 M
 ELASTIC MODULUS, Ec   = 0.300E+08 KN/SQ M

COMPUTATION RESULTS

- CASE ANALYZED   :   1
  VARIATION LENGTH   :   1
  VARIATION DIAMETER :   1

DRILLED SHAFT INFORMATION

 DIAMETER OF STEM   =   0.600 M
 DIAMETER OF BASE   =   0.600 M
 END OF STEM TO BASE   =   0.000 M
 ANGLE OF BELL   =   0.000 DEG.
 IGNORED TOP PORTION   =   3.500 M
 IGNORED BOTTOM PORTION   =   0.000 M
 AREA OF ONE PERCENT STEEL =   0.003 SQ. M
 ELASTIC MODULUS, Ec   = 0.300E+08 KN/SQ M
 VOLUME OF UNDERREAM   =   0.000 CU. M
 SHAFT LENGTH   =   15.000 M

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY
APPLIED TO THE ULTIMATE BASE RESISTANCE;
QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY
APPLIED TO THE ULTIMATE SIDE RESISTANCE AND
THE ULTIMATE BASE RESISTANCE.

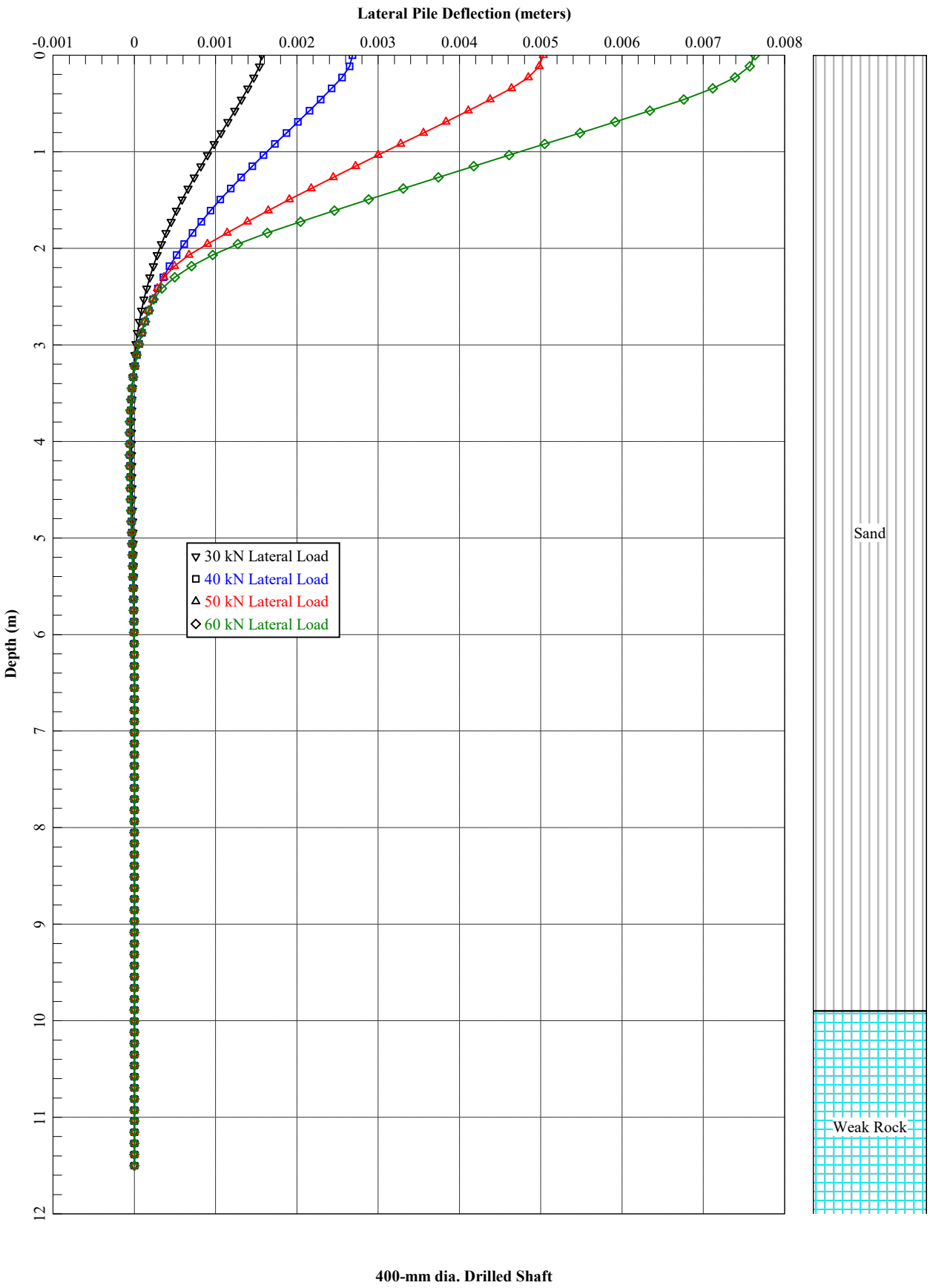
LENGTH (M)	VOLUME (CU.M)	QS (KN)	QB (KN)	QU (KN)	QBD (KN)	QDN (KN)	QU/VOLUME (KN /CU.M)
3.7	1.0	6.2	484.6	490.8	167.7	164.0	474.46
4.0	1.1	12.8	516.8	529.6	185.1	177.4	472.65
4.3	1.2	20.0	549.0	569.0	203.0	191.0	471.50
4.6	1.3	27.7	581.2	608.8	221.4	204.8	470.88
4.9	1.4	35.8	613.4	649.2	240.3	218.8	470.70
5.2	1.5	44.5	630.9	675.3	254.7	228.1	460.86
5.5	1.6	53.6	633.7	687.2	264.8	232.6	442.93
5.8	1.6	63.2	633.7	696.8	274.4	236.5	425.48
6.1	1.7	73.2	633.7	706.9	284.5	240.5	410.05
6.4	1.8	83.8	633.7	717.5	295.0	244.7	396.35
6.7	1.9	94.8	633.7	728.5	306.0	249.1	384.15
7.0	2.0	106.3	633.7	740.0	317.5	253.7	373.25
7.3	2.1	118.3	633.7	751.9	329.5	258.5	363.48
7.6	2.2	130.7	633.7	764.4	341.9	263.5	354.70
7.9	2.2	143.6	633.7	777.3	354.8	268.7	346.81
8.2	2.3	157.0	633.7	790.6	368.2	274.0	339.71
8.5	2.4	170.8	633.7	804.4	382.0	279.5	333.30
8.8	2.5	185.0	633.7	818.7	396.2	285.2	327.51
9.1	2.6	199.7	736.4	936.1	445.2	325.4	362.00
9.4	2.7	214.9	814.3	1029.2	486.3	357.4	385.15
9.8	2.8	230.5	831.3	1061.8	507.6	369.3	384.96
10.1	2.8	575.0	850.0	1425.1	858.4	513.4	500.99
10.4	2.9	919.4	856.7	1776.1	1205.0	653.3	606.04
10.7	3.0	1256.9	857.5	2114.4	1542.7	788.6	700.84
11.0	3.1	1588.2	855.2	2443.4	1873.2	920.3	787.38
11.3	3.2	1913.9	851.1	2765.0	2197.6	1049.3	866.95
11.6	3.3	2234.7	845.8	3080.6	2516.7	1175.8	940.48
11.9	3.4	2550.9	840.0	3390.9	2830.9	1300.4	1008.68
12.2	3.4	2862.9	833.7	3696.6	3140.8	1423.1	1072.13
12.5	3.5	3171.0	827.2	3998.2	3446.7	1544.1	1131.31
12.8	3.6	3475.3	820.6	4295.9	3748.9	1663.7	1186.61
13.1	3.7	3776.2	813.9	4590.1	4047.5	1781.8	1238.39
13.4	3.8	4073.8	807.3	4881.0	4342.8	1898.6	1286.94
13.7	3.9	4368.2	800.6	5168.8	4635.1	2014.1	1332.54
14.0	4.0	4659.6	794.0	5453.6	4924.3	2128.5	1375.41
14.3	4.1	4948.1	787.5	5735.7	5210.7	2241.8	1415.76
14.6	4.1	5233.9	781.1	6015.1	5494.3	2354.0	1453.79
14.9	4.2	5517.1	774.8	6291.9	5775.4	2465.1	1489.66

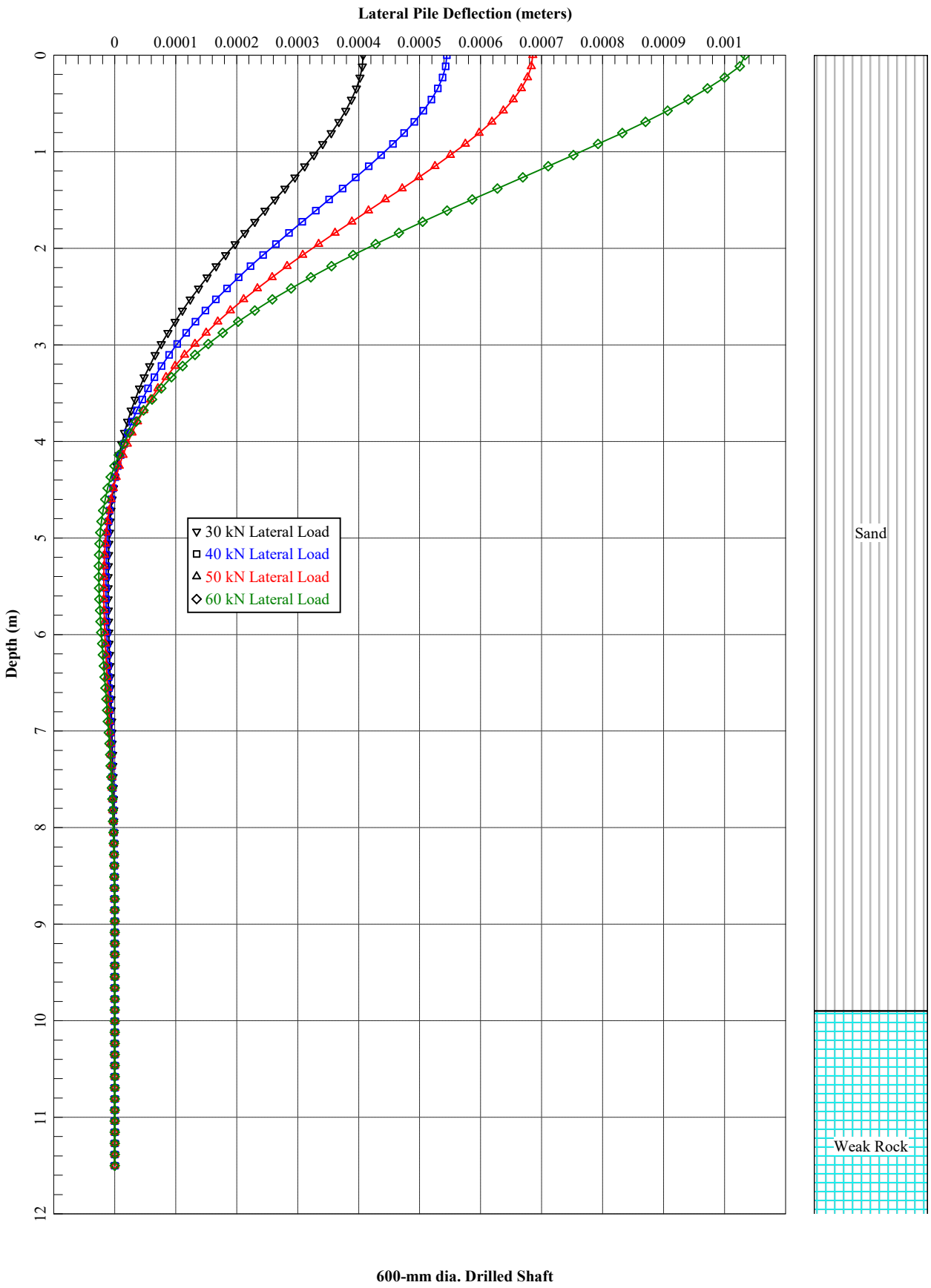
AXIAL LOAD VS SETTLEMENT CURVES

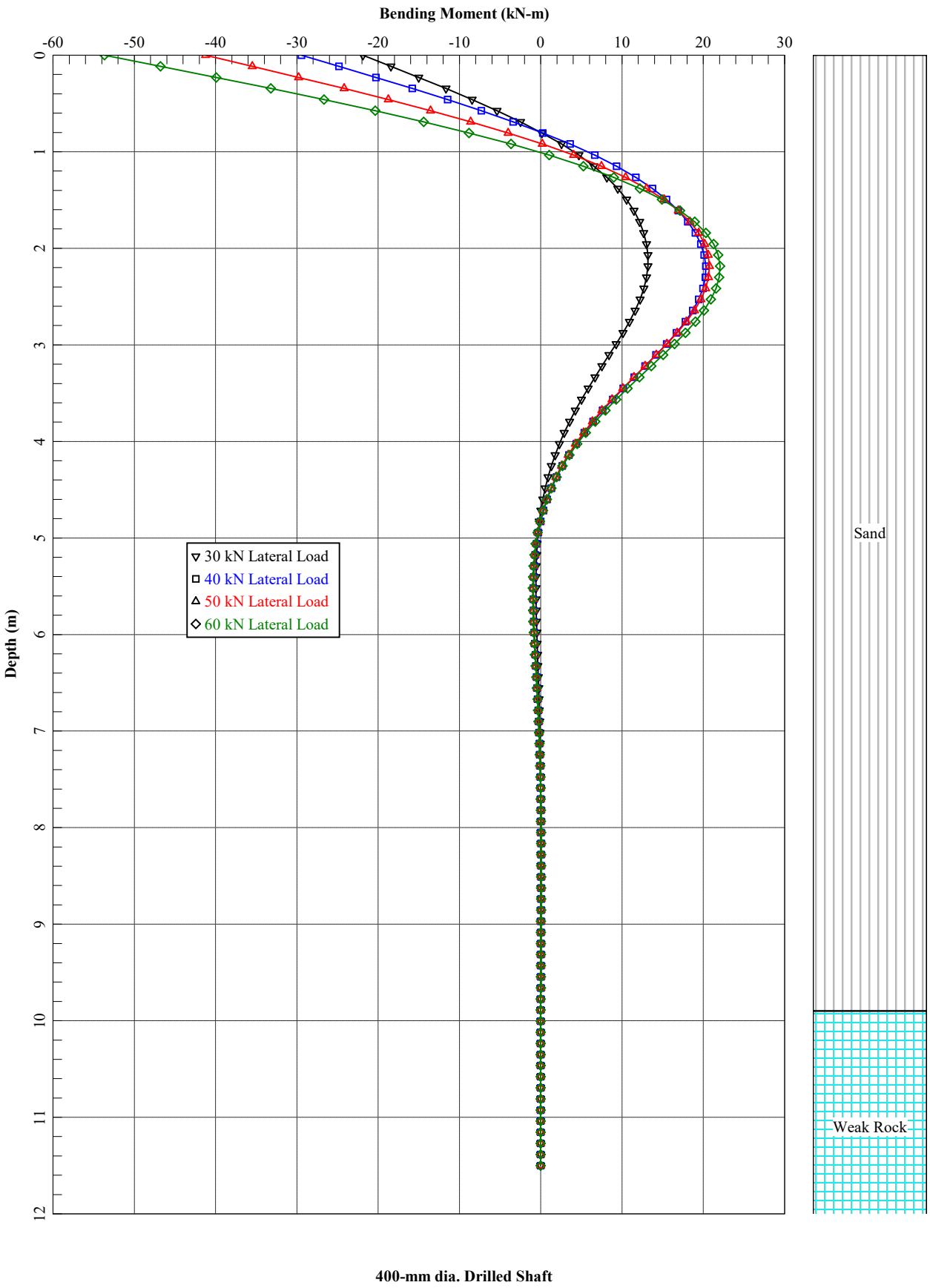
LOAD SETTLEMENT RELATIONSHIP

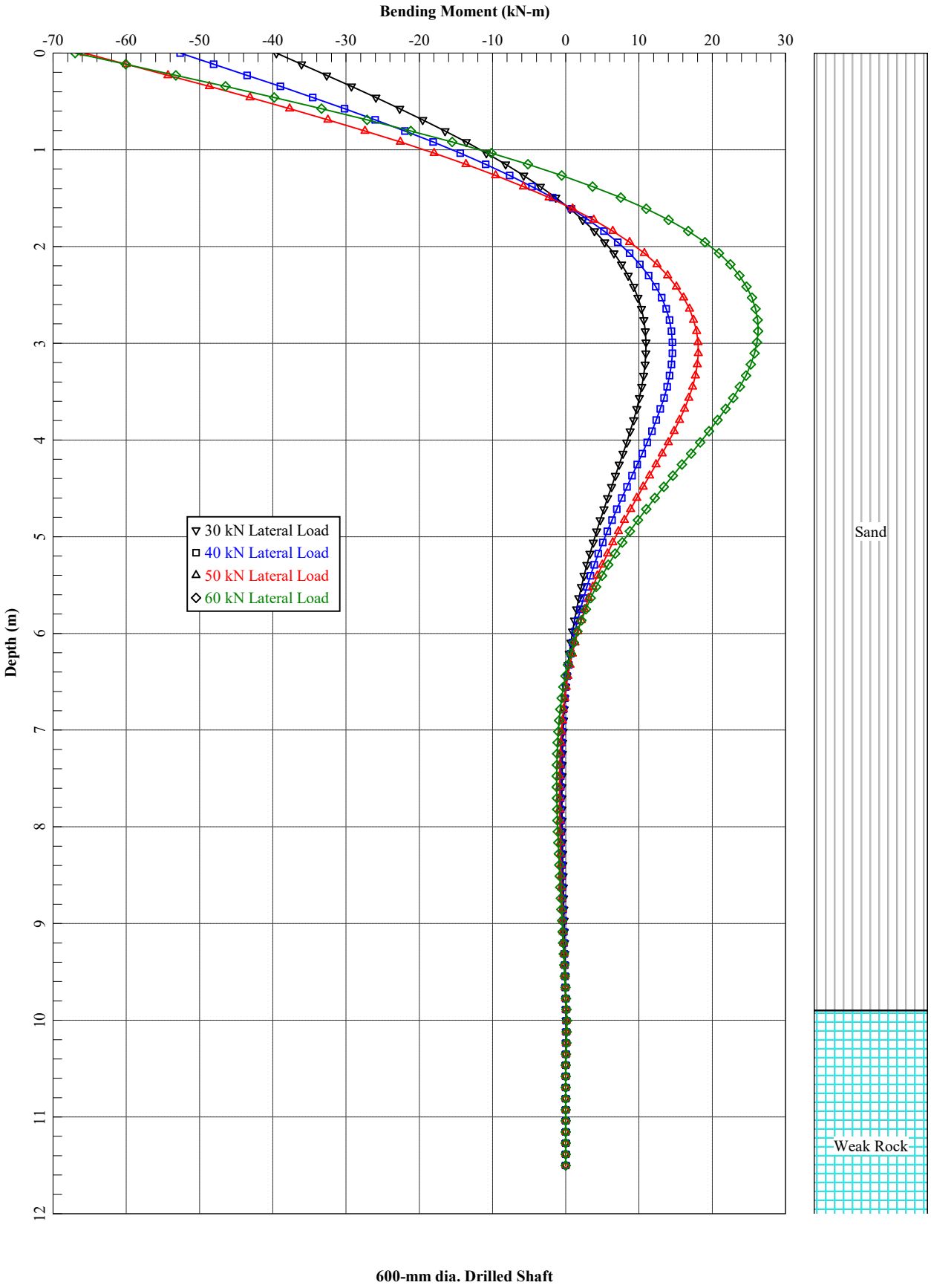
TOP LOAD kN	TOP MOVEMENT M
0.6136E+03	0.7597E-03
0.6307E+03	0.8063E-03
0.6557E+03	0.8755E-03
0.6923E+03	0.9784E-03
0.7460E+03	0.1131E-02
0.8251E+03	0.1359E-02
0.9418E+03	0.1698E-02
0.1111E+04	0.2200E-02
0.1349E+04	0.2935E-02
0.1675E+04	0.4003E-02
0.2111E+04	0.5541E-02
0.2666E+04	0.7737E-02
0.3463E+04	0.1148E-01
0.4826E+04	0.2055E-01
0.6228E+04	0.3716E-01

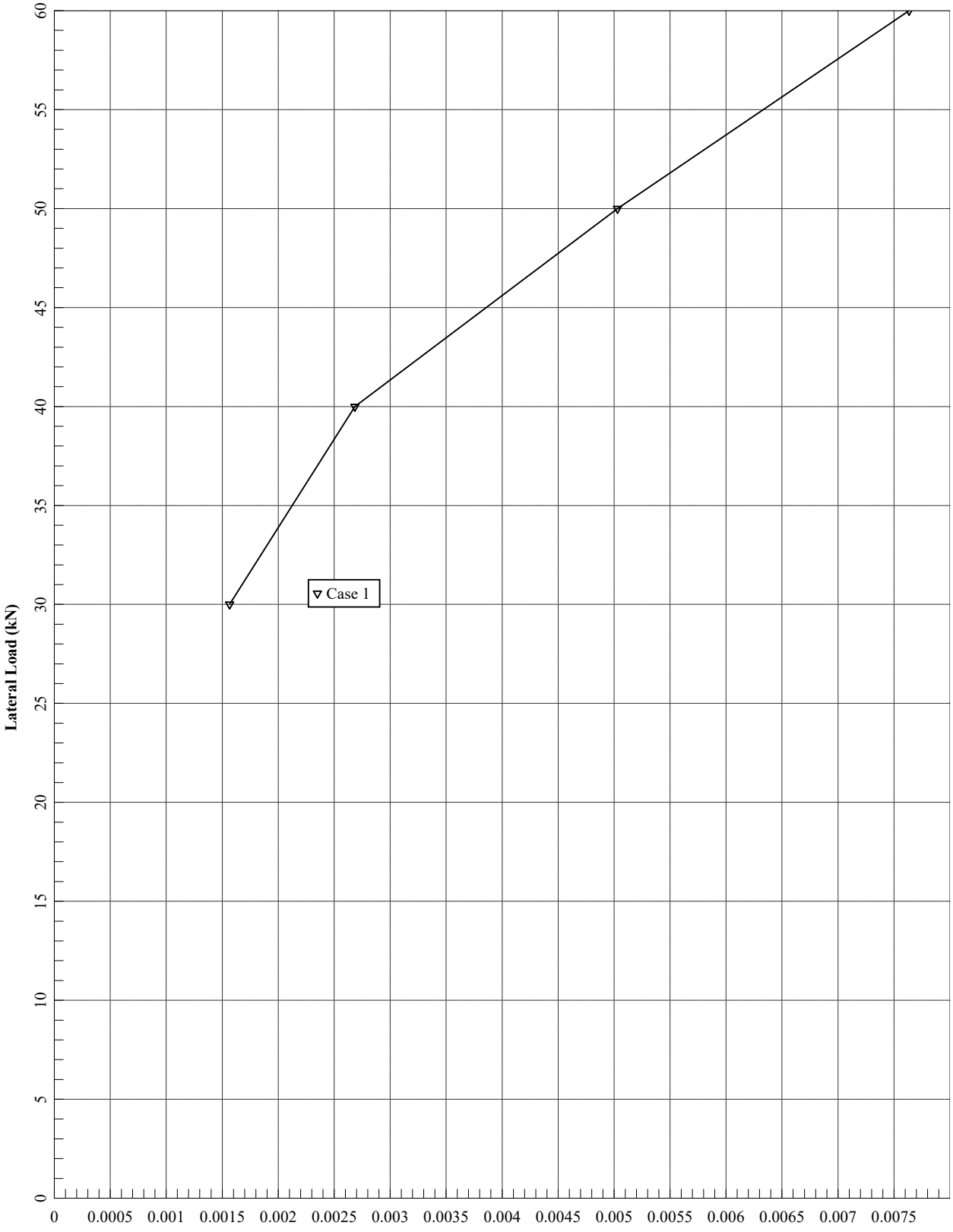
APPENDIX IV

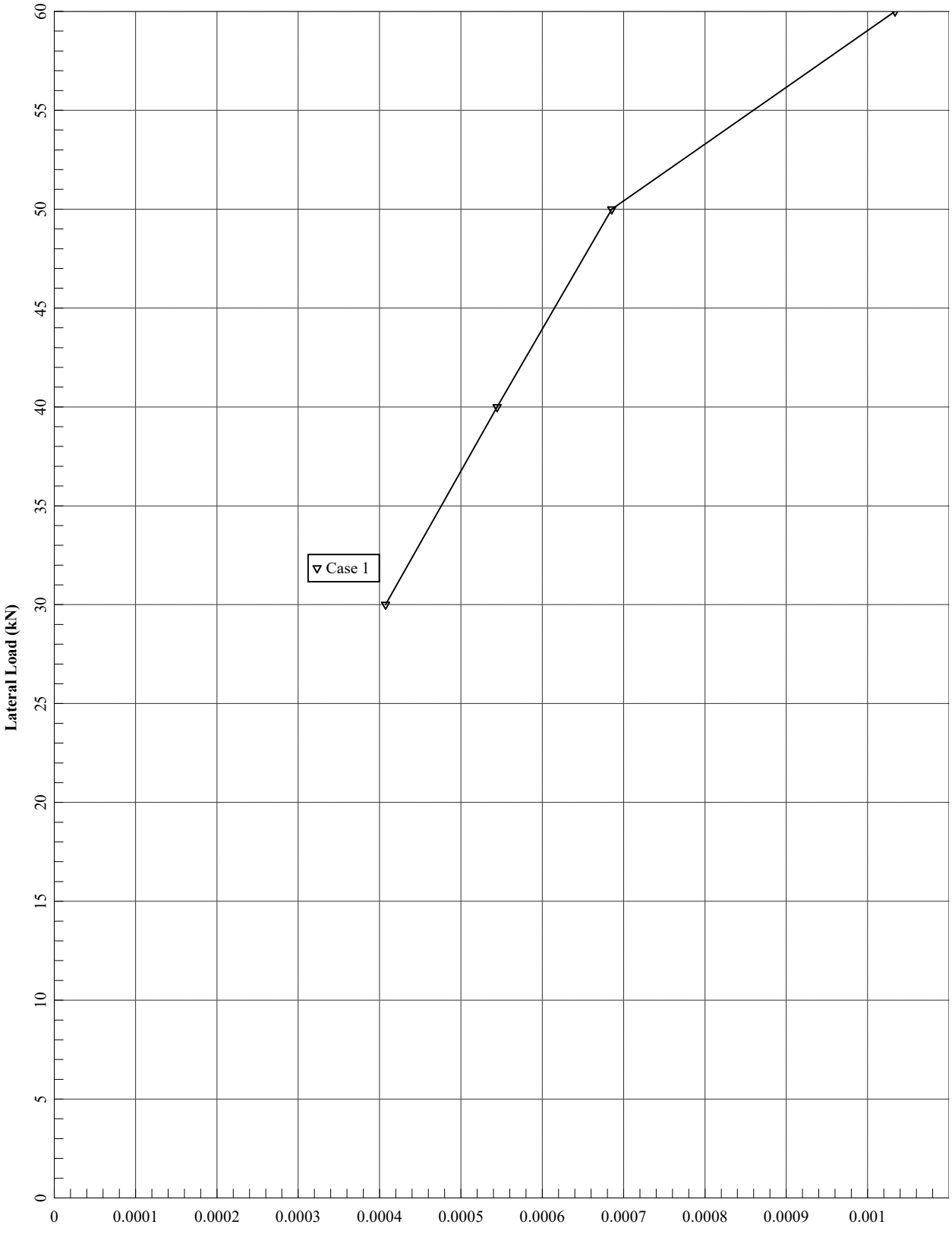

Lateral Pile Deflection (meters)
-0.001
0
0.001
0.002
0.003
0.004
0.005
0.006
0.007
0.008
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
30 kN Lateral Load
40 kN Lateral Load
50 kN Lateral Load
60 kN Lateral Load
Sand
Weak Rock
400-mm dia. Drilled Shaft

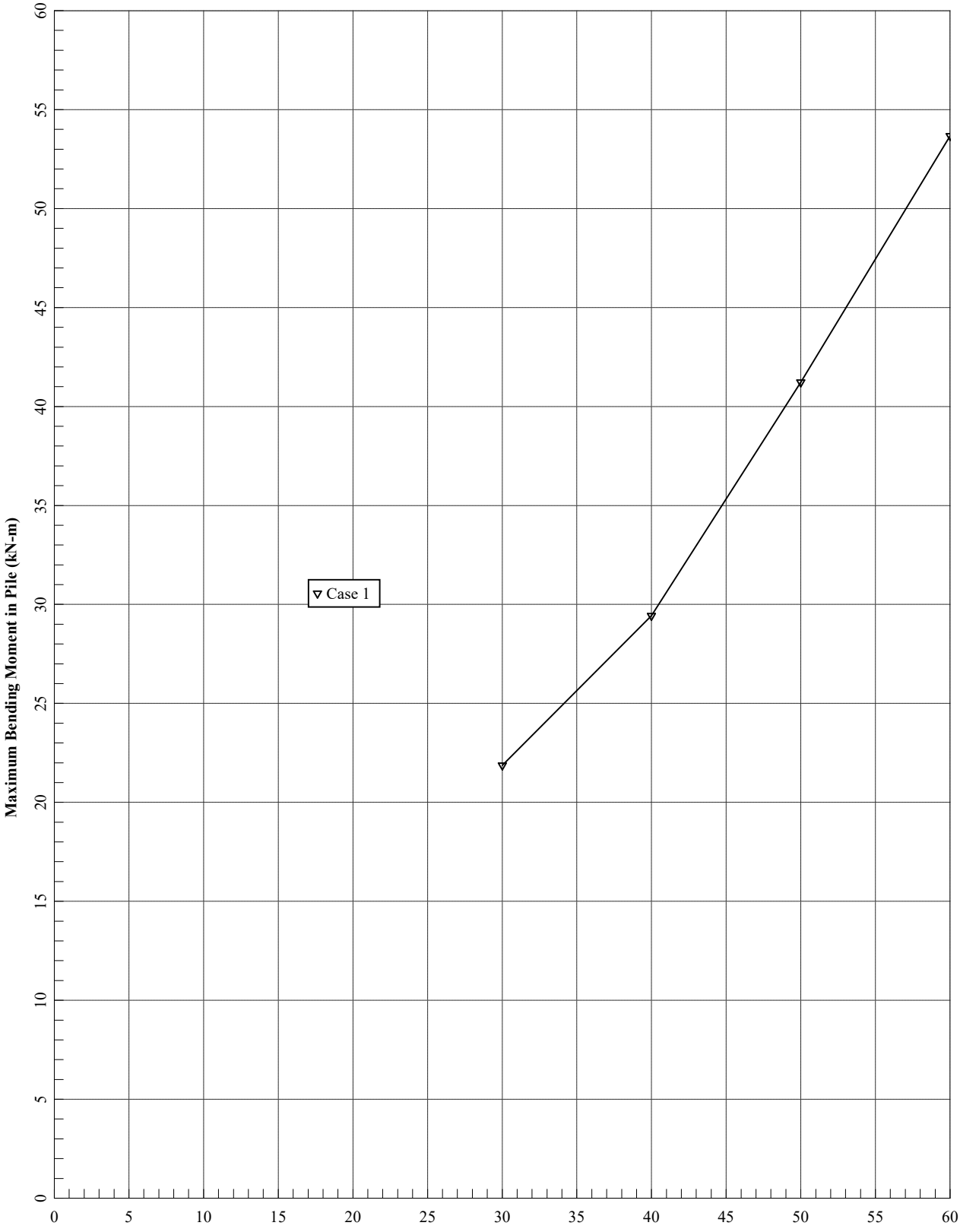

Lateral Pile Deflection (meters)
0
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
0.0007
0.0008
0.0009
0.001
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
30 kN Lateral Load
40 kN Lateral Load
50 kN Lateral Load
60 kN Lateral Load
Sand
Weak Rock
600-mm dia. Drilled Shaft

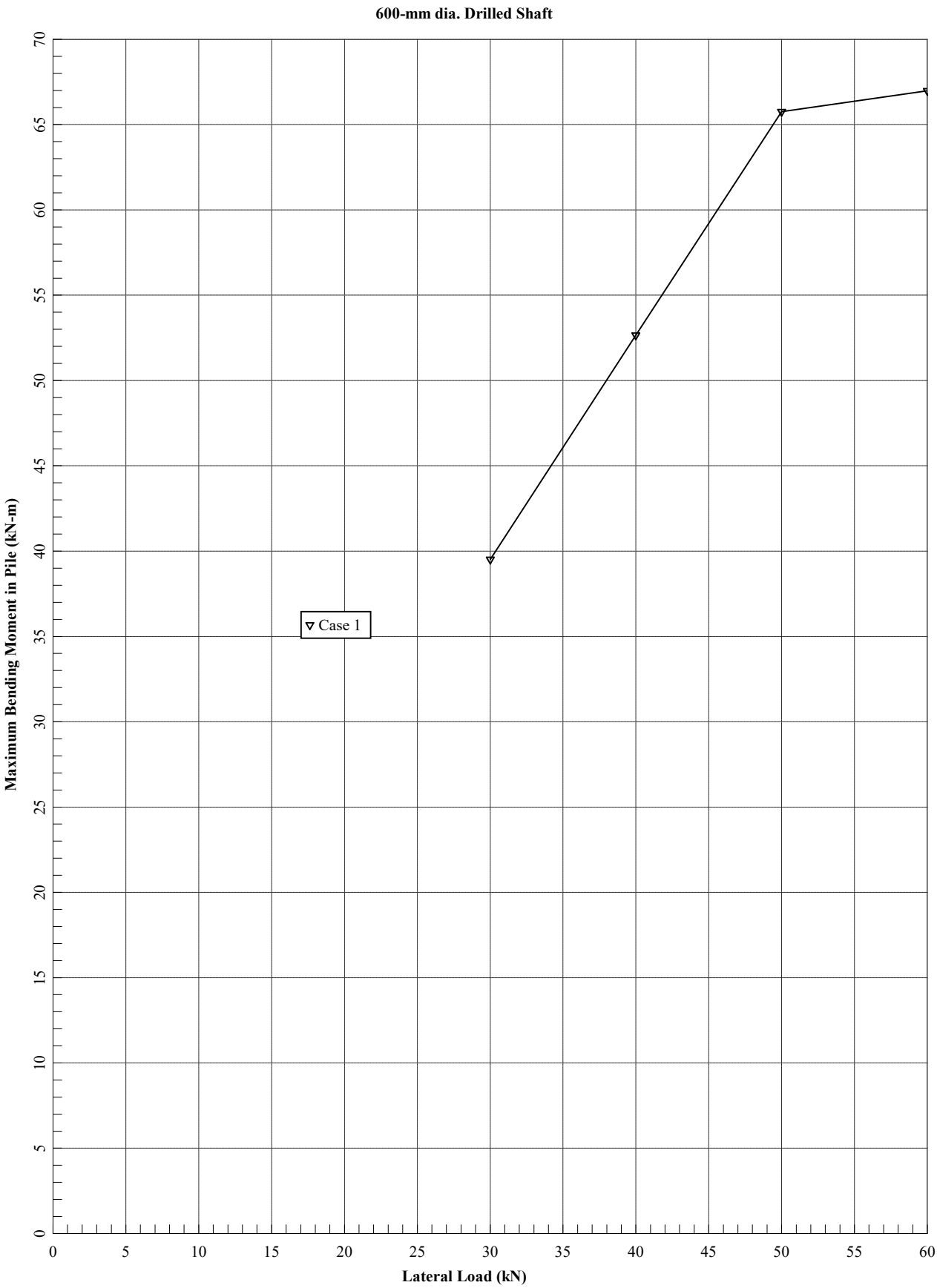

Bending Moment (kN-m)
-60
-50
-40
-30
-20
-10
0
10
20
30
0
1
2
3
4
5
6
7
8
9
10
11
12
Depth (m)
30 kN Lateral Load
40 kN Lateral Load
50 kN Lateral Load
60 kN Lateral Load
Sand
Weak Rock
400-mm dia. Drilled Shaft


Bending Moment (kN-m)
-70
-60
-50
-40
-30
-20
-10
0
10
20
30
Depth (m)
0
1
2
3
4
5
6
7
8
9
10
11
12
30 kN Lateral Load
40 kN Lateral Load
50 kN Lateral Load
60 kN Lateral Load
Sand
Weak Rock
600-mm dia. Drilled Shaft


Lateral Load (kN)
0
5
10
15
20
25
30
35
40
45
50
55
60
0
0.0005
0.001
0.0015
0.002
0.0025
0.003
0.0035
0.004
0.0045
0.005
0.0055
0.006
0.0065
0.007
0.0075
Case 1
Pile-head Deflection (m)
400-mm dia. Drilled Shaft


Lateral Load (kN)
0
5
10
15
20
25
30
35
40
45
50
55
60
0
0.0001
0.0002
0.0003
0.0004
0.0005
0.0006
0.0007
0.0008
0.0009
0.001
Case 1
Pile-head Deflection (m)
600-mm dia. Drilled Shaft


Maximum Bending Moment in Pile (kN-m)
0
5
10
15
20
25
30
35
40
45
50
55
60
Case 1
0
5
10
15
20
25
30
35
40
45
50
55
60
Lateral Load (kN)
400-mm dia. Drilled Shaft


600-mm dia. Drilled Shaft
Maximum Bending Moment in Pile (kN-m)
Lateral Load (kN)
Case 1
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70

APPENDIX V

==========

LPile for Windows, Version 2019-11.005

Analysis of Individual Piles and Drilled Shafts
Subjected to Lateral Loading Using the p-y Method
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==========

This copy of LPile is being used by:

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Serial Number of Security Device: 156316401

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is a violation of the software license agreement.

Files Used for Analysis

Path to file locations:
\Program Files (x86)\Ensoft\Lpile2019\

Name of input data file:
24146b.lp11d

Name of output report file:
24146b.lp11o

Name of plot output file:
24146b.lp11p

Name of runtime message file:
24146b.lp11r

Date and Time of Analysis

Date: December 5, 2024 Time: 7:56:00

Problem Title

Project Name: G. I. for Murbee Development, Barbuda

Job Number: GA 24 146

Client: Murbee Resorts Inc.

Engineer: M. J. Joab

Description:

Program Options and Settings

Computational Options:
- Conventional Analysis

Engineering Units Used for Data Input and Computations:
- International System Units (kilonewtons, meters, millimeters)

Analysis Control Options:

- Maximum number of iterations allowed	=	500
- Deflection tolerance for convergence	=	2.5400E-07 m
- Maximum allowable deflection	=	2.5400 m
- Number of pile increments	=	100

Loading Type and Number of Cycles of Loading:
- Static loading specified

- Use of p-y modification factors for p-y curves not selected

- Analysis uses layering correction (Method of Georgiadis)
- No distributed lateral loads are entered
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Input of moment resistance at the pile tip not selected
- Input of side resistance moment along pile not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:
- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

Pile Structural Properties and Geometry

Number of pile sections defined = 1
Total length of pile = 11.500 m
Depth of ground surface below top of pile = 0.0000 m

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point	Depth Below Pile Head meters	Pile Diameter millimeters
1	0.000	600.00
2	11.500	600.00

Input Structural Properties for Pile Sections:

Pile Section No. 1:

Section 1 is a round drilled shaft, bored pile, or CIDH pile
Length of section = 11.500000 m
Shaft Diameter = 0.600000 m

Shear capacity of section	=	0.0000 kN

Ground Slope and Pile Batter Angles

Ground Slope Angle	=	0.000 degrees
	=	0.000 radians
Pile Batter Angle	=	0.000 degrees
	=	0.000 radians

Soil and Rock Layering Information

The soil profile is modelled using 2 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	0.0000 m
Distance from top of pile to bottom of layer	=	9.900000 m
Effective unit weight at top of layer	=	8.000000 kN/m3
Effective unit weight at bottom of layer	=	8.000000 kN/m3
Friction angle at top of layer	=	39.000000 deg.
Friction angle at bottom of layer	=	39.000000 deg.
Subgrade k at top of layer	=	33900. kN/m3
Subgrade k at bottom of layer	=	33900. kN/m3

Layer 2 is weak rock, p-y criteria by Reese, 1997

Distance from top of pile to top of layer	=	9.900000 m
Distance from top of pile to bottom of layer	=	15.000000 m
Effective unit weight at top of layer	=	8.000000 kN/m3
Effective unit weight at bottom of layer	=	8.000000 kN/m3
Uniaxial compressive strength at top of layer	=	3100. kPa
Uniaxial compressive strength at bottom of layer	=	3100. kPa
Initial modulus of rock at top of layer	=	3000000. kPa
Initial modulus of rock at bottom of layer	=	3000000. kPa
RQD of rock at top of layer	=	20.000000 %
RQD of rock at bottom of layer	=	20.000000 %
k rm of rock at top of layer	=	0.0002500
k rm of rock at bottom of layer	=	0.0002500

(Depth of the lowest soil layer extends 3.500 m below the pile tip)

Summary of Input Soil Properties

```
Layer         Soil Type          Layer      Effective    Angle of     Uniaxial
              E50                    Rock Mass
Layer           Name             Depth       Unit Wt.    Friction        qu
RQD %         or           kpy        Modulus
 Num.     (p-y Curve Type)         m          kN/m3        deg.          kPa
              krm         kN/m3         kPa
-----   -------------------   ----------   ----------   ----------   ----------
----------   ----------   ----------   ----------
  1            Sand                 0.00       8.0000      39.0000       --
 --           --           33900.       --
          (Reese, et al.)         9.9000       8.0000      39.0000       --
 --           --           33900.       --
  2            Weak               9.9000       8.0000       --            3100.
20.0000     2.50E-04       --         3000000.
               Rock              15.0000       8.0000       --            3100.
20.0000     2.50E-04       --         3000000.
```

Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

Pile-head Loading and Pile-head Fixity Conditions

Number of loads specified = 4

```
Load    Load         Condition               Condition            Axial Thrust
Compute Top y     Run Analysis
 No.    Type             1                       2                 Force, kN
vs. Pile Length
-----   ----   --------------------   -----------------------   ----------------
---------------    ------------
   1     2     V =    30.000000 kN    S =       0.0000 m/m            0.0000000
    No               Yes
   2     2     V =    40.000000 kN    S =       0.0000 m/m            0.0000000
    No               Yes
```

```
   3     2     V =    50.000000 kN    S =       0.0000 m/m           0.0000000
    No               Yes
   4     2     V =    60.000000 kN    S =       0.0000 m/m           0.0000000
    No               Yes

V = shear force applied normal to pile axis
M = bending moment applied to pile head
y = lateral deflection normal to pile axis
S = pile slope relative to original pile batter angle
R = rotational stiffness applied to pile head
Values of top y vs. pile lengths can be computed only for load types with
specified shear loading (Load Types 1, 2, and 3).
Thrust force is assumed to be acting axially for all pile batter angles.



--------------------------------------------------------------------------------
     Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness
--------------------------------------------------------------------------------

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:
-------------------

Dimensions and Properties of Drilled Shaft (Bored Pile):
--------------------------------------------------------

Length of Section                                    =    11.500000 m
Shaft Diameter                                       =     0.600000 m
Concrete Cover Thickness (to edge of long. rebar)    =     0.076200 m
Number of Reinforcing Bars                           =            6 bars
Yield Stress of Reinforcing Bars                     =      413685. kPa
Modulus of Elasticity of Reinforcing Bars            =   199947979. kPa
Gross Area of Shaft                                  =     0.282743 sq. m
Total Area of Reinforcing Steel                      =     0.003058 sq. m
Area Ratio of Steel Reinforcement                    =         1.08 percent
Edge-to-Edge Bar Spacing                             =     0.185700 m
Maximum Concrete Aggregate Size                      =     0.019050 m
Ratio of Bar Spacing to Aggregate Size               =         9.75
Offset of Center of Rebar Cage from Center of Pile   =       0.0000 m

Axial Structural Capacities:
----------------------------

Nom. Axial Structural Capacity = 0.85 Fc Ac + Fy As  =     7821.506 kN
Tensile Load for Cracking of Concrete                =     -872.568 kN
Nominal Axial Tensile Capacity                       =    -1265.074 kN
```

Reinforcing Bar Dimensions and Positions Used in Computations:

Bar Number	Bar Diam. meters	Bar Area sq. m.	X meters	Y meters
1	0.025400	0.0005097	0.211100	0.00000
2	0.025400	0.0005097	0.105550	0.182818
3	0.025400	0.0005097	-0.105550	0.182818
4	0.025400	0.0005097	-0.211100	0.00000
5	0.025400	0.0005097	-0.105550	-0.182818
6	0.025400	0.0005097	0.105550	-0.182818

NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero = 185.70 millimeters
between bars 5 and 6.

Ratio of bar spacing to maximum aggregate size = 9.75

Concrete Properties:

Compressive Strength of Concrete	=	27579. kPa
Modulus of Elasticity of Concrete	=	24855577. kPa
Modulus of Rupture of Concrete	=	-3270. kPa
Compression Strain at Peak Stress	=	0.001886
Tensile Strain at Fracture of Concrete	=	-0.0001154
Maximum Coarse Aggregate Size	=	0.019050 m

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 1

Number	Axial Thrust Force kN
1	0.000

Definitions of Run Messages and Notes:

C = concrete in section has cracked in tension.
Y = stress in reinforcing steel has reached yield stress.
T = ACI 318 criteria for tension-controlled section met, tensile strain in reinforcement exceeds 0.005 while simultaneously compressive strain in concrete more than 0.003. See ACI 318, Section 10.3.4.

Z = depth of tensile zone in concrete section is less than 10 percent of section depth.

Bending Stiffness (EI) = Computed Bending Moment / Curvature.
Position of neutral axis is measured from edge of compression side of pile.
Compressive stresses and strains are positive in sign.
Tensile stresses and strains are negative in sign.

Axial Thrust Force = 0.000 kN

Bending Curvature rad/m	Bending Max Conc Stress kPa	Bending Max Steel Moment kN-m	Bending Stiffness kN-m2	Depth to N Axis m	Max Comp Strain m/m	Max Tens Strain m/m	Run Msg
0.00004921	425.7504088	9.7054903	197216.	0.3000022	0.00001476	-0.00001476	
		1919.					
0.00009843	848.1889736	19.3627810	196726.	0.3000023	0.00002953	-0.00002953	
		3838.					
0.0001476	1267.	28.9718722	196236.	0.3000023	0.00004429	-0.00004429	
		5756.					
0.0001969	1683.	38.5327638	195746.	0.3000023	0.00005906	-0.00005905	
		7675.					
0.0002461	2096.	48.0454559	195257.	0.3000023	0.00007382	-0.00007382	
		9594.					
0.0002953	2505.	57.5099485	194767.	0.3000023	0.00008858	-0.00008858	
		11513.					
0.0003445	2911.	66.9262415	194277.	0.3000023	0.0001033	-0.0001033	
		13432.					
0.0003937	1636.	66.9262415	169993.	0.1473162	0.00005800	-0.0001782	
		-27370.					C
0.0004429	1838.	66.9262415	151105.	0.1473647	0.00006527	-0.0002005	
		-30786.					C
0.0004921	2039.	66.9262415	135994.	0.1474133	0.00007255	-0.0002227	
		-34202.					C
0.0005413	2239.	66.9262415	123631.	0.1474620	0.00007983	-0.0002450	
		-37617.					C
0.0005906	2439.	66.9262415	113328.	0.1475109	0.00008711	-0.0002672	
		-41031.					C
0.0006398	2638.	66.9262415	104611.	0.1475598	0.00009440	-0.0002895	
		-44444.					C
0.0006890	2836.	66.9262415	97139.	0.1476089	0.0001017	-0.0003117	
		-47856.					C
0.0007382	3034.	66.9262415	90663.	0.1476580	0.0001090	-0.0003339	
		-51267.					C
0.0007874		66.9262415	84996.	0.1477073	0.0001163	-0.0003561	

```
   3231.       -54678. C
0.0008366    66.9262415        79997.     0.1477567     0.0001236    -0.0003784
   3428.       -58087. C
0.0008858    66.9262415        75552.     0.1478062     0.0001309    -0.0004006
   3623.       -61495. C
0.0009350    66.9262415        71576.     0.1478558     0.0001383    -0.0004228
   3818.       -64902. C
0.0009843    66.9262415        67997.     0.1479056     0.0001456    -0.0004450
   4013.       -68308. C
0.0010335    66.9262415        64759.     0.1479554     0.0001529    -0.0004672
   4207.       -71713. C
0.0010827    66.9262415        61816.     0.1480054     0.0001602    -0.0004894
   4400.       -75117. C
0.0011319    66.9262415        59128.     0.1480555     0.0001676    -0.0005116
   4592.       -78520. C
0.0011811    66.9262415        56664.     0.1481057     0.0001749    -0.0005337
   4784.       -81922. C
0.0012303    66.9262415        54398.     0.1481560     0.0001823    -0.0005559
   4975.       -85323. C
0.0012795    66.9262415        52305.     0.1482065     0.0001896    -0.0005781
   5165.       -88723. C
0.0013287    66.9262415        50368.     0.1482570     0.0001970    -0.0006002
   5355.       -92122. C
0.0013780    66.9262415        48569.     0.1483077     0.0002044    -0.0006224
   5544.       -95520. C
0.0014272    66.9262415        46895.     0.1483585     0.0002117    -0.0006446
   5733.       -98917. C
0.0014764    66.9262415        45331.     0.1484094     0.0002191    -0.0006667
   5920.      -102313. C
0.0015256    66.9262415        43869.     0.1484605     0.0002265    -0.0006889
   6107.      -105708. C
0.0015748    66.9262415        42498.     0.1485116     0.0002339    -0.0007110
   6294.      -109102. C
0.0016240    66.9262415        41210.     0.1485629     0.0002413    -0.0007331
   6480.      -112495. C
0.0016732    66.9262415        39998.     0.1486144     0.0002487    -0.0007553
   6665.      -115886. C
0.0017224    66.9262415        38855.     0.1486659     0.0002561    -0.0007774
   6849.      -119277. C
0.0017717    66.9262415        37776.     0.1487176     0.0002635    -0.0007995
   7033.      -122667. C
0.0018209    66.9262415        36755.     0.1487693     0.0002709    -0.0008216
   7215.      -126055. C
0.0018701    66.9262415        35788.     0.1488213     0.0002783    -0.0008437
   7398.      -129443. C
0.0019193    68.2910992        35581.     0.1488733     0.0002857    -0.0008658
   7579.      -132829. C
0.0020177    71.7479096        35559.     0.1489778     0.0003006    -0.0009100
   7940.      -139599. C
0.0021161    75.2000991        35536.     0.1490828     0.0003155    -0.0009542
```

8299. -146364. C
0.0022146 78.6476374 35514. 0.1491883 0.0003304 -0.0009984
8654. -153125. C
0.0023130 82.0904942 35491. 0.1492943 0.0003453 -0.0010425
9007. -159881. C
0.0024114 85.5286385 35468. 0.1494008 0.0003603 -0.0010866
9357. -166633. C
0.0025098 88.9620311 35445. 0.1495079 0.0003752 -0.0011307
9705. -173381. C
0.0026083 92.3906561 35422. 0.1496156 0.0003902 -0.0011747
10049. -180124. C
0.0027067 95.8144736 35399. 0.1497237 0.0004053 -0.0012188
10390. -186863. C
0.0028051 99.2334511 35376. 0.1498325 0.0004203 -0.0012628
10729. -193597. C
0.0029035 102.6475556 35353. 0.1499418 0.0004354 -0.0013068
11065. -200326. C
0.0030020 106.0567539 35329. 0.1500516 0.0004505 -0.0013507
11398. -207051. C
0.0031004 109.4610120 35306. 0.1501620 0.0004656 -0.0013947
11728. -213771. C
0.0031988 112.8602956 35282. 0.1502730 0.0004807 -0.0014386
12056. -220486. C
0.0032972 116.2545702 35258. 0.1503846 0.0004959 -0.0014825
12380. -227197. C
0.0033957 119.6438003 35234. 0.1504968 0.0005110 -0.0015264
12701. -233903. C
0.0034941 123.0279505 35210. 0.1506096 0.0005262 -0.0015702
13020. -240604. C
0.0035925 126.4069844 35186. 0.1507229 0.0005415 -0.0016140
13336. -247300. C
0.0036909 129.7808718 35162. 0.1508369 0.0005567 -0.0016578
13648. -253991. C
0.0037894 133.1495624 35138. 0.1509515 0.0005720 -0.0017016
13958. -260678. C
0.0038878 136.5130190 35113. 0.1510667 0.0005873 -0.0017454
14265. -267359. C
0.0039862 139.8712162 35089. 0.1511825 0.0006026 -0.0017891
14568. -274035. C
0.0040846 143.2241086 35064. 0.1512990 0.0006180 -0.0018328
14869. -280706. C
0.0041831 146.5716570 35039. 0.1514161 0.0006334 -0.0018765
15167. -287372. C
0.0042815 149.9138213 35014. 0.1515339 0.0006488 -0.0019201
15461. -294033. C
0.0043799 153.2505611 34989. 0.1516523 0.0006642 -0.0019637
15753. -300689. C
0.0044783 156.5818354 34964. 0.1517714 0.0006797 -0.0020073
16042. -307339. C
0.0045768 159.9076025 34939. 0.1518912 0.0006952 -0.0020509

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  16327.      -313984. C
0.0046752   163.2278201        34914.     0.1520116     0.0007107    -0.0020944
  16610.      -320624. C
0.0047736   166.5424453        34888.     0.1521327     0.0007262    -0.0021379
  16889.      -327259. C
0.0048720   169.8514346        34862.     0.1522546     0.0007418    -0.0021814
  17165.      -333888. C
0.0049705   173.1547437        34837.     0.1523771     0.0007574    -0.0022249
  17438.      -340511. C
0.0050689   176.4523277        34811.     0.1525003     0.0007730    -0.0022683
  17708.      -347129. C
0.0051673   179.7441411        34785.     0.1526243     0.0007887    -0.0023117
  17975.      -353741. C
0.0052657   183.0301376        34759.     0.1527490     0.0008043    -0.0023551
  18239.      -360348. C
0.0053642   186.3102703        34732.     0.1528744     0.0008200    -0.0023985
  18499.      -366949. C
0.0054626   189.5844936        34706.     0.1530006     0.0008358    -0.0024418
  18756.      -373544. C
0.0055610   192.8532071        34679.     0.1531217     0.0008515    -0.0024851
  19010.      -380140. C
0.0056594   196.1159675        34653.     0.1532434     0.0008673    -0.0025284
  19260.      -386730. C
0.0057579   199.3727279        34626.     0.1533659     0.0008831    -0.0025717
  19507.      -393315. C
0.0058563   202.6234405        34599.     0.1534891     0.0008989    -0.0026149
  19751.      -399894. C
0.0062500   214.7432790        34359.     0.1537839     0.0009611    -0.0027889
  20674.      -413685. CY
0.0066437   220.1318508        33134.     0.1524654     0.0010129    -0.0029733
  21394.      -413685. CY
0.0070374   223.7142505        31789.     0.1508568     0.0010616    -0.0031608
  22035.      -413685. CY
0.0074311   227.2661685        30583.     0.1494497     0.0011106    -0.0033481
  22643.      -413685. CY
0.0078248   230.7869347        29494.     0.1482144     0.0011597    -0.0035351
  23219.      -413685. CY
0.0082185   234.2758514        28506.     0.1471269     0.0012092    -0.0037219
  23762.      -413685. CY
0.0086122   237.7179989        27602.     0.1461166     0.0012584    -0.0039089
  24267.      -413685. CY
0.0090059   241.1261387        26774.     0.1452162     0.0013078    -0.0040957
  24737.      -413685. CY
0.0093996   244.5015852        26012.     0.1444194     0.0013575    -0.0042823
  25174.      -413685. CY
0.0097933   247.8435476        25307.     0.1437145     0.0014074    -0.0044685
  25577.      -413685. CY
0.0101870   251.1511852        24654.     0.1430916     0.0014577    -0.0046545
  25945.      -413685. CY
0.0105807   254.4236176        24046.     0.1425422     0.0015082    -0.0048402
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  26277.      -413685. CY
0.0109744   257.6599217        23478.     0.1420591     0.0015590    -0.0050256
  26573.      -413685. CY
0.0113681   260.8591027        22947.     0.1416364     0.0016101    -0.0052107
  26833.      -413685. CY
0.0117618   264.0202145        22447.     0.1412688     0.0016616    -0.0053955
  27055.      -413685. CY
0.0121555   267.1259780        21976.     0.1409427     0.0017132    -0.0055801
  27239.      -413685. CY
0.0125492   269.8470491        21503.     0.1405247     0.0017635    -0.0057661
  27379.      -413685. CY
0.0129429   271.9030468        21008.     0.1399303     0.0018111    -0.0059546
  27478.      -413685. CY
0.0133366   273.2232462        20487.     0.1391343     0.0018556    -0.0061464
  27540.      -413685. CY
0.0137303   273.9059254        19949.     0.1381750     0.0018972    -0.0063410
  27572.      -413685. CY
0.0141240   274.2286714        19416.     0.1371582     0.0019372    -0.0065372
  27560.      -413685. CY
0.0145177   274.5217535        18909.     0.1362064     0.0019774    -0.0067332
  27567.      -413685. CY
0.0149114   274.8034370        18429.     0.1353178     0.0020178    -0.0069291
  27579.      -413685. CY
0.0153051   275.0443510        17971.     0.1344420     0.0020577    -0.0071254
  27553.      -413685. CY
0.0156988   275.2612085        17534.     0.1335928     0.0020972    -0.0073220
  27574.      -413685. CY
0.0160925   275.4670437        17118.     0.1327977     0.0021370    -0.0075185
  27559.      -413685. CY
0.0164862   275.6595171        16721.     0.1320548     0.0021771    -0.0077146
  27555.      -413685. CY
0.0168799   275.8440411        16342.     0.1313563     0.0022173    -0.0079107
  27575.      -413685. CY
0.0172736   276.0184644        15979.     0.1307010     0.0022577    -0.0081065
  27560.      -413685. CY
0.0176673   276.1802592        15632.     0.1300879     0.0022983    -0.0083021
  27546.      -413685. CY
0.0180610   276.3352285        15300.     0.1295099     0.0023391    -0.0084975
  27570.      -413685. CY
0.0184547   276.4817207        14982.     0.1289612     0.0023799    -0.0086929
  27579.      -413685. CY
0.0188484   276.5950531        14675.     0.1283964     0.0024201    -0.0088890
  27525.      -413685. CY
0.0192421   276.7022881        14380.     0.1278626     0.0024603    -0.0090849
  27550.      -413685. CY
0.0196358   276.8044474        14097.     0.1273570     0.0025008    -0.0092807
  27570.      -413685. CY
0.0200295   276.9014256        13825.     0.1268782     0.0025413    -0.0094764
  27579.      -413685. CY
0.0204232   276.9880731        13562.     0.1264293     0.0025821    -0.0096718
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      27532.      -413685. CY
    0.0208169   277.0690654        13310.     0.1260045     0.0026230    -0.0098671
      27535.      -413685. CY
    0.0212106   277.1459676        13066.     0.1256010     0.0026641    -0.0100623
      27560.      -413685. CY
    0.0216043   277.2185679        12832.     0.1252180     0.0027053    -0.0102573
      27575.      -413685. CY
    0.0239665   277.5416821        11580.     0.1233122     0.0029554    -0.0114246
      27578.      -413685. CY
    0.0263287   277.6745636        10546.     0.1217839     0.0032064    -0.0125908
      27575.      -413685. CYT
    0.0286909   277.6870336         9679.     0.1206197     0.0034607    -0.0137539
      27550.      -413685. CYT
    0.0310531   277.6870336         8942.     0.1197498     0.0037186    -0.0149133
      27460.      -413685. CYT
    0.0334154   277.6870336         8310.     0.1197255     0.0040007    -0.0160485
      27559.      -413685. CYT


--------------------------------------------------------------------------------
   Summary of Results for Nominal Moment Capacity for Section 1
--------------------------------------------------------------------------------

Moment values interpolated at maximum compressive strain = 0.003
or maximum developed moment if pile fails at smaller strains.

 Load           Axial Thrust        Nominal Mom. Cap.      Max. Comp.
  No.              kN                   kN-m                 Strain
 ----         ----------------     ------------------     ------------
   1                0.000               277.565           0.00300000

Note that the values of moment capacity in the table above are not
factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether
the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.75).

The above values should be multiplied by the appropriate strength reduction
factor to compute ultimate moment capacity according to ACI 318,
or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding
bending stiffnesses computed for common resistance factor values used for
reinforced concrete sections.

Axial     Resist.       Nominal        Nominal     Ult. (Fac)    Ult. (Fac)   Bend.
Stiff.
Load      Factor       Ax. Thrust    Moment Cap    Ax. Thrust    Moment Cap    at
Ult Mom
 No.                      kN           kN-m           kN             kN-m
```

kN-m^2

1	0.65	0.0000	277.565307	0.0000	180.417449	34779.
1	0.75	0.0000	277.565307	0.0000	208.173980	34489.
1	0.90	0.0000	277.565307	0.0000	249.808776	24919.

Layering Correction Equivalent Depths of Soil & Rock Layers

Layer No.	Top of Layer Below Pile Head meters	Equivalent Top Depth Below Grnd Surf meters	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer kN	F1 Integral for Layer kN
1	0.00	0.00	N.A.	No	0.00	10552.
2	9.9000	9.9000	No	Yes	N.A.	N.A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 1

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head = 30.0 kN
Rotation of pile head = 0.000E+00 radians
Axial load at pile head = 0.0 kN

(Zero slope for this load indicates fixed-head conditions)

Depth	Deflect.	Bending	Shear	Slope	Total	Bending	Soil

Res. Soil Spr. Distrib.

X	y	Moment	Force	S	Stress	Stiffness	p	Es*h	Lat. Load
meters	meters	kN-m	kN	radians	kPa*	kN-m^2	kN/m	kN/m	kN/m
0.00	4.07E-04	-39.5184	30.0000	0.00	0.00	195685.	0.00	0.00	0.00
0.1150	4.06E-04	-36.0684	29.9090	-2.22E-05	0.00	195685.	-1.5826	448.3275	0.00
0.2300	4.02E-04	-32.6393	29.6377	-4.24E-05	0.00	196014.	-3.1358	896.6550	0.00
0.3450	3.96E-04	-29.2517	29.1909	-6.05E-05	0.00	196217.	-4.6338	1345.	0.00
0.4600	3.88E-04	-25.9254	28.5764	-7.67E-05	0.00	196352.	-6.0545	1793.	0.00
0.5750	3.79E-04	-22.6792	27.8039	-9.09E-05	0.00	196510.	-7.3792	2242.	0.00
0.6900	3.67E-04	-19.5305	26.8855	-1.03E-04	0.00	196713.	-8.5927	2690.	0.00
0.8050	3.55E-04	-16.4955	25.8347	-1.14E-04	0.00	196811.	-9.6828	3138.	0.00
0.9200	3.41E-04	-13.5886	24.6661	-1.23E-04	0.00	196935.	-10.6406	3587.	0.00
1.0350	3.27E-04	-10.8223	23.3953	-1.30E-04	0.00	197114.	-11.4601	4035.	0.00
1.1500	3.11E-04	-8.2076	22.0384	-1.35E-04	0.00	197216.	-12.1377	4483.	0.00
1.2650	2.96E-04	-5.7535	20.6118	-1.39E-04	0.00	197216.	-12.6727	4932.	0.00
1.3800	2.79E-04	-3.4669	19.1319	-1.42E-04	0.00	197216.	-13.0661	5380.	0.00
1.4950	2.63E-04	-1.3531	17.6146	-1.43E-04	0.00	197216.	-13.3214	5828.	0.00
1.6100	2.46E-04	0.5844	16.0756	-1.44E-04	0.00	197216.	-13.4434	6277.	0.00
1.7250	2.30E-04	2.3442	14.5299	-1.43E-04	0.00	197216.	-13.4388	6725.	0.00
1.8400	2.13E-04	3.9263	12.9915	-1.41E-04	0.00	197216.	-13.3154	7173.	0.00
1.9550	1.97E-04	5.3323	11.4736	-1.38E-04	0.00	197216.	-13.0820	7622.	0.00
2.0700	1.82E-04	6.5652	9.9884	-1.35E-04	0.00	197216.	-12.7483	8070.	0.00
2.1850	1.66E-04	7.6296	8.5467	-1.31E-04	0.00	197216.	-12.3246	8518.	0.00
2.3000	1.52E-04	8.5310	7.1583	-1.26E-04	0.00	197216.	-11.8217	8967.	0.00
2.4150	1.37E-04	9.2760	5.8317	-1.21E-04	0.00	197216.			

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-11.2504      9415.       0.00
    2.5300   1.24E-04     9.8723     4.5740  -1.15E-04       0.00    197199.
-10.6218      9863.       0.00
    2.6450   1.11E-04    10.3280     3.3913  -1.09E-04       0.00    197156.
-9.9468     10312.       0.00
    2.7600   9.87E-05    10.6523     2.2883  -1.03E-04       0.00    197128.
-9.2358     10760.       0.00
    2.8750   8.72E-05    10.8544     1.2685  -9.69E-05       0.00    197111.
-8.4992     11208.       0.00
    2.9900   7.64E-05    10.9440     0.3344  -9.05E-05       0.00    197104.
-7.7468     11657.       0.00
    3.1050   6.64E-05    10.9313    -0.5128  -8.41E-05       0.00    197105.
-6.9876     12105.       0.00
    3.2200   5.71E-05    10.8261    -1.2728  -7.78E-05       0.00    197114.
-6.2301     12553.       0.00
    3.3350   4.85E-05    10.6385    -1.9463  -7.15E-05       0.00    197129.
-5.4822     13001.       0.00
    3.4500   4.06E-05    10.3784    -2.5347  -6.54E-05       0.00    197152.
-4.7508     13450.       0.00
    3.5650   3.34E-05    10.0555    -3.0403  -5.94E-05       0.00    197181.
-4.0422     13898.       0.00
    3.6800   2.69E-05     9.6792    -3.4660  -5.37E-05       0.00    197216.
-3.3618     14346.       0.00
    3.7950   2.11E-05     9.2584    -3.8154  -4.82E-05       0.00    197216.
-2.7142     14795.       0.00
    3.9100   1.59E-05     8.8016    -4.0924  -4.29E-05       0.00    197216.
-2.1033     15243.       0.00
    4.0250   1.12E-05     8.3171    -4.3014  -3.79E-05       0.00    197216.
-1.5322     15691.       0.00
    4.1400   7.15E-06     7.8123    -4.4472  -3.32E-05       0.00    197216.
-1.0032     16140.       0.00
    4.2550   3.59E-06     7.2942    -4.5347  -2.88E-05       0.00    197216.
-0.5179     16588.       0.00
    4.3700   5.22E-07     6.7693    -4.5689  -2.47E-05       0.00    197216.
-0.07731     17036.       0.00
    4.4850  -2.09E-06     6.2434    -4.5551  -2.09E-05       0.00    197216.
0.3182     17485.       0.00
    4.6000  -4.29E-06     5.7217    -4.4983  -1.74E-05       0.00    197216.
0.6687     17933.       0.00
    4.7150  -6.10E-06     5.2088    -4.4038  -1.42E-05       0.00    197216.
0.9751     18381.       0.00
    4.8300  -7.56E-06     4.7088    -4.2765  -1.13E-05       0.00    197216.
1.2384     18830.       0.00
    4.9450  -8.71E-06     4.2252    -4.1214  -8.74E-06       0.00    197216.
1.4601     19278.       0.00
    5.0600  -9.57E-06     3.7609    -3.9430  -6.41E-06       0.00    197216.
1.6422     19726.       0.00
    5.1750  -1.02E-05     3.3183    -3.7458  -4.35E-06       0.00    197216.
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    5.2900  -1.06E-05     2.8994    -3.5340  -2.54E-06       0.00    197216.
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    9.3150   4.36E-08    -0.1409     0.2883   8.30E-08       0.00    197216.
-0.01378     36315.       0.00
    9.4300   4.85E-08    -0.1079     0.2867   1.04E-08       0.00    197216.
-0.01549     36763.       0.00
    9.5450   4.60E-08   -0.07499     0.2849  -4.29E-08       0.00    197216.
-0.01490     37211.       0.00
    9.6600   3.86E-08   -0.04233     0.2833  -7.71E-08       0.00    197216.
-0.01264     37660.       0.00
    9.7750   2.83E-08   -0.00983     0.2821  -9.23E-08       0.00    197216.
-0.00938     38108.       0.00
    9.8900   1.74E-08    0.02255     0.2812  -8.86E-08       0.00    197216.
-0.00582     38556.       0.00
   10.0050   7.93E-09    0.05484     0.1121  -6.60E-08       0.00    197216.
-2.9355   4.26E+07       0.00
   10.1200   2.18E-09    0.04832    -0.1127  -3.60E-08       0.00    197216.
-0.9734   5.14E+07       0.00
   10.2350  -3.35E-10    0.02892    -0.1586  -1.34E-08       0.00    197216.
0.1753   6.02E+07       0.00
   10.3500  -9.10E-10    0.01184    -0.1171  -1.55E-09       0.00    197216.
0.5459   6.90E+07       0.00
   10.4650  -6.91E-10    0.00198   -0.05886   2.48E-09       0.00    197216.
0.4674   7.78E+07       0.00
   10.5800  -3.39E-10   -0.00170   -0.01732   2.57E-09       0.00    197216.
0.2551   8.66E+07       0.00
   10.6950  -1.00E-10   -0.00200    0.00213   1.49E-09       0.00    197216.
0.08324   9.55E+07       0.00
   10.8100   3.80E-12   -0.00121    0.00672   5.54E-10       0.00    197216.
-0.00345   1.04E+08       0.00
   10.9250   2.70E-11  -4.55E-04    0.00500   6.92E-11       0.00    197216.
-0.02658   1.13E+08       0.00
   11.0400   1.97E-11  -5.68E-05    0.00227  -8.01E-11       0.00    197216.
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-0.02091   1.22E+08       0.00
   11.1550   8.60E-12   6.55E-05   5.01E-04  -7.76E-11       0.00    197216.
-0.00978   1.31E+08       0.00
   11.2700   1.88E-12   5.83E-05  -1.93E-04  -4.15E-11       0.00    197216.
-0.00228   1.40E+08       0.00
   11.3850       0.00   2.11E-05  -2.54E-04  -1.83E-11       0.00    197216.
0.00121   1.48E+08       0.00
   11.5000  -2.34E-12       0.00       0.00  -1.22E-11       0.00    197216.
0.00320   7.86E+07       0.00

* This analysis computed pile response using nonlinear moment-curvature rela-
  tionships. Values of total stress due to combined axial and bending stresses
  are computed only for elastic sections only and do not equal the actual
  stresses in concrete and steel. Stresses in concrete and steel may be inter-
  polated from the output for nonlinear bending properties relative to the
  magnitude of bending moment developed in the pile.


Output Summary for Load Case No. 1:

Pile-head deflection             =     0.00040729 meters
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =   -39.51841368 kN-m
Maximum shear force              =    30.00000000 kN
Depth of maximum bending moment  =       0.000000 meters below pile head
Depth of maximum shear force     =       0.000000 meters below pile head
Number of iterations             =              6
Number of zero deflection points =              5



--------------------------------------------------------------------------------
                Computed Values of Pile Loading and Deflection
                  for Lateral Loading for Load Case Number 2
--------------------------------------------------------------------------------

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head                                 =         40.0 kN
Rotation of pile head                                    =    0.000E+00 radians
Axial load at pile head                                  =          0.0 kN

(Zero slope for this load indicates fixed-head conditions)

   Depth    Deflect.    Bending     Shear      Slope      Total     Bending   Soil
Res.  Soil Spr.  Distrib.
     X          y       Moment      Force        S       Stress    Stiffness      p
      Es*h     Lat. Load
  meters     meters      kN-m        kN       radians     kPa*      kN-m^2      kN/m
      kN/m       kN/m
```

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---------- ---------- ----------
      0.00   5.45E-04   -52.6585   40.0000   0.00   0.00   194996.
0.00   0.00   0.00
    0.1150   5.43E-04   -48.0585   39.8783 -2.97E-05   0.00   194996.
-2.1158   448.3275   0.00
    0.2300   5.38E-04   -43.4865   39.5156 -5.67E-05   0.00   195464.
-4.1924   896.6550   0.00
    0.3450   5.30E-04   -38.9700   38.9183 -8.09E-05   0.00   195719.
-6.1951   1345.   0.00
    0.4600   5.19E-04   -34.5353   38.0967 -1.02E-04   0.00   195918.
-8.0945   1793.   0.00
    0.5750   5.06E-04   -30.2077   37.0640 -1.21E-04   0.00   196155.
-9.8657   2242.   0.00
    0.6900   4.91E-04   -26.0106   35.8361 -1.38E-04   0.00   196348.
-11.4883   2690.   0.00
    0.8050   4.74E-04   -21.9654   34.4311 -1.52E-04   0.00   196551.
-12.9461   3138.   0.00
    0.9200   4.56E-04   -18.0914   32.8687 -1.64E-04   0.00   196760.
-14.2274   3587.   0.00
    1.0350   4.37E-04   -14.4056   31.1695 -1.73E-04   0.00   196895.
-15.3239   4035.   0.00
    1.1500   4.16E-04   -10.9225   29.3550 -1.81E-04   0.00   197106.
-16.2312   4483.   0.00
    1.2650   3.95E-04   -7.6540   27.4472 -1.86E-04   0.00   197216.
-16.9480   4932.   0.00
    1.3800   3.74E-04   -4.6096   25.4679 -1.90E-04   0.00   197216.
-17.4760   5380.   0.00
    1.4950   3.52E-04   -1.7964   23.4384 -1.91E-04   0.00   197216.
-17.8195   5828.   0.00
    1.6100   3.30E-04   0.7812   21.3796 -1.92E-04   0.00   197216.
-17.9852   6277.   0.00
    1.7250   3.08E-04   3.1210   19.3115 -1.91E-04   0.00   197216.
-17.9819   6725.   0.00
    1.8400   2.86E-04   5.2229   17.2529 -1.88E-04   0.00   197216.
-17.8199   7173.   0.00
    1.9550   2.64E-04   7.0891   15.2214 -1.85E-04   0.00   197216.
-17.5110   7622.   0.00
    2.0700   2.43E-04   8.7238   13.2331 -1.80E-04   0.00   197216.
-17.0681   8070.   0.00
    2.1850   2.23E-04   10.1327   11.3026 -1.74E-04   0.00   197174.
-16.5049   8518.   0.00
    2.3000   2.03E-04   11.3234   9.4430 -1.68E-04   0.00   197075.
-15.8356   8967.   0.00
    2.4150   1.84E-04   12.3046   7.7332 -1.61E-04   0.00   197008.
-13.9012   8682.   0.00
    2.5300   1.66E-04   13.1020   6.1520 -1.54E-04   0.00   196961.
-13.5973   9420.   0.00
    2.6450   1.49E-04   13.7196   4.6129 -1.46E-04   0.00   196928.
-13.1704   10183.   0.00

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    2.7600   1.32E-04    14.1630     3.1433  -1.38E-04       0.00    196906.
-12.3872     10760.       0.00
    2.8750   1.17E-04    14.4426     1.7753  -1.30E-04       0.00    196893.
-11.4037     11208.       0.00
    2.9900   1.03E-04    14.5713     0.5217  -1.21E-04       0.00    196887.
-10.3985     11657.       0.00
    3.1050   8.91E-05    14.5625    -0.6158  -1.13E-04       0.00    196888.
-9.3838     12105.       0.00
    3.2200   7.67E-05    14.4297    -1.6367  -1.04E-04       0.00    196894.
-8.3712     12553.       0.00
    3.3350   6.52E-05    14.1861    -2.5419  -9.58E-05       0.00    196905.
-7.3710     13001.       0.00
    3.4500   5.47E-05    13.8451    -3.3333  -8.76E-05       0.00    196922.
-6.3927     13450.       0.00
    3.5650   4.51E-05    13.4195    -4.0139  -7.96E-05       0.00    196944.
-5.4445     13898.       0.00
    3.6800   3.63E-05    12.9219    -4.5877  -7.19E-05       0.00    196971.
-4.5339     14346.       0.00
    3.7950   2.85E-05    12.3643    -5.0592  -6.46E-05       0.00    197004.
-3.6669     14795.       0.00
    3.9100   2.15E-05    11.7582    -5.4339  -5.75E-05       0.00    197044.
-2.8489     15243.       0.00
    4.0250   1.53E-05    11.1145    -5.7175  -5.09E-05       0.00    197091.
-2.0839     15691.       0.00
    4.1400   9.80E-06    10.4432    -5.9164  -4.46E-05       0.00    197146.
-1.3750     16140.       0.00
    4.2550   5.02E-06     9.7537    -6.0371  -3.87E-05       0.00    197211.
-0.7245     16588.       0.00
    4.3700   9.02E-07     9.0547    -6.0865  -3.32E-05       0.00    197216.
-0.1337     17036.       0.00
    4.4850  -2.61E-06     8.3538    -6.0713  -2.81E-05       0.00    197216.
0.3969     17485.       0.00
    4.6000  -5.56E-06     7.6583    -5.9986  -2.34E-05       0.00    197216.
0.8676     17933.       0.00
    4.7150  -8.00E-06     6.9742    -5.8752  -1.92E-05       0.00    197216.
1.2792     18381.       0.00
    4.8300  -9.97E-06     6.3070    -5.7077  -1.53E-05       0.00    197216.
1.6332     18830.       0.00
    4.9450  -1.15E-05     5.6614    -5.5027  -1.18E-05       0.00    197216.
1.9317     19278.       0.00
    5.0600  -1.27E-05     5.0413    -5.2665  -8.70E-06       0.00    197216.
2.1772     19726.       0.00
    5.1750  -1.35E-05     4.4501    -5.0049  -5.93E-06       0.00    197216.
2.3725     20175.       0.00
    5.2900  -1.41E-05     3.8902    -4.7235  -3.50E-06       0.00    197216.
2.5207     20623.       0.00
    5.4050  -1.43E-05     3.3637    -4.4276  -1.38E-06       0.00    197216.
2.6253     21071.       0.00
    5.5200  -1.44E-05     2.8719    -4.1220   4.35E-07       0.00    197216.
2.6898     21520.       0.00
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    5.6350  -1.42E-05     2.4156    -3.8110   1.98E-06       0.00    197216.
2.7179     21968.       0.00
    5.7500  -1.39E-05     1.9953    -3.4987   3.26E-06       0.00    197216.
2.7133     22416.       0.00
    5.8650  -1.35E-05     1.6109    -3.1886   4.31E-06       0.00    197216.
2.6796     22865.       0.00
    5.9800  -1.29E-05     1.2620    -2.8839   5.15E-06       0.00    197216.
2.6206     23313.       0.00
    6.0950  -1.23E-05     0.9476    -2.5871   5.80E-06       0.00    197216.
2.5399     23761.       0.00
    6.2100  -1.16E-05     0.6669    -2.3007   6.27E-06       0.00    197216.
2.4408     24210.       0.00
    6.3250  -1.09E-05     0.4185    -2.0266   6.58E-06       0.00    197216.
2.3267     24658.       0.00
    6.4400  -1.01E-05     0.2008    -1.7663   6.76E-06       0.00    197216.
2.2006     25106.       0.00
    6.5550  -9.30E-06    0.01222    -1.5210   6.83E-06       0.00    197216.
2.0655     25555.       0.00
    6.6700  -8.51E-06    -0.1490    -1.2916   6.79E-06       0.00    197216.
1.9242     26003.       0.00
    6.7850  -7.73E-06    -0.2848    -1.0787   6.66E-06       0.00    197216.
1.7790     26451.       0.00
    6.9000  -6.98E-06    -0.3971    -0.8825   6.46E-06       0.00    197216.
1.6322     26900.       0.00
    7.0150  -6.25E-06    -0.4878    -0.7032   6.20E-06       0.00    197216.
1.4859     27348.       0.00
    7.1300  -5.55E-06    -0.5589    -0.5406   5.90E-06       0.00    197216.
1.3418     27796.       0.00
    7.2450  -4.89E-06    -0.6122    -0.3944   5.56E-06       0.00    197216.
1.2015     28245.       0.00
    7.3600  -4.27E-06    -0.6496    -0.2640   5.19E-06       0.00    197216.
1.0662     28693.       0.00
    7.4750  -3.70E-06    -0.6729    -0.1488   4.80E-06       0.00    197216.
0.9372     29141.       0.00
    7.5900  -3.17E-06    -0.6838   -0.04802   4.41E-06       0.00    197216.
0.8153     29590.       0.00
    7.7050  -2.68E-06    -0.6839    0.03918   4.01E-06       0.00    197216.
0.7013     30038.       0.00
    7.8200  -2.25E-06    -0.6748     0.1137   3.61E-06       0.00    197216.
0.5956     30486.       0.00
    7.9350  -1.85E-06    -0.6578     0.1767   3.22E-06       0.00    197216.
0.4987     30935.       0.00
    8.0500  -1.51E-06    -0.6341     0.2290   2.85E-06       0.00    197216.
0.4108     31383.       0.00
    8.1650  -1.20E-06    -0.6051     0.2717   2.49E-06       0.00    197216.
0.3319     31831.       0.00
    8.2800  -9.33E-07    -0.5717     0.3058   2.14E-06       0.00    197216.
0.2620     32280.       0.00
    8.3950  -7.06E-07    -0.5348     0.3324   1.82E-06       0.00    197216.
0.2010     32728.       0.00
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    8.5100  -5.15E-07    -0.4952     0.3525   1.52E-06       0.00    197216.
0.1485     33176.       0.00
    8.6250  -3.57E-07    -0.4537     0.3671   1.24E-06       0.00    197216.
0.1042     33625.       0.00
    8.7400  -2.29E-07    -0.4108     0.3769   9.91E-07       0.00    197216.
0.06777    34073.       0.00
    8.8550  -1.29E-07    -0.3670     0.3831   7.65E-07       0.00    197216.
0.03858    34521.       0.00
    8.9700  -5.29E-08    -0.3227     0.3862   5.64E-07       0.00    197216.
0.01608    34970.       0.00
    9.0850   1.10E-09    -0.2782     0.3871   3.88E-07       0.00    197216.
-3.40E-04    35418.       0.00
    9.2000   3.64E-08    -0.2336     0.3864   2.39E-07       0.00    197216.
-0.01136    35866.       0.00
    9.3150   5.61E-08    -0.1893     0.3848   1.16E-07       0.00    197216.
-0.01771    36315.       0.00
    9.4300   6.31E-08    -0.1451     0.3826   1.83E-08       0.00    197216.
-0.02016    36763.       0.00
    9.5450   6.03E-08    -0.1013     0.3803  -5.35E-08       0.00    197216.
-0.01951    37211.       0.00
    9.6600   5.08E-08   -0.05767     0.3782  -9.99E-08       0.00    197216.
-0.01662    37660.       0.00
    9.7750   3.73E-08   -0.01429     0.3766  -1.21E-07       0.00    197216.
-0.01237    38108.       0.00
    9.8900   2.30E-08    0.02893     0.3754  -1.17E-07       0.00    197216.
-0.00770    38556.       0.00
   10.0050   1.05E-08    0.07206     0.1513  -8.72E-08       0.00    197216.
-3.8899   4.26E+07       0.00
   10.1200   2.91E-09    0.06373    -0.1470  -4.76E-08       0.00    197216.
-1.2981   5.14E+07       0.00
   10.2350  -4.27E-10    0.03824    -0.2088  -1.78E-08       0.00    197216.
0.2236   6.02E+07       0.00
   10.3500  -1.20E-09    0.01571    -0.1547  -2.11E-09       0.00    197216.
0.7177   6.90E+07       0.00
   10.4650  -9.12E-10    0.00267   -0.07794   3.25E-09       0.00    197216.
0.6168   7.78E+07       0.00
   10.5800  -4.48E-10   -0.00222   -0.02306   3.38E-09       0.00    197216.
0.3376   8.66E+07       0.00
   10.6950  -1.33E-10   -0.00264    0.00271   1.97E-09       0.00    197216.
0.1107   9.55E+07       0.00
   10.8100   4.52E-12   -0.00159    0.00884   7.34E-10       0.00    197216.
-0.00410   1.04E+08       0.00
   10.9250   3.55E-11  -6.04E-04    0.00660   9.35E-11       0.00    197216.
-0.03494   1.13E+08       0.00
   11.0400   2.60E-11  -7.67E-05    0.00300  -1.05E-10       0.00    197216.
-0.02760   1.22E+08       0.00
   11.1550   1.14E-11   8.57E-05   6.68E-04  -1.02E-10       0.00    197216.
-0.01295   1.31E+08       0.00
   11.2700   2.50E-12   7.69E-05  -2.51E-04  -5.49E-11       0.00    197216.
-0.00304   1.40E+08       0.00
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   11.3850  -1.23E-12   2.79E-05  -3.34E-04  -2.43E-11       0.00    197216.
0.00159   1.48E+08       0.00
   11.5000  -3.09E-12      0.00       0.00  -1.62E-11       0.00    197216.
0.00423   7.86E+07       0.00

* This analysis computed pile response using nonlinear moment-curvature rela-
  tionships. Values of total stress due to combined axial and bending stresses
  are computed only for elastic sections only and do not equal the actual
  stresses in concrete and steel. Stresses in concrete and steel may be inter-
  polated from the output for nonlinear bending properties relative to the
  magnitude of bending moment developed in the pile.


Output Summary for Load Case No. 2:

Pile-head deflection             =     0.00054452 meters
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =   -52.65854943 kN-m
Maximum shear force              =    40.00000000 kN
Depth of maximum bending moment  =       0.000000 meters below pile head
Depth of maximum shear force     =       0.000000 meters below pile head
Number of iterations             =              6
Number of zero deflection points =              5



--------------------------------------------------------------------------------
                Computed Values of Pile Loading and Deflection
                  for Lateral Loading for Load Case Number 3
--------------------------------------------------------------------------------

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head                                 =         50.0 kN
Rotation of pile head                                    =    0.000E+00 radians
Axial load at pile head                                  =          0.0 kN

(Zero slope for this load indicates fixed-head conditions)

   Depth    Deflect.    Bending     Shear      Slope      Total     Bending   Soil
Res.  Soil Spr.  Distrib.
     X          y       Moment      Force        S       Stress    Stiffness      p
      Es*h     Lat. Load
  meters     meters      kN-m        kN       radians     kPa*      kN-m^2      kN/m
      kN/m       kN/m
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      0.00   6.85E-04   -65.7630    50.0000       0.00       0.00    194330.
0.00       0.00       0.00
    0.1150   6.83E-04   -60.0130    49.8469  -3.72E-05       0.00    194330.
```

-2.6632   448.3275   0.00
    0.2300   6.77E-04   -54.2982   49.3903 -7.10E-05   0.00   194914.
-5.2771   896.6550   0.00
    0.3450   6.67E-04   -48.6532   48.6384 -1.01E-04   0.00   195219.
-7.7987   1345.   0.00
    0.4600   6.54E-04   -43.1114   47.6040 -1.28E-04   0.00   195483.
-10.1908   1793.   0.00
    0.5750   6.37E-04   -37.7043   46.3038 -1.52E-04   0.00   195779.
-12.4223   2242.   0.00
    0.6900   6.19E-04   -32.4615   44.7576 -1.73E-04   0.00   196024.
-14.4679   2690.   0.00
    0.8050   5.98E-04   -27.4100   42.9880 -1.90E-04   0.00   196292.
-16.3073   3138.   0.00
    0.9200   5.75E-04   -22.5742   41.0196 -2.05E-04   0.00   196516.
-17.9258   3587.   0.00
    1.0350   5.50E-04   -17.9755   38.8784 -2.17E-04   0.00   196764.
-19.3131   4035.   0.00
    1.1500   5.25E-04   -13.6322   36.5912 -2.26E-04   0.00   196932.
-20.4638   4483.   0.00
    1.2650   4.98E-04   -9.5595   34.1854 -2.33E-04   0.00   197216.
-21.3761   4932.   0.00
    1.3800   4.71E-04   -5.7696   31.6883 -2.37E-04   0.00   197216.
-22.0522   5380.   0.00
    1.4950   4.44E-04   -2.2712   29.1267 -2.40E-04   0.00   197216.
-22.4976   5828.   0.00
    1.6100   4.16E-04   0.9296   26.5267 -2.40E-04   0.00   197216.
-22.7204   6277.   0.00
    1.7250   3.89E-04   3.8299   23.9132 -2.39E-04   0.00   197216.
-22.7314   6725.   0.00
    1.8400   3.61E-04   6.4296   21.3099 -2.36E-04   0.00   197216.
-22.5436   7173.   0.00
    1.9550   3.35E-04   8.7312   18.7387 -2.31E-04   0.00   197216.
-22.1714   7622.   0.00
    2.0700   3.08E-04   10.7395   16.2201 -2.25E-04   0.00   197121.
-21.6308   8070.   0.00
    2.1850   2.83E-04   12.4618   13.7724 -2.19E-04   0.00   196998.
-20.9386   8518.   0.00
    2.3000   2.58E-04   13.9072   11.5018 -2.11E-04   0.00   196919.
-18.5496   8270.   0.00
    2.4150   2.34E-04   15.1072   9.5208 -2.03E-04   0.00   196864.
-15.9023   7810.   0.00
    2.5300   2.11E-04   16.0969   7.7094 -1.93E-04   0.00   196826.
-15.6005   8488.   0.00
    2.6450   1.90E-04   16.8804   5.9408 -1.84E-04   0.00   196798.
-15.1574   9190.   0.00
    2.7600   1.69E-04   17.4633   4.2308 -1.74E-04   0.00   196779.
-14.5815   9917.   0.00
    2.8750   1.50E-04   17.8535   2.5941 -1.63E-04   0.00   196767.
-13.8833   10665.   0.00
    2.9900   1.32E-04   18.0600   1.0440 -1.53E-04   0.00   196761.

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-13.0757     11434.       0.00
    3.1050   1.15E-04    18.0936    -0.4010  -1.42E-04       0.00    196760.
-12.0552     12105.       0.00
    3.2200   9.88E-05    17.9677    -1.7141  -1.32E-04       0.00    196764.
-10.7809     12553.       0.00
    3.3350   8.42E-05    17.6993    -2.8814  -1.21E-04       0.00    196772.
-9.5202     13001.       0.00
    3.4500   7.08E-05    17.3050    -3.9053  -1.11E-04       0.00    196784.
-8.2852     13450.       0.00
    3.5650   5.86E-05    16.8011    -4.7891  -1.01E-04       0.00    196801.
-7.0865     13898.       0.00
    3.6800   4.76E-05    16.2035    -5.5378  -9.16E-05       0.00    196822.
-5.9335     14346.       0.00
    3.7950   3.76E-05    15.5274    -6.1569  -8.23E-05       0.00    196847.
-4.8342     14795.       0.00
    3.9100   2.86E-05    14.7874    -6.6531  -7.34E-05       0.00    196878.
-3.7954     15243.       0.00
    4.0250   2.07E-05    13.9972    -7.0336  -6.50E-05       0.00    196914.
-2.8223     15691.       0.00
    4.1400   1.37E-05    13.1697    -7.3063  -5.71E-05       0.00    196957.
-1.9192     16140.       0.00
    4.2550   7.55E-06    12.3168    -7.4792  -4.97E-05       0.00    197007.
-1.0890     16588.       0.00
    4.3700   2.25E-06    11.4495    -7.5610  -4.27E-05       0.00    197066.
-0.3335     17036.       0.00
    4.4850  -2.28E-06    10.5777    -7.5603  -3.63E-05       0.00    197134.
0.3465     17485.       0.00
    4.6000  -6.10E-06     9.7106    -7.4857  -3.04E-05       0.00    197215.
0.9511     17933.       0.00
    4.7150  -9.27E-06     8.8560    -7.3458  -2.50E-05       0.00    197216.
1.4814     18381.       0.00
    4.8300  -1.18E-05     8.0211    -7.1491  -2.01E-05       0.00    197216.
1.9392     18830.       0.00
    4.9450  -1.39E-05     7.2117    -6.9038  -1.56E-05       0.00    197216.
2.3269     19278.       0.00
    5.0600  -1.54E-05     6.4332    -6.6178  -1.16E-05       0.00    197216.
2.6476     19726.       0.00
    5.1750  -1.66E-05     5.6896    -6.2986  -8.10E-06       0.00    197216.
2.9046     20175.       0.00
    5.2900  -1.73E-05     4.9845    -5.9532  -4.99E-06       0.00    197216.
3.1020     20623.       0.00
    5.4050  -1.77E-05     4.3204    -5.5883  -2.28E-06       0.00    197216.
3.2440     21071.       0.00
    5.5200  -1.78E-05     3.6992    -5.2100   6.23E-08       0.00    197216.
3.3349     21520.       0.00
    5.6350  -1.77E-05     3.1221    -4.8239   2.05E-06       0.00    197216.
3.3793     21968.       0.00
    5.7500  -1.73E-05     2.5897    -4.4352   3.72E-06       0.00    197216.
3.3818     22416.       0.00
    5.8650  -1.68E-05     2.1020    -4.0482   5.08E-06       0.00    197216.
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3.3472 22865. 0.00
5.9800 -1.62E-05 1.6586 -3.6672 6.18E-06 0.00 197216.
3.2801 23313. 0.00
6.0950 -1.54E-05 1.2586 -3.2954 7.03E-06 0.00 197216.
3.1848 23761. 0.00
6.2100 -1.46E-05 0.9006 -2.9360 7.66E-06 0.00 197216.
3.0658 24210. 0.00
6.3250 -1.37E-05 0.5833 -2.5914 8.09E-06 0.00 197216.
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6.4400 -1.27E-05 0.3046 -2.2637 8.35E-06 0.00 197216.
2.7729 25106. 0.00
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2.4320 26003. 0.00
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2.2519 26451. 0.00
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1.5308 28245. 0.00
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1.1988 29141. 0.00
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1.0453 29590. 0.00
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0.9013 30038. 0.00
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0.7677 30486. 0.00
7.9350 -2.40E-06 -0.8217 0.2051 4.09E-06 0.00 197216.
0.6450 30935. 0.00
8.0500 -1.95E-06 -0.7938 0.2728 3.62E-06 0.00 197216.
0.5334 31383. 0.00
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0.2660 32728. 0.00
8.5100 -6.89E-07 -0.6244 0.4349 1.96E-06 0.00 197216.
0.1987 33176. 0.00
8.6250 -4.85E-07 -0.5731 0.4544 1.61E-06 0.00 197216.
0.1418 33625. 0.00
8.7400 -3.19E-07 -0.5199 0.4680 1.29E-06 0.00 197216.

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0.09464     34073.       0.00
    8.8550  -1.89E-07    -0.4655     0.4767   1.00E-06       0.00    197216.
0.05669     34521.       0.00
    8.9700  -8.95E-08    -0.4103     0.4815   7.45E-07       0.00    197216.
0.02720     34970.       0.00
    9.0850  -1.76E-08    -0.3547     0.4834   5.22E-07       0.00    197216.
0.00541     35418.       0.00
    9.2000   3.05E-08    -0.2991     0.4832   3.31E-07       0.00    197216.
-0.00951     35866.       0.00
    9.3150   5.85E-08    -0.2436     0.4816   1.73E-07       0.00    197216.
-0.01849     36315.       0.00
    9.4300   7.02E-08    -0.1883     0.4792   4.68E-08       0.00    197216.
-0.02245     36763.       0.00
    9.5450   6.93E-08    -0.1333     0.4766  -4.69E-08       0.00    197216.
-0.02243     37211.       0.00
    9.6600   5.94E-08   -0.07868     0.4742  -1.09E-07       0.00    197216.
-0.01947     37660.       0.00
    9.7750   4.43E-08   -0.02427     0.4723  -1.39E-07       0.00    197216.
-0.01468     38108.       0.00
    9.8900   2.75E-08    0.02994     0.4709  -1.37E-07       0.00    197216.
-0.00923     38556.       0.00
   10.0050   1.28E-08    0.08404     0.1990  -1.04E-07       0.00    197216.
-4.7200   4.26E+07       0.00
   10.1200   3.63E-09    0.07571    -0.1656  -5.73E-08       0.00    197216.
-1.6198   5.14E+07       0.00
   10.2350  -4.27E-10    0.04596    -0.2459  -2.18E-08       0.00    197216.
0.2235   6.02E+07       0.00
   10.3500  -1.40E-09    0.01916    -0.1848  -2.86E-09       0.00    197216.
0.8392   6.90E+07       0.00
   10.4650  -1.09E-09    0.00346   -0.09426   3.73E-09       0.00    197216.
0.7346   7.78E+07       0.00
   10.5800  -5.40E-10   -0.00252   -0.02861   4.01E-09       0.00    197216.
0.4072   8.66E+07       0.00
   10.6950  -1.64E-10   -0.00312    0.00265   2.36E-09       0.00    197216.
0.1364   9.55E+07       0.00
   10.8100   2.66E-12   -0.00191    0.01036   8.95E-10       0.00    197216.
-0.00241   1.04E+08       0.00
   10.9250   4.15E-11  -7.36E-04    0.00787   1.23E-10       0.00    197216.
-0.04084   1.13E+08       0.00
   11.0400   3.10E-11  -1.01E-04    0.00363  -1.21E-10       0.00    197216.
-0.03291   1.22E+08       0.00
   11.1550   1.38E-11   9.86E-05   8.36E-04  -1.21E-10       0.00    197216.
-0.01566   1.31E+08       0.00
   11.2700   3.13E-12   9.11E-05  -2.83E-04  -6.61E-11       0.00    197216.
-0.00379   1.40E+08       0.00
   11.3850  -1.41E-12   3.35E-05  -3.96E-04  -2.97E-11       0.00    197216.
0.00182   1.48E+08       0.00
   11.5000  -3.71E-12       0.00       0.00  -1.99E-11       0.00    197216.
0.00507   7.86E+07       0.00
```

* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 3:

Pile-head deflection	=	0.00068537 meters
Computed slope at pile head	=	0.000000 radians
Maximum bending moment	=	-65.76297677 kN-m
Maximum shear force	=	50.00000000 kN
Depth of maximum bending moment	=	0.000000 meters below pile head
Depth of maximum shear force	=	0.000000 meters below pile head
Number of iterations	=	6
Number of zero deflection points	=	5

Computed Values of Pile Loading and Deflection
for Lateral Loading for Load Case Number 4

Pile-head conditions are Shear and Pile-head Rotation (Loading Type 2)

Shear force at pile head	=	60.0 kN
Rotation of pile head	=	0.000E+00 radians
Axial load at pile head	=	0.0 kN

(Zero slope for this load indicates fixed-head conditions)

Depth X	Deflect. y	Bending Moment	Shear Force	Slope S	Total Stress	Bending Stiffness	Soil Res. Es*h	Soil Spr. Lat. Load	Distrib. p
meters	meters	kN-m	kN	radians	kPa*	kN-m^2	kN/m	kN/m	kN/m
0.00	0.00103	-66.9754	60.0000	0.00	0.00	50297.	0.00	0.00	0.00
0.1150	0.00102	-60.0754	59.8261	-1.45E-04	0.00	50297.	-3.0235	339.3087	0.00
0.2300	0.00100	-53.2154	59.2830	-2.30E-04	0.00	194967.	-6.4223	738.4529	0.00
0.3450	9.72E-04	-46.4403	58.3368	-2.59E-04	0.00	195325.	-10.0330	1187.	0.00

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    0.4600   9.41E-04   -39.7979    56.9657  -2.84E-04       0.00    195667.
-13.8128      1689.       0.00
    0.5750   9.07E-04   -33.3382    55.1661  -3.06E-04       0.00    195977.
-17.4853      2218.       0.00
    0.6900   8.70E-04   -27.1097    52.9902  -3.24E-04       0.00    196303.
-20.3557      2690.       0.00
    0.8050   8.32E-04   -21.1504    50.5140  -3.38E-04       0.00    196600.
-22.7080      3138.       0.00
    0.9200   7.93E-04   -15.4915    47.7870  -3.48E-04       0.00    196848.
-24.7187      3587.       0.00
    1.0350   7.52E-04   -10.1594    44.8486  -3.56E-04       0.00    197171.
-26.3846      4035.       0.00
    1.1500   7.11E-04    -5.1763    41.7383  -3.60E-04       0.00    197216.
-27.7074      4483.       0.00
    1.2650   6.69E-04    -0.5596    38.4952  -3.62E-04       0.00    197216.
-28.6936      4932.       0.00
    1.3800   6.27E-04     3.6776    35.1575  -3.61E-04       0.00    197216.
-29.3536      5380.       0.00
    1.4950   5.86E-04     7.5266    31.7618  -3.58E-04       0.00    197216.
-29.7013      5828.       0.00
    1.6100   5.45E-04    10.9828    28.3432  -3.52E-04       0.00    197102.
-29.7538      6277.       0.00
    1.7250   5.05E-04    14.0456    24.9343  -3.45E-04       0.00    196912.
-29.5304      6725.       0.00
    1.8400   4.66E-04    16.7177    21.5658  -3.36E-04       0.00    196804.
-29.0527      7173.       0.00
    1.9550   4.28E-04    19.0057    18.2655  -3.26E-04       0.00    196735.
-28.3437      7622.       0.00
    2.0700   3.91E-04    20.9188    15.1015  -3.14E-04       0.00    196616.
-26.6821      7851.       0.00
    2.1850   3.55E-04    22.4790    12.1916  -3.01E-04       0.00    196521.
-23.9257      7741.       0.00
    2.3000   3.22E-04    23.7229     9.6187  -2.88E-04       0.00    196455.
-20.8195      7446.       0.00
    2.4150   2.89E-04    24.6913     7.3924  -2.74E-04       0.00    196407.
-17.8987      7116.       0.00
    2.5300   2.59E-04    25.4231     5.3572  -2.59E-04       0.00    196374.
-17.4968      7781.       0.00
    2.6450   2.30E-04    25.9235     3.3776  -2.44E-04       0.00    196352.
-16.9306      8477.       0.00
    2.7600   2.02E-04    26.2000     1.4720  -2.29E-04       0.00    196341.
-16.2101      9206.       0.00
    2.8750   1.77E-04    26.2621    -0.3426  -2.13E-04       0.00    196338.
-15.3477      9967.       0.00
    2.9900   1.53E-04    26.1212    -2.0507  -1.98E-04       0.00    196344.
-14.3584     10762.       0.00
    3.1050   1.32E-04    25.7904    -3.6724  -1.83E-04       0.00    196358.
-13.8461     12105.       0.00
    3.2200   1.11E-04    25.2765    -5.1677  -1.68E-04       0.00    196380.
-12.1593     12553.       0.00
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    3.3350   9.29E-05    24.6018    -6.4711  -1.53E-04       0.00    196411.
-10.5078     13001.       0.00
    3.4500   7.62E-05    23.7882    -7.5874  -1.39E-04       0.00    196451.
-8.9062     13450.       0.00
    3.5650   6.10E-05    22.8567    -8.5231  -1.25E-04       0.00    196500.
-7.3672     13898.       0.00
    3.6800   4.73E-05    21.8279    -9.2861  -1.12E-04       0.00    196559.
-5.9017     14346.       0.00
    3.7950   3.51E-05    20.7209    -9.8852  -9.99E-05       0.00    196629.
-4.5187     14795.       0.00
    3.9100   2.43E-05    19.5543   -10.3305  -8.81E-05       0.00    196712.
-3.2254     15243.       0.00
    4.0250   1.49E-05    18.3449   -10.6326  -7.70E-05       0.00    196753.
-2.0274     15691.       0.00
    4.1400   6.62E-06    17.1088   -10.8025  -6.67E-05       0.00    196791.
-0.9285     16140.       0.00
    4.2550  -4.77E-07    15.8603   -10.8520  -5.70E-05       0.00    196834.
0.06874     16588.       0.00
    4.3700  -6.50E-06    14.6128   -10.7926  -4.81E-05       0.00    196886.
0.9635     17036.       0.00
    4.4850  -1.15E-05    13.3780   -10.6363  -4.00E-05       0.00    196946.
1.7559     17485.       0.00
    4.6000  -1.57E-05    12.1665   -10.3946  -3.25E-05       0.00    197017.
2.4476     17933.       0.00
    4.7150  -1.90E-05    10.9873   -10.0789  -2.58E-05       0.00    197101.
3.0412     18381.       0.00
    4.8300  -2.16E-05     9.8483    -9.7005  -1.97E-05       0.00    197201.
3.5399     18830.       0.00
    4.9450  -2.36E-05     8.7562    -9.2700  -1.43E-05       0.00    197216.
3.9482     19278.       0.00
    5.0600  -2.49E-05     7.7162    -8.7974  -9.45E-06       0.00    197216.
4.2708     19726.       0.00
    5.1750  -2.57E-05     6.7328    -8.2923  -5.24E-06       0.00    197216.
4.5132     20175.       0.00
    5.2900  -2.61E-05     5.8090    -7.7636  -1.58E-06       0.00    197216.
4.6810     20623.       0.00
    5.4050  -2.61E-05     4.9471    -7.2196   1.55E-06       0.00    197216.
4.7804     21071.       0.00
    5.5200  -2.57E-05     4.1485    -6.6677   4.21E-06       0.00    197216.
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0.00880   7.86E+07       0.00

* This analysis computed pile response using nonlinear moment-curvature rela-
  tionships. Values of total stress due to combined axial and bending stresses
  are computed only for elastic sections only and do not equal the actual
  stresses in concrete and steel. Stresses in concrete and steel may be inter-
  polated from the output for nonlinear bending properties relative to the
```

magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 4:

```
Pile-head deflection             =     0.00103355 meters
Computed slope at pile head      =       0.000000 radians
Maximum bending moment           =   -66.97536718 kN-m
Maximum shear force              =    60.00000000 kN
Depth of maximum bending moment  =       0.000000 meters below pile head
Depth of maximum shear force     =       0.000000 meters below pile head
Number of iterations             =             31
Number of zero deflection points =              5
```

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, kN, and Load 2 = Moment, M, kN-m
Load Type 2: Load 1 = Shear, V, kN, and Load 2 = Slope, S, radians
Load Type 3: Load 1 = Shear, V, kN, and Load 2 = Rot. Stiffness, R, kN-m/rad.
Load Type 4: Load 1 = Top Deflection, y, m, and Load 2 = Moment, M, kN-m
Load Type 5: Load 1 = Top Deflection, y, m, and Load 2 = Slope, S, radians

Load Case No.	Load Type	Pile-head Load 1	Load Type	Pile-head Load 2	Axial Loading kN	Pile-head Deflection meters	Pile-head Rotation radians	Max Shear in Pile kN	Max Moment in Pile kN-m
1	V, kN	30.0000	S, rad	0.00	0.00	4.07E-04	0.00	30.0000	-39.5184
2	V, kN	40.0000	S, rad	0.00	0.00	5.45E-04	0.00	40.0000	-52.6585
3	V, kN	50.0000	S, rad	0.00	0.00	6.85E-04	0.00	50.0000	-65.7630
4	V, kN	60.0000	S, rad	0.00	0.00	0.00103	0.00	60.0000	-66.9754

Maximum pile-head deflection = 0.0010335512 meters
Maximum pile-head rotation = -0.0000000000 radians = -0.000000 deg.

The analysis ended normally.

Appendix 6: Hurricane Procedures Manual (Caribbean Disaster Mitigation Project, USAID)

Caribbean Disaster Mitigation Project

Implemented by the Organization of American States
Unit of Sustainable Development and Environment
for the USAID Office of Foreign Disaster Assistance and the Caribbean Regional Program



In the fall of 1998, the Caribbean Hotel Association (CHA) and the Caribbean Tourism Organization (CTO) produced a* Hurricane Procedures Manual *as a guidebook for tourist establishments in the Caribbean.
The Caribbean Disaster Mitigation Project supported the development of a chapter on 'Structural Vulnerability and Loss-Reduction Techniques' for inclusion in this manual.

Hurricane Procedures Manual

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The Caribbean Hurricane Experience

Hurricanes are a fact of life in the Caribbean (See Appendix 1). Within the past nine years, from 1988 through 1997, several hurricanes have unleashed their fury on the islands of the Caribbean. Hurricanes David in 1979, Allen in 1980 Gilbert in 1988, Hugo in 1989 and Luis and Marilyn in 1995 caused significant damage to hotels in Dominica, St. Lucia, Jamaica, Montserrat, Antigua,

and St. Thomas respectively. Marilyn also caused damage to beaches in Barbados. In 1995 and 1996, thirty-one storms crossed the Caribbean, the Atlantic and the Gulf of Mexico, causing the Regional Mechanism (Caribbean Disaster Response Agency) to be placed on alert nine times over the two years.

The 1995 Hurricane season was the most active, and perhaps the most destructive in recent decades. Hurricane Luis was the most destructive since Hurricane Hugo of 1989, with estimated damages of $2.5 billion occurring in the Caribbean from Luis alone. Following on Luis, Hurricane Bertha affected the region in 1996. Wind damage, storm waves, heavy rains and flooding caused major losses within the tourism sector. In addition, inadequately designed and constructed buildings, damaging media reports and inadequate insurance coverage in some instances have aggravated the financial and social consequences of these events. Recovery for some islands has been slow and some territories have had more than one impact in a single year or in consecutive years.

This hurricane procedures manual, first published in 1990 following Hurricane Hugo, has now been revised to meet the recurring needs of the tourism/hotel sectors for hazard mitigation. Hazard mitigation is defined by the Federal Emergency Management Agency (FEMA) of the United States as " actions taken to reduce or eliminate long-term risk to people and property from hazards and their effects". This goal can best be achieved by applying various strategies though structural and non-structural measures. Prevention and preparedness planning can help to reduce loss and most importantly will assist speedy resumption of business after the event.

There are some initiatives which need to be taken by the individual hotelier; others require partnerships among hoteliers or between hoteliers and selected stakeholders within the community; and still others require national and even regional collaboration.

This revised edition of the manual includes a chapter on structural vulnerability and loss reduction. One of the most cost-effective measures for mitigating disaster damages is to design and construct hazard resistant structures.

The time to prepare or plan for a hurricane is **before** the Event. The manual therefore, outlines the steps and activities which need to be taken before the hurricane season and certainly before a hurricane threatens. Managing the property and guests **during** an event is crucial to business continuity after the hurricane. Procedures are outlined for all phases of hurricane management. **Immediately following** a strike, there are several critical issues to be dealt with - these are described in the Section entitled **Recovery and Restoration.** Section IV entitled, **Structural Vulnerability and Loss Reduction**, outlines procedures to be followed by the hotelier to assess vulnerability.

The Manual

The manual has been designed to provide recommendations, tasks, and responsibilities for each major department within the facility. It allows for distribution of sections of the plan to the relevant departments, while at the same time allowing for the security and confidentiality of the entire plan. Procedures and responsibility for preparedness, and procedures for vulnerability assessment, appropriate design and retrofitting are outlined.

The prevention and preparedness phase includes: structural and non structural vulnerability assessments, maintenance requirements, retrofitting requirements, emergency supplies, mutual

aid agreements, guest information, training, insurance, community liaison, vital records, guest security, weather information, and media communication requirements.

The hurricane phase includes tasks for each department, form hurricane alert to strike. The recovery phase embodies guest relations, damage assessment, impact evaluation, clean-up and salvage, business restoration, and community relations.

The section on structural loss reduction details procedures to be followed for design, maintenance, repair and retrofitting before a hurricane strikes.

Testing, Maintaining, and Upgrading Procedures

This manual is a written document, and not a plan. The procedures detailed must be tested, and the details for each property and department worked out and corrected through training drills and simulation exercises.

Additionally, the procedures must be integrated into the overall management plan for the organization in terms of company policy, operational budget, training, and job descriptions. Training is vital to the success of hurricane preparedness and disaster management and properties should seek to communicate requirements to the respective staff and to implement training programmes for the relevant procedures.

Testing of the Plan Should:

➢Confirm that ALL personnel understand their responsibilities and can successfully carry them through.

➢ Serve as training for personnel.

➢ Be conducted on an annual basis, preferably before the onset of the hurricane season.

➢ Include consideration and review of the plan, incorporating changes as these are found necessary.

➢ Evaluate vulnerability assessments and requirements for maintenance, repair and retrofitting.

Acknowledgment

The revision of this Hurricane Procedures Manual has been a professional pleasure given the increasing exposure of the Caribbean Hotel sector to more intense and frequent hurricane activity within the region. I congratulate the Caribbean Hotel Association (CHA), and the Caribbean Tourism Organization (CTO) for this timely and well needed initiative. Special tribute to the Caribbean Disaster Mitigation Project (CDMP) which joined forces with the CHA and CTO. The CDMP is funded by the Office of Foreign Disaster Assistance (OFDA) of USAID and executed by the Organisation of American States (OAS).

I am grateful to Ms. Kelly Robinson, and Messrs Bill Moore and Alec Sanguinetti of the CHA and Mr Michael Youngman of the CTO for their valuable contribution.

Mr Al Wason, Professional Engineer and Disaster Mitigation Specialist, provided the substantial technical input for the section on Structural Vulnerability and Loss Reduction.

Mr. Joseph Murray of the Murray Group and Mr Luis Flamand of the CHA Insurance Company provided information for the Insurance component and WRH & Associates assisted with design and information for the communications plan.

Mr. Jerry Collymore and Ms. Audrey Mullings of the Caribbean Disaster Response Agency, CDERA, were generous with their reports on hurricane activity for the past 4 years.

Sarah Bell, Lovelette Brooks, and Sharonmae Shirley of Environmental Solutions Limited deserve special thanks for their revised design of the manual.

Grateful thanks to all who have contributed to making this manual a reality.

Eleanor B. Jones
Environmental Solutions Limited
Kingston, Jamaica W.I.

Letter from CHA

Dear Hotelier:

If the primary responsibility of a Trade Association is to respond to the needs of its members, then there could have been few more powerful imperatives than to assist the Hotel & Tourism Industry in dealing with the damage inflicted by hurricanes and other natural disasters in the Caribbean region.

Our sincere thanks must go to the International Hotel Association, whose generous donation from their Fund For the Future started the ball rolling; to American Express Travel related services and USAID/OFDA , who have supported this endeavour by including the chapter on structural loss reduction and picking up the printing bill. With help from CHA's own reserves, and matching support from CTO; this Hurricane Procedures Manual has thus become a reality. Our goal in bringing this project to fruition was to help you better protect the safety of your guests, your property, and certainly to strive to enhance the perpetuation of Caribbean Tourism.

Our thanks also to the professionalism and hard work of Eleanor Jones and Environmental Solutions for making our Manual a reality.

Signed,

John Bell

Executive Vice President

Letter from CTO

Dear Reader:

The Caribbean is blessed with such a glorious and delightful climate most of the time that, were it not for the occasional intrusion of hurricanes, we might be tempted to believe that we have already achieved heaven on earth. However, first Gilbert in 1988, Hugo in 1989, Luis and Marilyn in 1995 and 1996 respectively, are sad reminders that hurricanes do happen in the Caribbean, and that those unfortunate enough to encounter such violent forces of nature in an unprepared state can suffer considerable - and probably unnecessary damage. This Hurricane Preparedness Manual, which CHA and CTO have had prepared, with the technical expertise of Eleanor Jones and Environmental Solutions Ltd., is a timely and useful tool for the tourism sector. However, its real value lies in it being studied, and its action programme being complied with. For both tourism organizations, CHA and CTO, it is the first step in a total programme of education, training, and public relations, in meeting, coping with, and recovering from disasters.

I hope to hear from you readers how you value this document, and I would welcome any ideas on how it might be improved.

Yours Sincerely,

Jean Holder

Secretary General

Executive Summary

Hurricane Characteristics

In preparing for hurricanes, it is important to have some basic knowledge of hurricane characteristics and effects. The short section entitled Hurricane Characteristics provides just that information. The section describes the characteristics of a hurricane, hurricane effects, hurricane categories and the hurricane warning system.

Before a Hurricane

This phase should be ongoing throughout the year. Full preparation is the key to minimizing loss of life and property, and to ensuring speedy resumption of business. All Departments have tasks - but leadership is given by the General Manager, and the Emergency Coordinating Committee. During this stage, attention should be given to:

- Creation of the Emergency Coordinating Committee
- Vulnerability Assessment, including maintenance and retrofitting requirements
- Emergency supplies
- Mutual aid agreements
- Guest Information Packets
- Committee liaison policy
- Vital records protection
- Guest security protection
- Obtaining up-to-date weather information
- Training of staff
- Media Communications requirements*
- Insurance Coverage**

**Media Communication requirements will be discussed in Section V*
***Insurance Coverage will be discussed in Section VI*

During the Hurricane

The Hurricane section includes several phases of activity, from the period when the hurricane approaches the region, to the actual strike. Time is critical, and keeping tuned to weather information and national emergency procedures is important.

Section II - During the Hurricane, outlines the responsibilities of the Emergency Coordinating Committee and each of the departments by hurricane phase.

After the Hurricane

Safety of guests, communication with the outside, and prompt resumption of business are the major considerations in the period following the hurricane. Therefore the following elements require attention immediately after the hurricane:

- Activate the Communications Plan.
- Brief assessment of damage.
- Document (photograph) damage.

- Prioritize clean-up and salvage.
- Security of property, and safety of guests. Carry out head count.
- Seek mutual aid as needed, especially for comfort of guests.
- Facilitate contact between guests and organizations to enable communication with relatives and friends.
- Liaise with travel services concerning arrangements for guests.

Structural Vulnerability & Loss Reduction

Review of damage to buildings from recent events indicate failure of aspects of the structure to resist hurricanes. Hoteliers should be made aware of how hurricanes affect buildings so as to be able to effect quality control in roofs, windows, doors, foundations and other elements of structures. Design criteria to withstand both hurricanes and earthquakes are presented and procedures for assessing vulnerability and retrofitting are outlined. Maintenance plans are important to structural soundness.

Hurricane Characteristics

Hurricane Characteristics

SEASON: Commences June 1 and ends November 30, but storms may occur at other times of the year.

SPEED: Speed of advance of approximately 20-25km/hr (12-15 Knots).

COURSE: Normally moves from East/Southeast towards West/Northwest and Northwest during initial stages but curves towards the North as it progresses (in the Northern Hemisphere).

WIND SPEED: Wind speeds generally in excess of 135 km/hr (75 Knots) but may gust up to 315 kn/hr (175 Knots) (GILBERT Sept. 1988).

SURGE: Storm Surge may be experienced if hurricane passes close offshore 3-10m (10-33 feet) and conditions are conducive.

WIDTH: Width of destruction 170-250 km (106-155 miles).

RAINFALL: Up to 450 mm (18 in) in the first two (2) hours.

LULL: A deceptive lull lasting approximately 30 minutes occurs when the centre (the EYE) of the hurricane passes. Wind speed resumes intensity and quickly, immediately after the eye passes.

EYE: Is the centre of the hurricane where there are no winds and where barometric pressure is very low.

Hurricane Effects

➢ **Wind damage** - This is potentially one of the most destructive aspects of the hurricane. It can result in loss of roofs, windows, doors and vegetation.

➢ **Collapse of buildings**

➢ **Damage by fallen trees** - Disruption of electricity and telephone facilities, damage to buildings and blocking of roads.

➢ **Flying debris** - Zinc sheets, tree limbs, timber, roofing materials, fruits etc. can cause further damage to other structures.

➢ **Rain Damage** - Otherwise sturdy trees and light poles may collapse earlier than expected due to water saturation around their bases. Leaking roofs, from torrential downpour can saturate walls and destroy contents of buildings and cause the destruction of structures.

➢ **Flood Damage** - Disruption of surface communications. For example, roads, flooded or washed away; landslides; bridges destroyed; railway lines flooded or washed away; contamination of drinking water supplies.

➢ **Storm Surge** - Heavy seas, storm waves and storm surge can cause extensive damage and completely destroy structures and coastal features. The direction of approach of the hurricane and the physical form of the coastal area will influence the potential destructive force of the waves.

Hurricane Categories

Category 1 Winds 119-152 km (74-95 mph) or storm surge 1 -1 1/2 m (4-5 ft) above normal.

Category 2 Winds 154-177 km (96-110 mph) or storm surge 1 1/2 -2 1/2m (6-8 ft) above normal.

Category 3 Winds 178-209 km (111-130 mph) or storm surge 2 1/2-3 1/2m (9-12 ft) above normal.

Category 4 Winds greater than 249 km (155 mph) or storm surge greater than 51/2 (18 ft) above normal.

The Warning System

The following warnings will be issued prior to a Hurricane. Members of staff should pay careful attention to these warnings as there are certain procedures to follow after each warning. Some radio and television stations in the region have a special signal which precedes warning messages. Become familiar with them.

Phase A **HURRICANE ALERT** - Hurricane entering the region.

Phase B **HURRICANE WATCH** - 36 hours to landfall.

Phase C **HURRICANE WARNING** - 24 hours to landfall.

Phase D **EMERGENCY PHASE** - Strike.

Section I: Before the Hurricane Strikes

The Emergency Management Team

In order to ensure that this emergency manual is an integral part of the culture and practice in your establishment, an emergency coordinating (EC) committee should be established. This committee will serve as the overall coordinating and executing body for all emergencies and will be responsible for managing and implementing emergency preparedness mechanisms at all stages of a hurricane.

EC Committee Structure

The members of the emergency coordinating committee should be appointed by management. At the head of the committee, is the Emergency Coordinator. An Alternate Emergency Coordinator should also be designated in the event that Emergency Coordinator is absent. The committee should also consist of a public relations person, the environmental person (if your facility has one) and at least one representative from each of the departments (or areas of the hotel or resort. These department representatives need not be managers or heads of the management team but should be any member of staff who knows the department integrally and is capable of carrying out the requirements of a committee member. Figure 1 outlines a possible structure of the emergency coordinating committee.

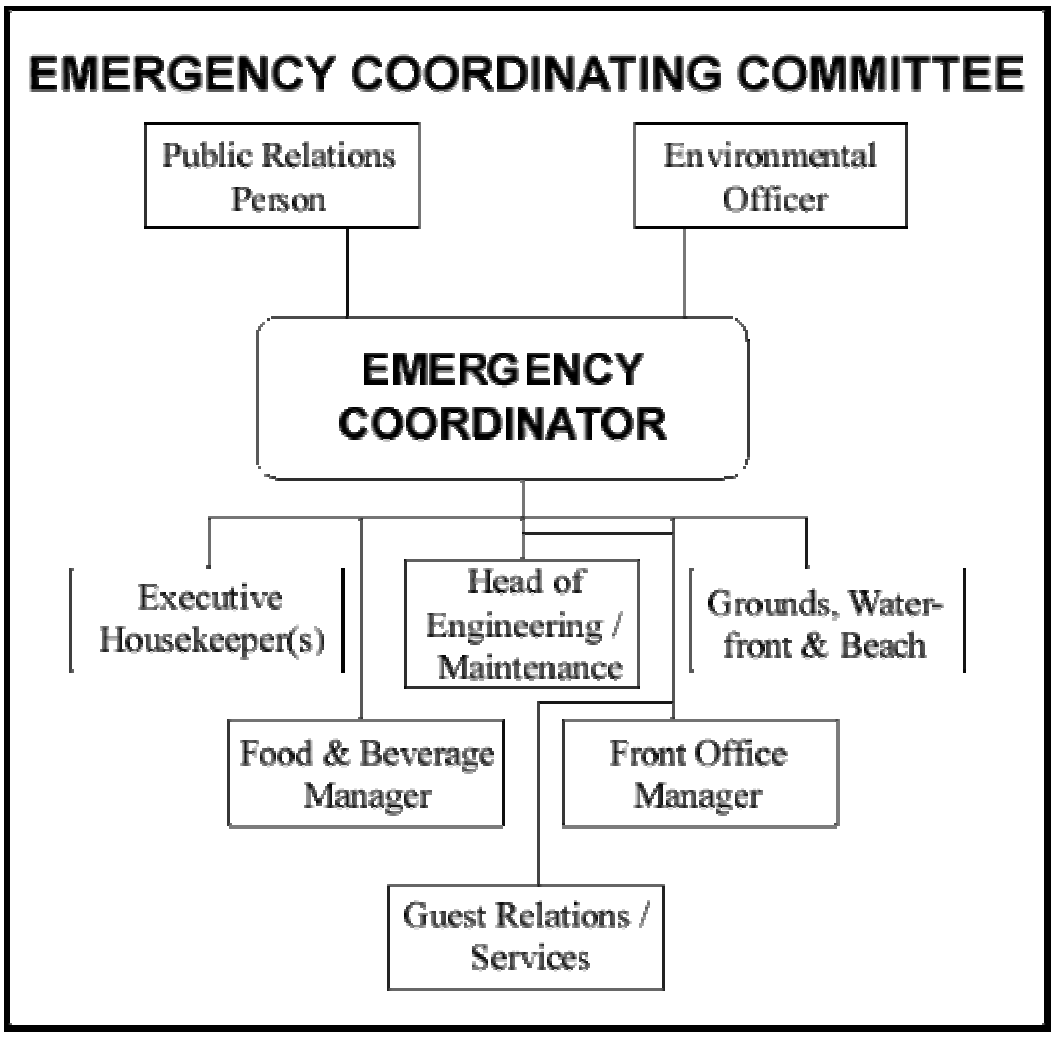

Figure 1: Emergency Coordinating Committee Structure

Committee Responsibilities

The first four projects of the EC Committee should be to:

(1) Familiarize themselves with the plan;

(2) Help the rest of the staff to become familiar with the plan;

(3) Designate responsibilities for action before, during and after a hurricane; and,

(4) Get first aid training.

All departments at your resort or hotel should be included when responsibilities are being assigned. These responsibilities should be made clear to each department and displayed in an openly accessible place within the department.

Suggestions for the EC Committee

➢ The EC Committee should meet at the end of March to review the maintenance report, review priority areas for action and review hurricane procedures with all staff.

➢ A second meeting must be held at the beginning of June, at the start of the hurricane season, to review and assess the level of preparedness, and fine-tune procedures.

With respect to the members of the Emergency Coordinating Committee, specific responsibilities are outlined as follows:

Emergency Coordinator (General Manager)

➢ Create the Emergency Coordinating Committee in consultation with other management staff at the hotel or resort.

➢ Overall coordination of regular hotel or resort operations and hurricane procedures.

➢ Liaise with emergency and information services (e.g. the National Office of Disaster Preparedness and Emergency Services, the Weather Reporting Station, appropriate community contacts) as well as mutual aid partners.

➢ Institute preventative measures (as described throughout this manual) to minimise opportunities for emergency situations.

➢ Conduct vulnerability assessment of the facility in consultation with other EC members and external expertise where necessary.

➢ Document the incident.

➢ Administer First-Aid when necessary.

Environmental Officer

➢ Give advice to the Emergency Coordinating Committee regarding Hurricane related prevention measures and Environmental matters on the property.

Public Relations Person

➢ Provide the link between the resort or hotel and the community, media and international stakeholders through a Communications Plan.

➢ It is also the responsibility of the PR person to keep the Communications Plan alive and to activate the Plan at the relevant time.

Other Emergency Team Members

- Ensure execution of prevention and preparedness tasks.

- Supervise clean-up activities.

- Ensure that sufficient quantities of emergency supplies (e.g. batteries, band-aids, stored water, etc.) are in stock.

- Dispose of damaged material.

- Administer first-aid where necessary.

There are many tasks that must be undertaken in order to properly prepare for a hurricane. The following charts can be used as *handy checklists* for ensuring that all tasks related to hurricane preparedness are completed.

Staff Liaison

TASK	RESPONSIBILITY
General Manager should meet with Departmental Heads; and Departmental Heads with staff.	Emergency Coordinating Committee

Recommendations

- Conduct monthly meetings on hurricane procedures.

Assess Your Risk

TASK	RESPONSIBILITY
☐ Check all buildings in March each year for both structural defects and non structural vulnerability. Check windows, doors, walls, roof, equipment, furniture, documents, etc. Repair or correct problems before the hurricane season.	Chief Engineer Emergency Coordinator Obtain external expertise where necessary
☐ Utilize Building Assessment Safety Checklist (Form 1). ☐ Ensure compliance with National Building Code where it exists.	Chief Engineer

☐ Create and implement Hurricane Maintenance Programme (esp. roof, windows, doors, etc.)	Emergency Coordinator
☐ Basic maintenance budget required.	Emergency Coordinating Committee
☐ Utilise the assessment reports to determine: ➢ the most appropriate location within the facility which will serve as the HEADQUARTERS/COMMAND POST during the event; ➢ which room may be easily converted for use as a FIRST-AID CENTRE; ➢ which rooms are most appropriate for the safety of the guests during the hurricane.	Emergency Coordinator/Engineering Maintenance Personnel Emergency Coordinating Committee

Recommendations

➢ Vulnerability assessment (Structural) of all buildings must be instituted as a permanent function of the Engineering Department (where one exists), or given to persons with equivalent responsibility. (See Section IV). Findings should be acted upon.

➢ Check non-structural vulnerability assessments twice annually - March and July each year. (Use Checklist - Form 1). The results of these assessments must be incorporated into the building maintenance programmes.

Weather Information

TASK	RESPONSIBILITY
☐ Keep radio tuned to channel for news where appropriate. ☐ Install weather band for continuous reports during the Hurricane Season.	Emergency Coordinating Committee

Recommendations

➢ Acquire radio and place in main office to ensure continuous monitoring of weather information.

➢ If internet access is available, check the following web sites and share relevant data with EC Committee and staff.

National Hurricane Centre - http://www.nhc.noaa.gov/

Weather Net - http://cirrus.sprl.umich.edu:80/wxnet/tropical.html

Atlantic Tropical Weather Centre -
http://banzai.neosoft.com/citylink/blake/tropical.html

➢ If cable or dish is available to your television, keep regular check of the weather channel to obtain updated hurricane and storm tracking information.

Vital Records

Determine secure storage areas for **VITAL RECORDS** and use for permanent on-site storage. Vital records of the company must be duplicated and stored off-site. (All magnetic tapes and computer disks should have back-ups in safe storage).

Emergency Supplies

TASK	RESPONSIBILITY
☐ Inventory tasks to be carried out by head of each department (or the equivalent) in the organization/facility.	General Manager / Financial Controller
☐ Inventory existing supplies.	Department Heads / EC Committee Rep.
☐ Requisition for replacement supplies.	Department Heads
☐ Prepare emergency supplies purchase orders, and keep in stock for distribution.	Department Heads

Recommendations

➢ Earmark and allocate funds for procurement of emergency supplies, and for regular maintenance of facilities. See suggested Emergency Supply Checklist (Form 2).

➢ Determine policy for handling keys and access to emergency supplies.

➢ Ascertain major department priority supplies for emergencies: e.g. Kitchen, Housekeeping, Engineering/Maintenance, First Aid, etc; then include in emergency budget.

Mutual Aid Agreements

TASK	RESPONSIBILITY
☐ Discuss mutual aid possibilities with relevant selected persons according to need and read agreements as necessary.	General Manager
☐ Review agreements annually and update status.	General Manager
☐ Where possible, share resource inventories which relate to particular agreements.	General Manager
☐ Negotiate purchase agreements on a contingency basis where necessary, e.g. hardware supplies.	General Manager

Recommendations

Formulate and adopt specific Mutual Aid Agreements with goods suppliers, neighbouring facilities, and operators on other islands, where applicable (Use Form 3). Areas of importance include:

➢ diesel and gasoline suppliers

➢ transportation for workers and possible evacuation of guests

➢ potable water

➢local bakeries and food supplies

➢ hardware supplies

➢heavy equipment service and rental companies.

Community Liaison Policy

TASK	RESPONSIBILITY

☐ Hold discussions on community relations and determine policy to be followed in terms of emergency assistance to community members.	General Manager
☐ Implement policy as soon as a decision is reached, by informing the National Emergency Organization, Hotel Management, staff, etc.	General Manager under direction from Corporate Body

Recommendations

➢ Define policy on acceptance of local guests in the event of a hurricane, and responsibility to the community in terms of assistance, etc.

Communications

TASK	RESPONSIBILITY
☐ Section V outlines a communications strategy. Adapt this prototype to suit your property.	General Manger Public Relations Person

Recommendations

➢The General Manager in consultation with the Board of Directors should define hotel policy on communications. **Section V** outlines steps for a communications plan.

Insurance

TASK	RESPONSIBILITIES
☐ Hold discussions on insurance and determine policy to be followed. Seek advice from insurance companies.	General Manager under the direction of the Corporate Body
☐ Implement policy as soon as a decision is reached.	General Manager

Recommendations

➢ The General Manager in consultation with the Board of Directors should define hotel policy on insurance coverage on physical structure, liability, and loss of profit. **Section VI** outlines steps for insurance coverage.

Guest Information

TASK	RESPONSIBILITY
☐ Prepare hurricane emergency procedures for guests. Keep on file.	Guest Relations/Services (see Form 4)
☐ Adapt guest information kits for condominiums and villas (as appropriate).	"
☐ Prepare a disclaimer letter for guests. Keep on file.	"

Recommendations

➢ Prepare guest information (brochures and disclaimer letter) for distribution at an appropriate time. Form 4.

Training

TASK	RESPONSIBILITY
☐Provide briefing sessions for staff on hurricane procedures for the home.	Emergency Coordinator through relevant organizations, e.g. Emergency Management Agency, CHA, Red Cross.
☐Include training in emergency procedures in orientation programme for new employees.	Emergency Coordinator

Recommendations

Conduct on-going training programmes in the following areas for different categories of staff:

➢ CPR, Basic First Aid

- Response procedures outlined in the manual
- Conducting regular exercises (Drills).

Evacuation of Guests

TASK	RESPONSIBILITY
☐Establish conditions under which evacuation will be necessary and state these in the plan, determining responsibilities of members of the staff for this task.	General Manager under direction from the Corporate Body.
☐Determine appropriate shelter with National Emergency Organization.	Same as above.

Recommendations

- Evacuation of guests to designated national shelters should be carried out only when this is felt to be the only appropriate course of action, given conditions for guest and staff safety.

Section II: During the Hurricane

Emergency Coordinating Committee

Phase A: Hurricane ALERT

TASKS
Hurricane Information
☐Map should be posted in the room designated as Command Centre, as instructed by General Manager, and at the Guest Information Centre Desk.
☐Telephone Operators should be instructed to refer ALL queries on the hurricane to the General Manager or designated spokesperson. (See Section V)

Recommendations:

➢A hurricane tracking map should be duplicated and used to track hurricane paths in the Caribbean.

➢Record information and establish and maintain contact with National Emergency coordinator and other local responsible authorities.

➢Make contact with the National Emergency Office and local authorities.

➢Ensure that all members of Coordinating Committee are made aware of hurricane developments.

Phase B: Hurricane WATCH

TASKS
Guest Information & Security
☐Locate pre-published guest emergency procedure letters.
☐Determine number of SAFE rooms for those persons that do not want to move to the central area. SUBMIT TO EMERGENCY TEAM. Give priority to disabled guests.

Recommendations

Make arrangements to:

➢Distribute to each guest room (with assistance from General Management Personnel) a Memo and the brochure instructing guests on hurricane procedures, as it affects them. ONLY DISTRIBUTE WHEN DIRECTED TO DO SO BY GENERAL MANAGER.

TASKS
Vital Records
☐Assist in securing all important files and equipment
Other Responsibilities
☐Maintain hurricane tracking map at Command Post as policy dictates.
☐Develop current list of key employees of Departments and contact addresses, phone numbers, etc.
☐Request all needed materials and supplies based on inventory provided; should include potable

water
☐Arrange worker transportation

Recommendations

➢General Manager, as head of Emergency Coordinating Team, meets with Team; discusses priorities for action based on activities achieved to date and staff/resource availability.

Phase B: Hurricane WARNING

➢Emergency Coordination Committee should lead the hurricane preparation procedures for each department. (*See each department's responsibilities for details*)

Phase C: EMERGENCY Phase

Special Note: During the Emergency Phase a skeleton Emergency Team of at least the General Manager and two other Committee members (preferably the Maintenance and the Kitchen Person) should remain.

TASKS
Guest Safety & Comfort (4-2 hours)
☐Evacuate guests to designated in-house shelter: a) alternatively, to designated safe rooms b) solicit voluntary assistance from guests as may be deemed necessary.
☐Check and ensure all rooms not designated safe are secured, unoccupied, and locked.
☐Address guests on activities for duration of hurricane.
☐Distribute games and/or initiate schedule of activities for guests (with assistance from volunteers).

General Manager / Offices

Phase A: Hurricane ALERT

➢Provide assistance and information to the EC Committee where and when - ever necessary.

Phase B: Hurricane WATCH

TASKS
Guest Information & Security
☐Determine number of guests likely to be resident at landfall of hurricane.
☐Liaise with sales and marketing personnel.
☐Determine schedule of events/ entertainment etc. available for guests to be included in guest memo.
☐Obtain list of all the guests and their room numbers. All EC Committee members should get a copy.

Recommendations

➢Review and backup computer files. Place existing hard copies, accounts, receipts, etc., in secure filing cabinets, away from areas subject to flooding etc.

➢Ensure staff on hand to settle guests’ bills where this has been adopted as established procedure.

TASKS
Mutual Aid
☐Reconfirmation of Mutual Aid Agreement, if necessary, and revision of requirements as perceived.
Staff Roster
☐Develop list and submit to Emergency Team.
☐Recall all key personnel as deemed necessary.
☐Make tentative arrangements for those who will stay on premises.
☐Distribute all key personnel as deemed necessary.

Recommendations:

➢Check and revise phone numbers of all Department Heads, Supervisors, and key personnel. Develop alternate list chart, dependent on those persons available (i.e. not on vacation, sick, etc.).

➢Make arrangements for employees to manage facility and guests during the crisis. Develop Staff Roster.

➢Allow employees time to make emergency preparations of their homes, ensuring they leave contact addresses, and are aware of possible rotation of staff roster.

Phase C: Hurricane WARNING

TASKS
Protection of Equipment, Supplies, and Vital Records (18-12 hours)
☐Secure and make sure adequate supplies of polyethelene sheeting available to cover desks, and equipment as needed.
☐Where necessary, prepare area for storage of small electrical items-(e.g. Calculators).
☐Disconnect and store all electrical appliances which will not be used up to the point of electrical failure.
Guest Accounts (12-6 hours)
☐Secure and lock away all vital records that are not necessary for usage within the next 24 hours.
☐Ensure all guest bills are paid or locked away in filing cabinets.
Staff Duty
☐Discharge all staff not required to be on hand.
☐Record and verify names of staff on duty.

Kitchen

Phase A: Hurricane ALERT/WATCH

TASKS

Food and Water Supplies
☐Take inventory of canned meats, vegetables, drinks, disposable sanitary ware, etc. (See Form 2).
☐Report status to General Manager or Team Leader, request additional supplies as necessary.

Recommendations

➢Conduct briefing meeting with kitchen staff, identifying priority tasks and delegate according to specific time requirements.

TASKS
Menu
☐Create cycle menu based on inventory.
☐Serve buffet style meals as determined necessary.
☐Sterilize and fill all available water containers; store in a safe place.
☐Make tentative arrangements with staff concerning possible rotation; establish contact addresses for key persons.
☐Allow staff to make personal emergency preparations.

Phase B: Hurricane WATCH

TASKS
Lighting, Cleaning, Mopping
☐Ensure provision of Emergency Lighting.
☐Place mops, buckets, garbage cans, etc. in strategic locations.

Recommendations:

➢Prepare for service during emergency phase.

Phase C: Hurricane WARNING/EMERGENCY Phase

TASKS
Food and Drink Service (12 hours up to Emergency Phase)
☐Set up tea/coffee/drink stations in or near designated shelter area, or safe blocks of rooms, using vacuum containers.
☐Raise or remove all items on floor areas subject to flooding
☐Prepare safe dining area and set up tables for guests
☐Arrange sterno heating with safe guard sternos. Arrange dishes and food
☐Close bars- no alcohol to be available
☐Serve sandwiches, soups, cold drinks- if all else fails
☐Chill canned juices/sodas to reduce demand for ice

Maintenance & Engineering Department

Phase A: Hurricane ALERT

TASKS
Cleaning
☐Clean all drains and remove debris on roofs/ drainage ditches
☐Clear or prepare rooms appropriate for storage of pool furniture

Recommendations:

➢Alert staff and brief them on developments.

➢Delegate and assign specific tasks, and define objectives in terms of time.

TASKS

Storage
☐Store pool chemicals
☐Clean out all floor drains
☐Prepare plywood and plastic sheeting to cover transformers in the event of leaks.
Emergency Supplies
☐Inventory existing emergency supplies and detail requests for additional supplies as necessary.
Standby Generators
☐Service plant and emergency generators. ➢Replenish diesel fuel ➢Service all cables and oil filters.
☐Test generator to check output reliability.
☐Provide rain/wind protection around plant.
Transport Vehicles
☐Check operating condition and service all transport vehicles.
☐Fill vehicles with fuel

Phase B: Hurricane WATCH

TASKS
Grounds
☐Trim limbs from large trees or those near buildings.
☐Remove coconuts from trees.
☐Clear drains -- including roofs.
Water Tanks

☐Fill water tanks with emergency water supplies.
Emergency Equipment
☐Service and test emergency power generators under load, prior to emergency use.
☐Check conditions of emergency equipment to ensure it is operable.
☐Secure emergency lighting supplies for kitchen, if generator not available.
☐Remove and store wind breaks from fences.
Flooding
☐Fill sandbags to protect areas from flooding, where appropriate.

Phase C: Hurricane WARNING

TASKS
Air Conditioning
☐Operate air conditioning/boilers until power fails.
Shutters
☐Install plywood or storm shutters to areas of glass or deemed most vulnerable to breakage.
Drains (12 Hours)
☐Ensure final check of drains cleared, including roof drains.
Tennis Courts
☐Remove nets from courts and store in secure area.
Swimming Pool (As necessary)
☐Lower water in pool by 2-3 feet.
☐If flooding begins in critical areas, use pumps to discharge storm water.
Satellite Dishes, Flags, Sign Boards, etc. (6-12 hours)

☐Dismantle satellite dishes, antennas, umbrellas, flags, sign boards, etc.
Pool Furniture (6 hours)
☐Store pool furniture not stored in pool. Secure those that need be, with rope.
Other Preparations
☐Tie down all other equipment which needs to be secured.
☐Load cameras with film.

Housekeeping / Laundry

Phase A: Hurricane ALERT

TASKS
☐Compile updated list of housekeeping staff, and establish a tentative roster.
☐All linen to be secured.
☐Distribute Guest Emergency procedures on direction from the Emergency Coordinator.

Recommendation:

➢Alert staff of conditions, and delegate tasks with respect to securing laundry facilities. Ensure that adequate linen, etc. are available.

Phase B / C: Hurricane WATCH / WARNING

TASKS
24 hours
☐Remove all patio furniture and pots and place in rooms.
☐Begin to secure rugs (roll up) drapes or remove and store in secure position in unoccupied guest rooms.

18 hours
☐Ensure that emergency lighting is available in all designated safe rooms.
☐All television sets (alarm clocks, radios etc.) should be secured in garbage bags, taped/stored in cupboards starting with unoccupied rooms.
☐Guests should be provided with large garbage bags to wrap suitcases.
8 hours
☐Finish securing all room furniture, draperies, etc.
☐Close all louvers securely in rooms.
☐Close all doors in unoccupied rooms. ➢Place all small damageable items in rooms not occupied, in closets, e.g. lamps, bed linen, etc.
6 hours
☐Ensure all tubs are filled in guest rooms with water for guest use.
☐Housekeeping to use old sheeting to stuff windows and under doors to prevent rain from soaking (assisted by ground staff).

Grounds Staff

Phase A / B / C: Hurricane ALERT / WATCH / WARNING

TASKS
Trees & Shrubbery
☐Trim trees.
Secure Objects
☐Secure all outdoor signs.
☐Secure all big lighting fixtures that could be blown away or other wise damaged.

☐Secure nets/tennis courts.
☐All loose objects to be secured and stored indoors where possible.
Shutters
☐Raise emergency guest shutters in rooms where supply exists.
☐Ensure sandbags are in place in critical areas where required.
Assist Housekeeping
☐Assist housekeeping staff to secure rooms.

Security

Phase A: Hurricane ALERT

TASKS
Staff Schedule
☐Establish necessary rotation schedule for backup.
Emergency Lighting
☐Secure lighting for immediate use. Activate radio with battery, and alternative communication facilities where established.
☐Secure all important files, equipment, and data.

Recommendation:

➢Determine adequacy of backup personnel.

Phase B / C: Hurricane WATCH / WARNING

TASKS

Security Posts
☐Establish security posts.
☐Take all steps necessary to ensure safety of all personal property.
Emergency Phase
☐Be on the alert for damages in the area and record.
☐Be on the lookout for intruders who will take advantage of the uncertain situation.

Section III: Recovery and Restoration

Immediately after a hurricane there are many tasks that must be attended to in order that operations are returned to normal as soon as possible.

The following **TASK/ RESPONSIBILITY** checklists should be used to ensure that all necessary tasks towards full recovery and restoration are completed.

Immediate Post Hurricane Hours

TASKS	RESPONSIBILITY
☐Establish overall ability to provide service to guests, based on resource availability, including Mutual Aid Agreements.	General Manager and Emergency Coordinating Team
☐Review and assessment resources to assist in clean-up and salvage operations and detailed damage assessment.	General Manager and Emergency Coordinating Team
☐Deploy staff available into teams with responsibility for: ➢ Damage Assessments (use Damage Assessment Report Form) and	General Manager and Emergency Coordinating Team

➢Clean-up Salvage	
☐Assess shortfalls in returning to normal operations.	General Manager and Emergency Coordinating Team
☐Assess and negotiate for joint use, lending, borrowing, and sharing of facilities, equipment, and personnel services.	General Manager and Emergency Coordinating Team
Guest Relations	
☐Carry out head count of guests.	Emergency Coordinating Team
☐Find alternative accommodations for guests, if this proves necessary, utilizing mutual aid agreements.	General Manager and Emergency Coordinating Team
☐Use media, where necessary, to provide workers with information regarding resumption of duties.	General Manager and Emergency Coordinating Team
☐Liaise with travel services and provide guests with information on possible travel arrangements, given the state of these services.	General Manager and Emergency Coordinating Team
☐Facilitate contact between guests and those organizations which may be able to facilitate communication with their relatives and friends, for example; local Embassies, the Red Cross, or American Express.	General Manager and Emergency Coordinating Team
☐Provide guests with information on interim arrangements being provided for their comfort and safety.	Emergency Coordinating Team

Recommendations

➢The Emergency Management Team members should make a brief assessment of the damage then meet to discuss and agree on priority activities to be taken.

➢The Manager should activate Mutual Aid Agreements (inter-hotel/company agreements for recovery operations.)

➢Provide information to guests to reduce their anxiety and to assure them that their interests are not being neglected.

➢Accurate information to the media should be provided as requested. Ensure that statements to the press are accurate, and brief, and without exaggeration. Be positive. (See the Communication Plan - Section V)

➢The loss of credibility with the public and guests following a crisis, such as a hurricane, could affect future operations, market share, and customer base.

Damage Assessment

TASKS	RESPONSIBILITY
☐Consult Priority Repairs Needs Report, developed by the initial inspection team immediately following the event (See Damage Assessment Report).	General Manager and Engineering and Maintenance
☐Photograph damage	Damage Assessment Team
☐Survey properties on basis of priority identified above. Insurance under-writer to accompany team/or retained quantity surveyor.	Damage Assessment Team
☐Itemize structural and non-structural damage.	Damage Assessment Team
☐Itemize damage to specific building equipment.	Damage Assessment Team
☐Itemize damage to utilities and communications system.	Damage Assessment Team
☐Identify need for contracted services.	Engineering and Maintenance
☐Identify labour and material needs for damage repair.	Engineering and Maintenance
☐Estimate each building’s repair costs.	Engineering and Maintenance
☐Summarize damage survey with estimated repair cost.	Engineering and Maintenance
☐Develop recovery schedule.	Engineering and Maintenance
☐Request advice on redesign or modification of vulnerable elements.	Engineering and Maintenance

Recommendations

➢Assess structural and non-structural weaknesses which contributed to damage.

Impact Evaluation

TASKS	RESPONSIBILITY
☐Identify disrupted telephone and power services, water shortages, damage to major transportation routes, and disruption of public transportation facilities.	General Manager and Emergency Coordinating Team
☐Ascertain projected restoration period.	General Manager
☐Contact employees to ascertain extent to which personal damage and dislocation will prevent work resumption.	Emergency Coordinating Team
☐Assess level of human resources needed for recovery work.	General Manager
☐Make decision relative to hiring temporary personnel.	General Manager
☐Assess reallocation of resources and unplanned expenditure.	General Manager

Recommendations

➢Identify effect of event on total environment within which each property is located.

➢Determine emergency measures needed to facilitate business restoration in the interim short-term period prior to full recovery.

➢Identify areas of dislocation.

Clean Up And Salvage

TASKS	RESPONSIBILITY
☐Establish temporary dump on premises, where necessary.	Emergency Coordinating Team
☐Activate clean-up and salvage team.	General Manager
☐Activate mutual aid for transportation and other support for	General Manager

recovery activities.	
☐Clean-up facilities; utilize voluntary assistance of those guests with any interest.	Clean-up and Salvage Team
☐Secure contractor services where needed.	General Manager
☐Request professional assistance if necessary.	General Manager

Recommendations

➢Identify, remove, and dispose of rubble and debris.

Business Restoration

TASKS	RESPONSIBILITY
☐Activate plan for temporary front office, in the event of damage.	General Manager
☐Ensure that key personnel (or back-up staff) report to headquarters, provide assistance where necessary.	General Manager
☐Provide transportation for movement of key personnel and supplies.	General Manager
☐Implement recovery plan for business operations, revising marketing strategy as opportunity presents itself.	General Manager

Recommendations

➢Examine possibilities for change in marketing strategies, as in many instances, accommodation facilities for relief and rehabilitation workers are required.

Community Relations

TASKS	RESPONSIBILITY
☐Obtain information on extent and magnitude of damage to overall area in which the properties are located.	General Manager and Emergency Coordinating Team

☐Obtain information on governmental action schedule to restore roads and utilities.	General Manager
☐Negotiate assistance for structural inspection and demolition, where necessary.	General Manager
☐Negotiate several permits, as may be required, for recovery operations.	General Manager
☐Make known any assistance which the hotel can provide to the community, e.g. shelter, food, etc.	General Manager or Public Relations Person

Recommendations:

➢Establish and maintain means of communication exchange with relevant public sector agencies.

➢Consult matrix of responsibilities in local National Disaster Plan to determine which agencies to contact in case of need.

Appendix 7: A Guide to Tsunamis for Hotels: Tsunami Evacuation Procedures (Intergovernmental Oceanographic Commission of UNESCO, Manuals and Guides No. 69)

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

NORTH-EASTERN ATLANTIC AND MEDITERRANEAN
Tsunami Information Center
NEAMTIC

A GUIDE TO TSUNAMIS FOR HOTELS



IOC Manuals and Guides N° 69

A GUIDE TO TSUNAMIS FOR HOTELS

Tsunami Evacuation Procedures

A Guide to Tsunamis for Hotels: Tsunami Evacuation Procedures. IOC Manuals and Guides, 69. (IOC/2012/MG/69)

English only.

Electronic copy of this guideline could be downloaded from http://neamtic.ioc-unesco.org

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These guidelines have been prepared in fulfilment of a task of the Tsunami Information Centre (NEAMTIC) Project of the Intergovernmental Coordination Group (ICG) of the Tsunami Warning and Mitigation System in the North-eastern Atlantic, the Mediterranean and Connected Seas (NEAMTWS). NEAMTIC is a two years project funded by the European Union's Directorate General ECHO, it is coordinated by the Intergovernmental Oceanographic Commission of UNESCO and is done in partnership with the Commissariat à l'énergie atomique et aux energies alternatives (France), the Presidenza del Consiglio dei Ministri – Dipartimento della Protezione Civile (Italy), the National Observatory of Athens (Greece), and the Fundação da Faculdade de Ciências da Universidade de Lisboa (Portugal).

Foreword

Following the disastrous 2004 Indian Ocean tsunami, the Intergovernmental Oceanographic Commission of UNESCO (UNESCO-IOC) was given a mandate by its Member States to facilitate the expansion of global coverage of Tsunami Warning and Mitigation Systems (TWS) and to co-ordinate the establishment of a TWS for a region comprising the North-eastern Atlantic, the Mediterranean and Connected Seas. As part of this process, a Tsunami Information Centre (NEAMTIC) is being created to serve the needs of civil protection agencies and the public at large, providing information on warning systems, risks and good practices in respect of tsunamis and other sea-level related hazards. This guideline forms a foundation for these objectives. It provides guidance for hotel managers to assist and guide their guests for evacuation in case of a tsunami event. This is particularly important in the NEAM region considering that the Mediterranean is the first tourist destination in the world. As highlighted in the UNESCO/UNU Symposium "The Great East Japan Tsunami on 11 March 2011 and Tsunami Warning Systems: Policy Perspectives" final statement, tsunami preparedness involves also the awareness component which may be improved by educating the public about the nature and threat of the hazard but also on safe behavior to be adopted in case of an event. Early self-evacuation is of major importance.

Wendy Watson-Wright

Assistant Director General, UNESCO

Executive Secretary of IOC

Executive Summary

This booklet summaries steps that will guide hotels to prepare for tsunami hazards. This guidebook is to be use by hotel management; it is intended to direct them on how to build the hotel's capacity in evacuation planning for tsunami emergency. The guidebook outlines the necessary steps to be undertaken, such as preliminary preparedness assessment using a checklist from the "Tsunami Ready" Toolbox, understanding the warnings (natural warning and official warning), deciding on an evacuation strategy, consideration for a hotel to be an evacuation area and the standard operating procedures for tsunami emergency.

This guidebook is devided into five parts. The first part provides a brief information of what is a tsunami and why it is important for hotels to address this hazard as part of their business. Part 2 decribes the tsunami hazard in the North-Eastern Atlantic and the Mediterranean Seas and efforts that has been taken in response to mitigate the hazard. Part 3 focuses on aspects that hotels need to take into consideration in building tsunami preparedness. This part also elaborates three different situations that influences evacuation strategies. Part 4 elaborates on considerations for a hotel to decides if the hotel could be a tsunami evacuation area, including determining the evacuation place in the hotel premises and on the signage needed for the evacuation place. Finaly, part 5 highlights the evacuation planning and procedures for the hotel that may serve as their standard operating procedures in tsunami emergency.

This guidebook explains the steps in building tsunami preparedness, however, to successfully develop the plans and procedures the hotel has to do all the ground work. It is recommended to work through participatory approach with all hotel stakeholders (staff and management) to simultaneously build in the capacity and ownership. At the same time, the hotel should also coordinates with the local disaster management office and/or other local authorities and stakeholders working on disaster and emergency management (for example red cross) to know more about the tsunami risks in the area as well as other local disaster management issues .

I. Introduction

Hotel is a part of the tourism industry that relies on guests/visitors. However, most hotels are located in tourist areas that are more and more exposed to disasters such as earthquake, volcano, sea level rise, and tsunami. Hotel guests, as tourists, usually are not familiar with the local situation and therefore are considered as one of the vulnerable group. Most of the times tourist are not aware of the nature and threat posed by the hazards in that particular area; thus the guess will not know what to do, and where to go if there is a disaster emergency. During emergency they came to a situation where they need to rely on those who know more about the local situation. In this case the hotel staff and management will be the most reliable source for the guests. Therefore, hotels need to include disaster preparedness as an integrated part of their business operation.

Although tsunami events occur less frequent compared to other disasters, recent tsunami events in the Indian Ocean (2004); Indonesia (2004, 2006, and 2010); Chile (2010); and Japan (2011) have shown that the effects of tsunamis can be catastrophic. The first priority when a tsunami occurs is the evacuation of the people in the tsunami risk areas. The time span between a warning and the impact of the first tsunami wave might be very short (especially for the locally generated tsunamis). This will affect on the when, how, and where the people have to be evacuated.

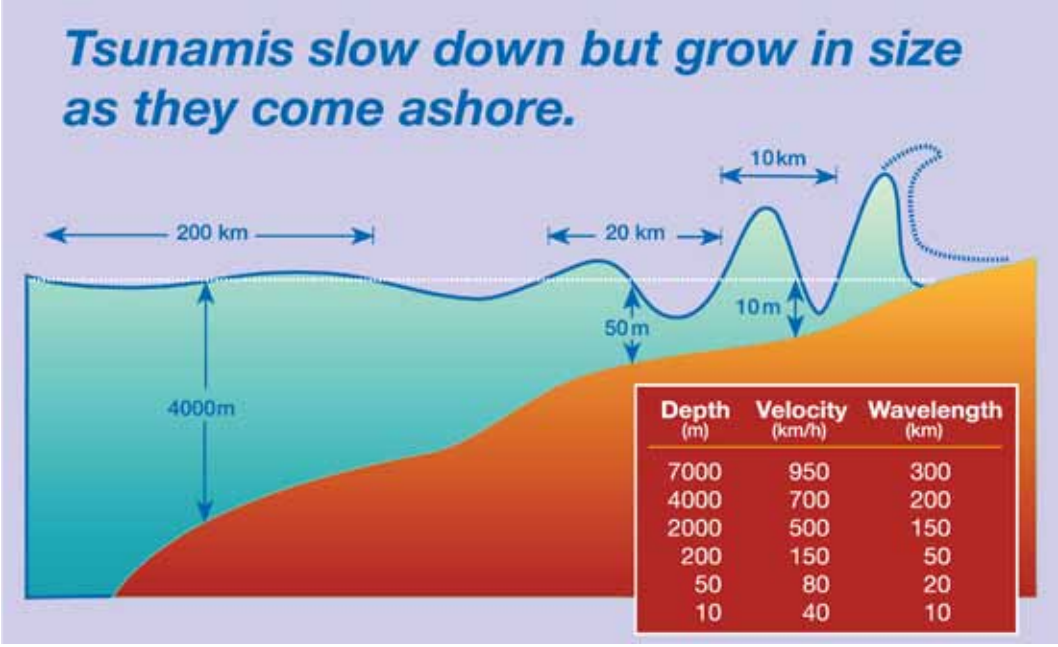
Once a tsunami early warning is received (either natural warning or official warning) hotels are responsible to assist and guide their guests for evacuation. It is very important for the tsunami evacuation plans and procedures to be integrated as one of the hotel's operational systems.

In the North-Eastern Atlantic and Mediterranean coastal areas, tsunami happens less frequently compared to the Pacific. However, there are evidence and records that major tsunamis have happened and have caused fatalities and damaged, for example in Crete (365), in Lisbon (1775), in Messina (1908), and in Aegean Sea (1956). The most recent tsunami happened in 2002 in Stromboli and in 2003 in Algeria, fortunately are not too damaging. This historical record of past tsunamis, scientific trace of events, and written and/or oral reports, indicate a high certainty that another tsunami can happen in the future. It is not a matter of "*if the tsunami will happen*" but more of a question of "*when the next tsunami will happen*". Since most tsunamis resulted from an earthquake activity, it is not possible to predict when the next tsunami will happen. For this reason preparedness is the key for people to be able to respond to and recover from when the tsunami strikes again.

What is a Tsunami?

Tsunami is a Japanese word closely translating to ‘harbour wave’. Tsunamis are large ocean waves generated by major earthquakes beneath the ocean floor or major landslides into the ocean. Tsunamis that are caused by severe nearby earthquakes are known as **locally generated tsunamis**; this type of tsunami may reach the coast within minutes. Tsunamis that are generated by very large earthquakes far away in other areas of the ocean are known as **distant tsunamis**. Waves caused by these earthquakes travel at hundreds of miles per hour, reaching the coast several hours after the earthquake.

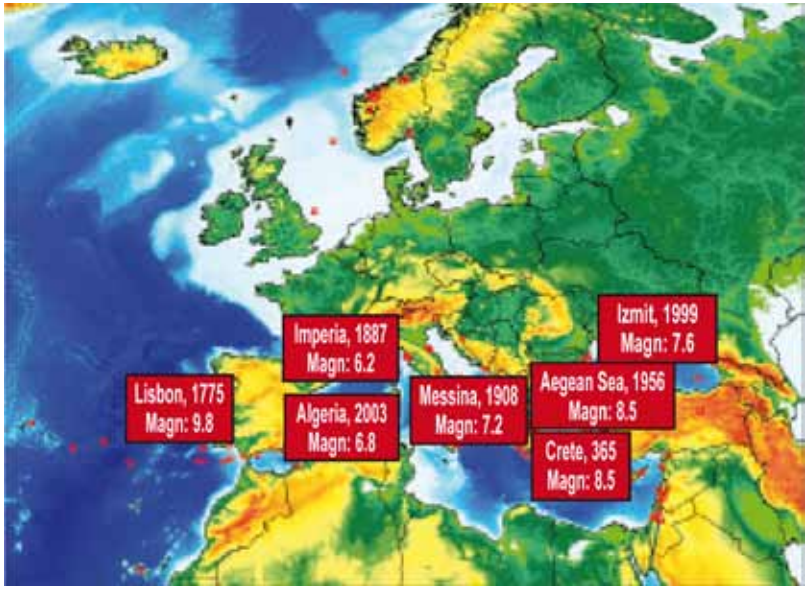
In the deep ocean tsunami travel at jet airliner speeds but the waves are only a few centimeters high and cannot be felt aboard ships. When the waves enter shallow water, they may rise to several meters or, in some cases, tens of meters, striking the coast with devastating force. Tsunami waves can come ashore in many different ways among which are: a wall of water (resembling white wash), a rapidly rising tide, and a series of surf like breakers. The first wave may not be the largest and the series of waves may impact coastlines for several hours.



II. Tsunami Hazard and Mitigation in the North-Eastern Atlantic and the Mediterranean Seas (NEAMS)

Tsunami Facts in NEAM Seas

Although it is less frequent than in the Pacific tsunamis can hit the Mediterranean and North East Atlantic coastal areas, causing extensive loss of lives and properties. Major tsunamis with ten-thousands of casualties and severe damages happened to coastal cities in the past such as in Crete (365), Lisbon in 1775, Messina in 1908 and Aegean Sea in 1956 . Even recently, a tsunami has been generated in the Izmit Bay it has affected the coastline extensively following the 1999 Izmit earthquake. At some locality the inundation distance ranged up to 35 meters. Furthermore, tsunamis have been generated in 2002 in Stromboli and in 2003 in Algeria though fortunately not very damaging. These historical record of past tsunamis, scientific trace of events, and written and/or oral reports, indicates that a high certainty that another tsunami can happen in the future.



The Mediterranean area represents the collision between the European and the African plates, and comprises a number of geodynamic regions affected by a different seismic activity extended from West to East. Furthermore volcanic and geomorphological processes could be at the origin of tsunamis in the area.

This geodynamic condition and the historical records confirmed us that it is not a matter of “if tsunami can happen” in these regions but it is a question of “when it will happen”. This also tells us

Tsunamis in the North-Eastern Atlantic and the Mediterranean (S.Tinti)

Because of the active lithospheric plate convergence, the Mediterranean Sea region is geodynamically characterized by high seismicity and significant volcanism. Furthermore, coastal and submarine landslides are quite frequent, partly in response to the steep terrain that characterizes much of the basin. Tsunamis are among the most remarkable phenomena associated with earthquakes, volcanic eruptions and landslides in the Mediterranean Basin. Until recently, however, it was a widely held belief that tsunamis either did not occur in the Mediterranean Sea or they were so rare that they did not pose a threat to coastal communities. Catastrophic tsunamis are more frequent on Pacific Ocean coasts where both local and transoceanic tsunamis have been documented. On the contrary, large tsunami recurrence in the Mediterranean Sea is of the order of several decades and the memory of tsunamis is short-lived. Tsunami catalogues for the Mediterranean Sea have been compiled by several authors [1].

[1] Strong Tsunamis in the Mediterranean Sea; A Re-evaluation; Gerassimos A. Papadopoulos and Anna Fokaefs, Institute of Geodynamics, National Observatory of Athens, Athens-11810, Greece. ISET Journal of Earthquake Technology, Paper No. 463, Vol. 42, No. 4, December 2005, pp. 159-170

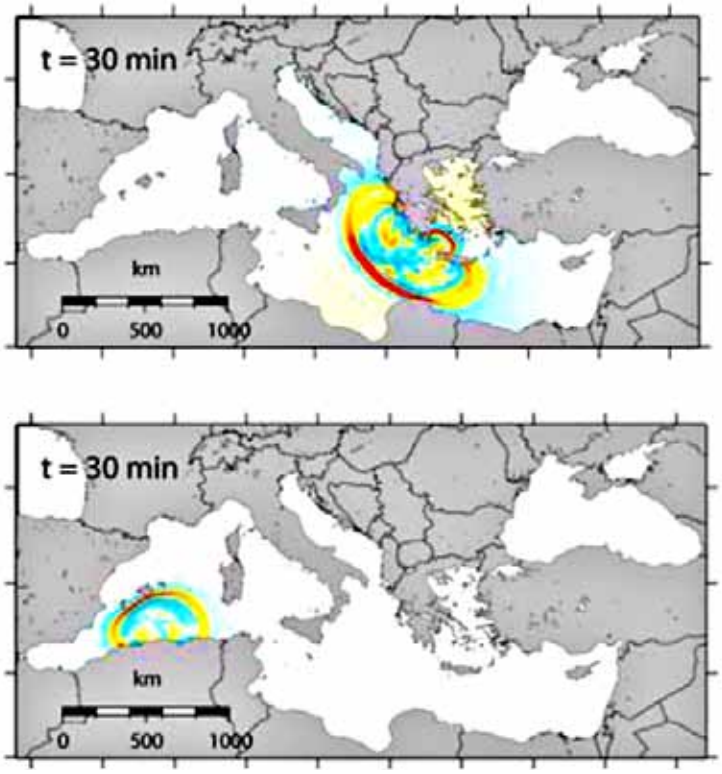
that tsunami risks exists. Therefore, hotels along the coastline facing the Mediterranean Sea and the North-eastern Atlantic need to understand this risks and make sure the preparedness and response capacity are build in their operational system.

Understanding the hazard and identifying the risks

To start to work on disaster management plan, disaster risk reduction, and evacuation planning hotels have to first understand what are the types of hazard that threat the hotel's area and what are the risks caused by these hazards. Tsunami has been identified as one type of hazard that is a threat to the North-eastern Atlantic and the Mediterranean Seas coastal area. Therefore, for hotels that are located in these coasts need to consider tsunami as one of the hazard and assess what are the risks.

Tsunami hazard is complex in nature for it can happen at any time and depending on the location it might only gives a very limited time for the people to evacuate. To assess this hazard one has to understand the geophysical condition of the source, to know how the tsunami is generated by the source, and to know the extent of the inundation that can happen as the tsunami reaches the coast. To have a better understanding the tsunami hazard in the area the hotel needs to:

- Coordinate with local disaster management office and policy makers to understand tsunami hazard in the area and what have been done to mitigate the hazard;
- Know about tsunamis that have come ashore in the hotel area in the past;
- Check hazard maps to know the hotel area's level of threat based on different scenarios: possible time frame of arrival, how the tsunami waves propagate to the area, as well as estimated inundation area and depth in the hotel area.



Example of Tsunamis propagation after 30 minutes from different sources, the scenario above the source is in the western Hellenic arc and bellow is in the north Algeria. (Tsunami Early Warning and Mitigation System in the North Eastern Atlantic, the Mediterranean and Connected Seas, NEAMTWS, Implementation Plan)

Once the hotel knows about the hazards that threaten the hotel's area, the hotel needs to assess what are the potential risk that will affect the hotel if a disaster strikes.

Risk identification and assessment is a process of measuring the potential of loss of life, injury, property damages and economic impact caused by the hazards. Risk assessments involve evaluation of the vulnerability of the people (among other staff, guest, visitors, including guest's children, and people with special needs) and building and facilities (such as integrity of the building structure, water supply, and power supply). Assessment should also consider the hotel's business risks, analyzing the impact if the disaster happens (for example post disaster tourism market and insurance coverage). The main important question to ask in identifying the risk is "what would happen if earthquake and tsunami strikes?" and elaborate the question with: what if it happened at night? what if it happened when the hotel were at the highest occupancy? and what if it happen during cold weather time?

Understanding the tsunami risks in the hotel area will be the basis for the hotel management to better focus on their activities and resources in building response capacity (such as develop tsunami emergency response standard operating procedures), take the necessary actions (for example make sure the building meet the criteria to be designated as vertical evacuation building, re-locate the hotel's power supply and communication system to a safer place), and working on tsunami preparedness (for example conduct regular tsunami exercise involving all staff, related stakeholders and if necessary the hotel guests).

Hotel guests and visitors should be consider as vulnerable group since they usually have limited knowledge of the area. Hotels have the responsibility to ensure the safety and wellbeings of their guests and visitors by informing of the potential disaster and actions to be taken in case of emergency.

Understanding the warning

Natural warning

An earthquake is one of nature's tsunami warning sign, when you feel a strong earthquake that makes you can hardly stand, or a slow shaking but for a longer time, a Tsunami may have been generated (locally generated tsunamis). Tsunami may be preceded by a rapid fall in sea level as the ocean retreats exposing fishes and corals on the sea bottom. In the deep ocean, tsunami wave travels in a speed of jet airplane and slow down as it comes to shallow water but the height of the waves grow in height with a strong and destructing force.

Natural Warning Signs of a Tsunami:

- *An earthquake (strong shaking that make you can hardly stand, or a long slow shaking for more than a minute)*
- *Sea water receding, exposing the fish and corals at the bottom of the sea*
- *A strange loud sound coming from the sea (i.e. loud roar)*

Under these circumstances (locally generated tsunamis), there may not be enough time for an *official warning*. There might be only a very short lead time between the earthquake and the first arriving tsunami wave. For locally generated tsunamis, the hotel should take this natural warning as a sign to evacuate their guests, visitors, and staffs immediately inland and/or to higher ground, and/or to the designated evacuation area.

Official warning

In case of distant tsunami (regional or ocean wide), earthquake might not be the first warning, an earthquake might occur far away across the sea and generated a tsunami wave that propagating toward the coastline in the hotel area. In this case, the hotel will receive the first warning from the responsible authority in the country, the National Tsunami Warning Center (NTWC) and/or the National Disaster Management Office (NDMO), depending on the country tsunami early warning system setting.

The hotel should rely on this warning notification issued by the NTWC to decide when to evacuate their guests, visitors, and staff. Therefore it is important to understand the official warning system and meaning of the warning notification.

In the aftermath of the 2004 Indian Ocean Tsunami in December 2004, the Intergovernmental Oceanographic Commission (IOC) of UNESCO was given the mandate to coordinate and facilitate the global tsunami early warning system. The global coverage is divided into four major regions: the Pacific, Indian Ocean, Caribbean, and North-Eastern Atlantic and the Mediterranean Seas (NEAM). The Tsunami Early Warning System developed for the NEAM region known as North-Eastern Atlantic and the Mediterranean Seas Tsunami Warning System (NEAMTWS). Based on the experience in the Pacific, each region would also maintain a regional Tsunami Information Centre, in this case namely North-Eastern Atlantic and the Mediterranean Seas Tsunami Information Centre (NEAMTIC)

North-Eastern Atlantic and the Mediterranean Seas Tsunami Warning System (NEAMTWS)

The structure of NEAMTWS consist of Tsunami Watch Providers (TWPs), National Tsunami Warning Centers (NTWSs), and Tsunami Warning Focal Points representing each member states. For regular update of NEAMTWS please visit: *www.ioc-tsunami.org/neamtws*

Tsunami Watch Providers (TWPs)

Tsunami Watch Providers are National Tsunami Warning Centers (NTWCs) that are willing and able to provide tsunami alert information to the other Member States at the designated Forecast Points; Tsunami Watch Recipients are the Tsunami Warning Focal Points that will receive the information. TWPs will be responsible in:

- Collecting, recording, processing and analyzing of earthquake data for the rapid initial assessment (locating the earthquake, its depth, its magnitude and its origin time) as a basis for the alert system.
- Computing the arrival time of the tsunami in the forecasting points as listed in the Communication Plan.
- Collecting, recording, processing and analyzing of sea level data for confirming and monitoring the tsunami or for cancelling elements of the alert system.
- Making decisions in accordance with the Communication Plan to elaborate messages.
- Disseminating to the Member States focal points (and national warning centres) of the messages in accordance with the Communication Plan, including tsunami travel time, amplitude and period of the measured tsunami, and cancellation messages .

National Tsunami Warning Centres (NTWCs)

Each member country of the NEAMTWS is responsible for establishing their own National Tsunami warning Centres. The main responsible of NTWC is to provide warnings as soon as possible after a potential tsunami generation; to issue warnings for all destructive tsunamis; to make sure the warning centers operate continuously and the warning messages are sent and received promptly and is understood by the users of the system. Therefore these centers will have the function of:

- Collecting, recording, and processing of earthquake data for the rapid initial warning locating the earthquake, its depth, its magnitude and its origin time)

- Computating the arrival time of the tsunami in the national forecasting points
- Collecting, recording, and processing of sea level data for confirming or cancelling the warning.

Tsunami Warning Focal Point (TWFPs)

The Tsunami Warning Focal Point (TWFP) is a 24/7 contact person, or other official point of contact or address designated by a government. TWFP is available at the national level to rapidly receive and issue tsunami event information (such as warnings). The Tsunami Warning Focal Point is either the emergency authority (civil defense or other designated agency responsible for public safety), or has the responsibility of notifying the emergency authority of the event characteristics (earthquake and/or tsunami), in accordance with the national standard operating procedures. The Tsunami Warning Focal Point receives international tsunami warnings from the NEAMTWS or other regional warning centres.

North-Eastern Atlantic and the Mediterranean Seas Tsunami Information Centre (NEAMTIC)

The North-Eastern Atlantic and the Mediterranean Seas Tsunami Information Centre (NEAMTIC) is a part of the activities coordinated by the Intergovernmental Oceanographic Commission (IOC) of UNESCO and carried out by Member States to developing the NEAMTWS. The objectives of NEAMTIC are:

- Providing information to civil protection authorities and the general public on warning systems for tsunamis and other sea-level related hazards, and on the activities of IOC and European Union (EU) in the field of tsunami preparedness.
- Building capacity through one training workshop on tsunami early warning systems, standard operating procedures, numerical models to determine tsunami travel time, and ISO signage;
- Making citizens, especially youth, aware of the risks of floods from the sea in coastal areas, such as tsunamis, storm surges and strong swells, providing them with knowledge on the phenomena and practices of safe behavior.
- Identifying, sharing and disseminating good practices in plans, methods and procedures to strengthen preparedness for sea level related hazards.
- Fostering linkages between the EU and IOC on intergovernmental and transnational actions to develop NEAMTWS.

For more information on NEAMTIC and get more awareness materials please visit: *www.neamtic.ioc-tsunami.org*

III. HOTEL PREPAREDNESS

What is Preparedness

Preparedness is activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warning as well as the temporary evacuation of people and property from threatened locations (UN/ISDR, 2004).

Disaster preparedness involves forecasting and taking preventive measures prior to an imminent threat. Preparedness comprises the ability to understand the warning (including the ability to receive and interpret the warning), to organize evacuation and/or other measures to be taken to minimize potential loss of life and damage during a disaster and to organize timely and effective rescue, relief and assistance.

Preparedness improves the response to the effects of a disaster; therefore, requires a standard operating procedure and regular testing of the systems and plans.

A disaster-prepared hotel is a hotel that has established its standard operating procedures, systems and plans. They are readily organized for the steps necessary in cases of a tsunami, including: emergency response, evacuation during disaster, and recovery plans after disaster. All of the hotel's stakeholders (management and staff) know how to prepare to, respond to, and recover from disaster.

Building Tsunami Preparedness

In general, hotel business has been characterized as business that has solid and consistent operating procedures and systems. Most hotels have established their emergency response system, especially to fire hazards. Therefore, building the tsunami preparedness should be embedded into the existing system. However, it still will require different adjustment and adaptation considering the complexity of tsunami hazard.

To build tsunami preparedness, the hotel needs to first assess its current capacity and to build based on the need to be more prepared. In Indonesia, to build tsunami preparedness in the hotel industry,

the Indonesian Ministry of Culture and Tourism in cooperation with Bali Hotels Association, supported by the German Centrum für Migration and Entwicklung (CIM) has developed a checklist that enables hotels to assess their state of preparedness[2]. This checklist were implemented in several hotels in Bali under their "**Tsunami Ready"** programme (*www.tsunamiready.com*).

The checklist consists of six categories and in each category there are sets of questions to be answer to assess the state of current tsunami preparedness (see Annex):

- **Information Sources and Interpretation**, is to check the hotel's capacity to receive official tsunami warnings from the authority, interpret the warnings, and to disseminate the warning within the hotel.
- **Evacuation Procedures**, is to check the hotel's evacuation procedures from rooms, beach, and public places within the hotel.
- **Evacuation Route and Shelters**, is to check the hotel's evacuation route and signs, including the hotel as vertical evacuation.
- **Community Relations**, is to check external relations with the communities surrounding the hotel.
- **Cooperation**, is to check the cooperation amongst hotels in the surrounding area.
- **Post Tsunami**, is to check all of the preparation that needs to be considered post tsunami disaster.

This checklist is only a suggestion and to be use as a starting point. Each hotel might want to adjust and/or add more to the lists in accordance to the local context, regulation, hotel situation and needs. This checklist could also be use as tools to monitor and evaluate how the hotel is progressing in building their tsunami preparedness.

Once the hotel knows their current state of tsunami preparedness, the hotel can start to build their capacity to increase their tsunami preparedness. These are essential points the hotel needs to build in relation with the tsunami preparedness:

- **Early warning systems**: Hotels should be able to timely receive the warning, especially official warnings, have the ability to understand the warning, and are able to further disseminate the warning to reach all part of the hotel. All hotel guests, visitors, and staff need to be able to hear and receive the warning. To receive the warning, the hotels need to have a close cooperation with the national authorities who are responsible, at national level, for issuing the warning.

[2] *The Tsunami Ready Toolbox, Alexander Kesper, Ministry of Culture and Tourism Republic of Indonesia, Bali Hotels Association, Centrum fur Internationale Migration und Entwicklung, 2008*

- **Evacuation and Shelter:** This should be the primary concern of hotels, especially considering guest and visitors are considered vulnerable since they might not be familiar with the local situation. The hotel has to make sure that all guests, visitors, and staff could be safely evacuated to a designated safe area. Furthermore, taking into consideration that the hotel might be fully occupied, the safe area should be able to accommodate all evacuate. The hotel needs to assess if their building can be considered as vertical evacuation building (meeting all the criteria and standards) or not - in which they have to evacuate all guests, visitors, and staff out of the hotel premises.
- **Emergency Command Function:** In case of emergency hotels should have clear definition of the roles and responsibilities of each stakeholder. Each hotel unit / department should have a clear defined function what they have to do, who will do what and where, and whom they have to report to.
- **Emergency Personnel and Resources:** Hotels need to have procedures to mobilize staffs as emergency personnel with specific roles and ensure that all emergency response is carried out according to plan. Hotels need to ensure that the emergency personnel have the knowledge and skill to perform their duties as emergency personnel. Hotels also need to have all resources needed for emergency and during emergency is available at anytime.
- **Communication and supplies:** Public infrastructure might be paralyzed for several days after the disaster, communication may be cut off. Hotels need to make sure they have emergency communication equipment available, in working condition, and at hand, during and after the disaster, for example satellite phones. Past experience also shows that, in some cases, emergency supplies (water, food, and medical) can take several days before they can get through. Hotels need to ensure that they will have supplies to support them during emergency situation.
- **External Coordination:** THe hotels need to coordinate with local administration and disaster management office (DMO) in developing the hotel's evacuation plan and emergency response. Check the local DMO post tsunami emergency plans and make the hotel's emergency plan based on the DMO's capacity. Form alliance with other hotel and businesses in the area to have better coordination and cooperation and develop common strategy in responding to the disaster.
- **Department Close Down Procedure:** Most hotels might already have this Department Close Down Procedures such as for fire related emergency, weather related emergency, and others. These procedures could be adapted for tsunami emergency. However, it is important to understand that in tsunami emergency, there might by only little time available, especially for the

locally generated tsunami cases. Therefore, it is important to concentrate on the essentials and/or have specific procedures for tsunami emergency.

- **Records Management:** Hotels needs to ensure that all important documents and records are well secured during emergency. Guests hotel records will be very important for post emergency response and reliefs as well as to make sure all people are accounted.
- **Restoring main functions and plan for recovery:** Hotels have to have plans on restoring their main function (water, sanitary, electricity, and communication) for emergency use after the disaster and have a short and midterm plan to recover from the disaster.

Evacuation Strategy

Tsunami threat in each countries are different, therefore, the setting of the tsunami early warning are different from one country to another. There are countries that have a National Tsunami Early Warning Centre with the capacity to detect, analyse, and issue warning when a tsunami is coming to their coastline. Other country, which has lower tsunami threat, might rely on information from the Tsunami Watch Providers (TWPs). These settings will affect the time line of how long they will be able to issue the warning. Therefore hotels need to understand the tsunami early warning setting in their country to decide on their evacuation strategy. There are three basic possible scenarios that can be taken as a consideration to decide whether guests, visitors, and staff need to do an evacuation:

1. Earthquake is felt in the hotel area, but no tsunami warning is issued.
2. Earthquake is felt in the hotel area and a tsunami warning is issued.
3. Tsunami warning is issued, although the earthquake is not felt in the hotel area.

These situations would require different decisions and actions by the hotel, especially if related to tsunami evacuation procedures.

1. Earthquake is felt in the hotel area, but no tsunami warning is issued

Hotels located in an earthquake prone area might feel the earth shakes as it happened. The hotel management needs to decide whether to evacuate the guests from the building or not. Depending on the intensity of the earthquake felt in the hotel area, the hotel management might want to decide to evacuate all guests, visitors and staff once the shaking stops. The hotel has to decide on which earthquake intensity strength they would like to do evacuation

Hotel management also has to understand that an earthquake can be a natural sign of a tsunami. There is also a possibility that the official warning mechanism did not work because of the earthquake. Therefore, even there is no official tsunami warning received, hotel management might still needs to consider doing tsunami evacuation procedures *(See page 6).*

as their standard operating procedures. Should the earthquake reach the level of intensity strength that the hotel has decided to do evacuation, they need to start to evacuate all guests, visitors and staffs once the shaking stops. Earthquake evacuation should be done from inside of the building to the designated assembly area outside the building (an open space). The evacuation procedures involved evacuating guests from their rooms; from restaurants, lobby, function rooms (Ball room, meeting rooms) and corridors; from beach and pool areas; as well as evacuating the staff from the operating department of the hotel (diagram 3.1.). At the same time, after the shaking stops, the hotel management needs to confirm with the authorities whether the earthquake has generated a tsunami. If the authorities confirmed that **the earthquake did not generates a tsunami** and no tsunami warning is issued, then they should proceed with

In locally generated tsunami, time is very crucial. Hotel management has to consider that the first wave may arrive with minutes. There is only short time period between the time of the earthquake and the time of the arrival of the first tsunami wave.

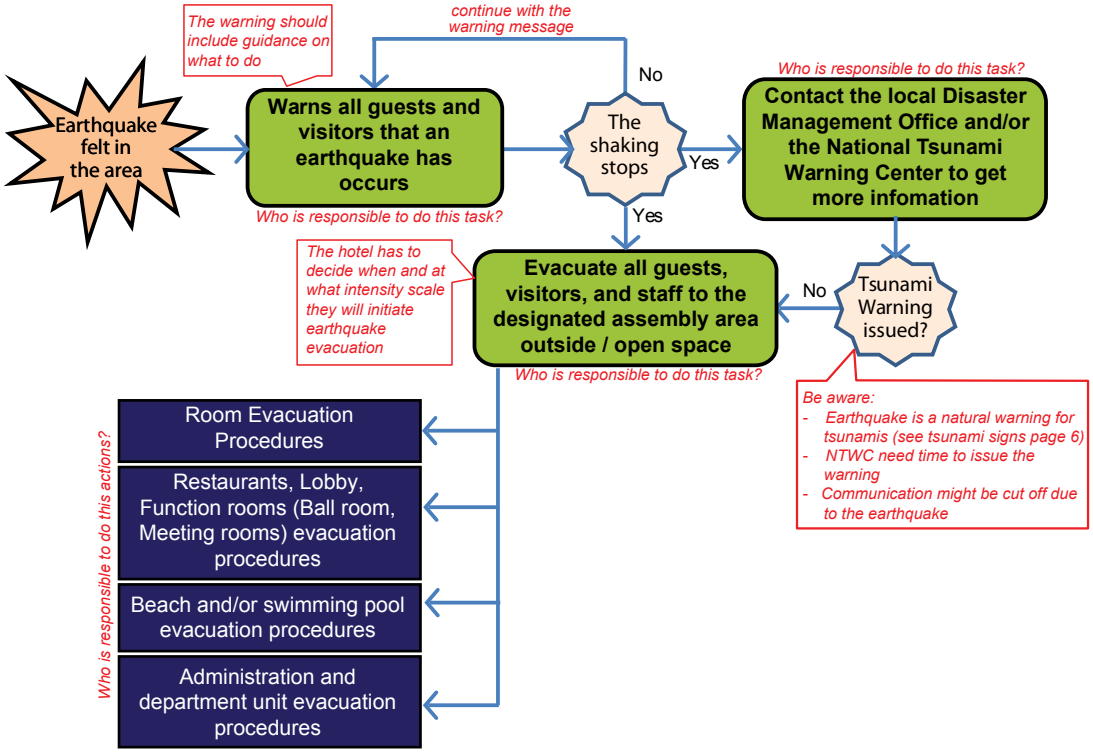


Diagram 3.1. Decision Making on Tsunami Evacuation When Earthquake is felt in the Area, no tsunami warning is issued

earthquake evacuation and emergency response. Hotel management needs to understand that it might take several minutes for the authorities to analyze and decide whether a tsunami warning would be issued or not. Hotel management also has to understand that there is a possibility that the official warning mechanism did not work because of the earthquake. Therefore, even if there is no official tsunami warning received, hotels management might still need to consider doing tsunami evacuation procedures.

2. Earthquake is felt in the hotel area and tsunami warning is issued

In the case that an earthquake is felt in the hotel area and confirmation is received from the authorities that the earthquake has generated a tsunami (locally generated tsunamis), the hotel management will need to immediately start to initiate their tsunami evacuation procedures (diagram 3.2.). While the earthquake evacuation is in process the hotel also needs to warn all guests, visitors, and staffs that a tsunami warning has been issued and tsunami evacuation procedures has been initiated.

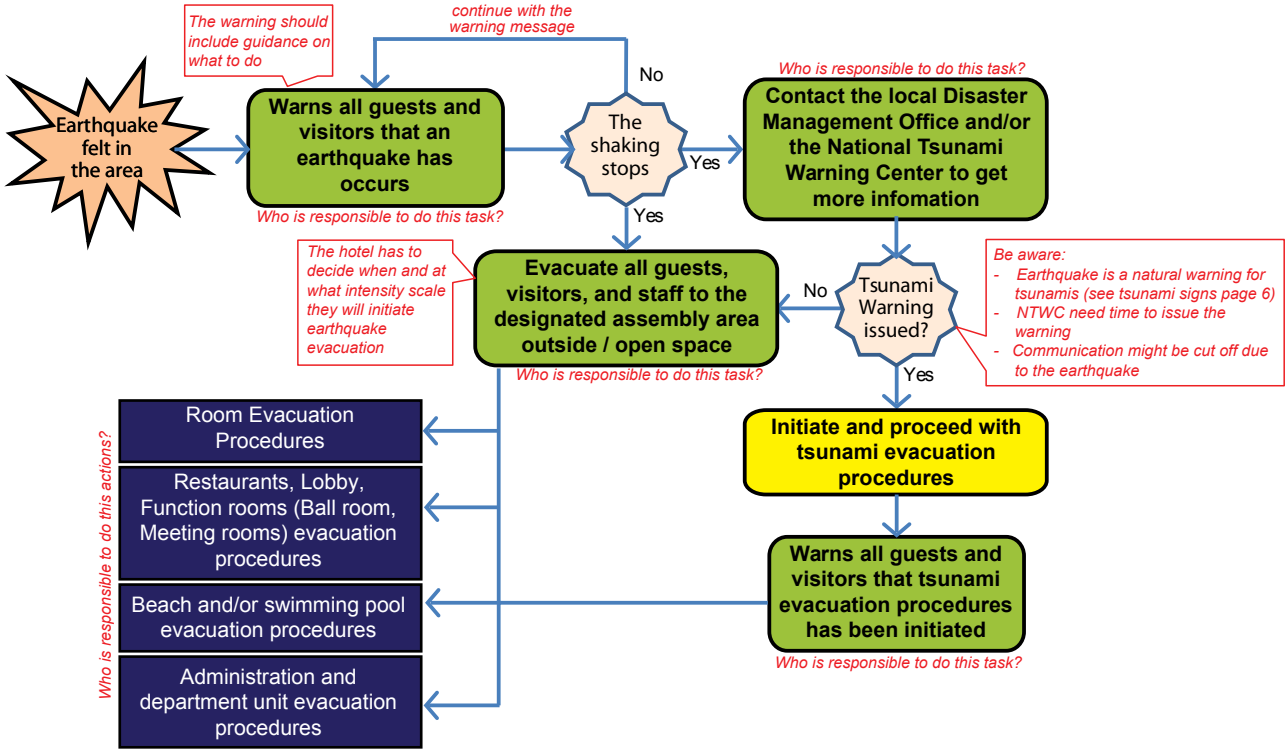


Diagram 3.2. Decision Making on Tsunami Evacuation When Earthquake is felt in the Area and a Tsunami Warning is ssued

3. Tsunami warning has been issued although no earthquake is felt in the hotel area

Tsunami threat in some countries is due to a regional or ocean wide tsunamis, a tsunami that is generated by an earthquake that happened across the ocean. The earthquake is not felt anywhere near the hotel area, therefore, nobody in the hotel is aware that a tsunami is heading toward the coastline. In this type of situation the only reliable information is the official warning issued by the National Tsunami Warning Centre (NTWC) of the country.

Once the warning is received, the hotel needs to understand the information/message specifically the level of the warning, the estimated time of arrival, and any advice issued by the National Tsunami Warning Centre. Depending on the distance, a threat of a regional or ocean wide tsunami, might take a few hours to arrive in the coastline. The threat might decreases or escalates as it travels through the ocean. Therefore, it is important to continue to monitor the warning that is issued by the NTWC. Should the warning be issued as a low threat (depending on the analysis and evaluation of the NTWC) there might not be a need to do a full evacuation. Evacuating people from the beach (for hotels located by the beach) might be sufficient. Other action that might be taken is to start all preparation for tsunami evacuation so when the threat escalates and tsunami evacuation procedure needs to be initiated all preparation has been done (diagram 3.3.)

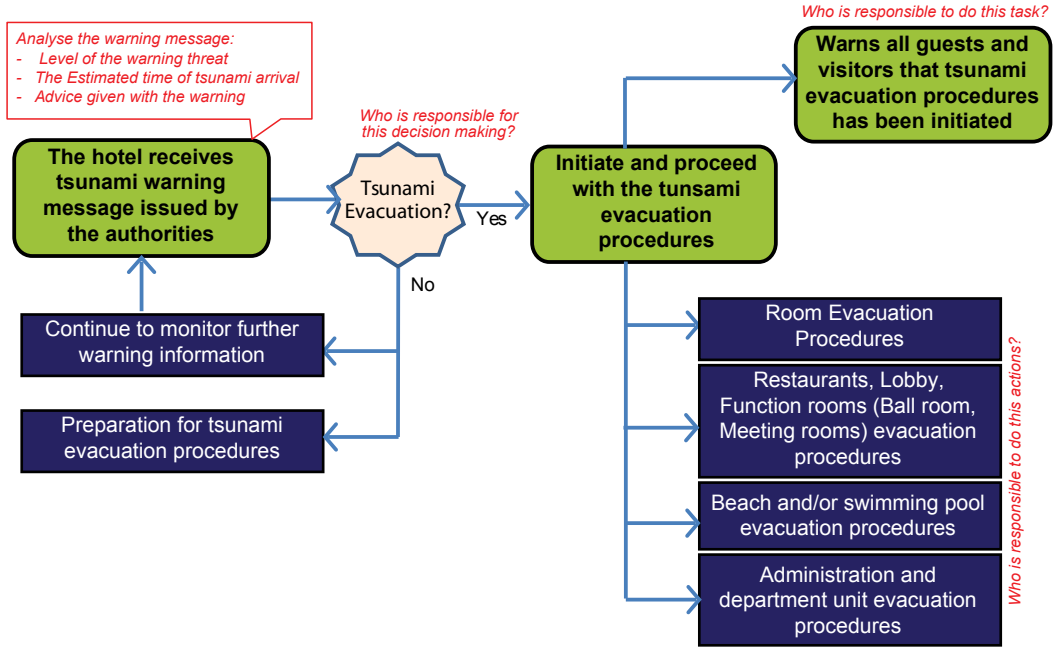


Diagram 3.3. Decision Making on Tsunami Evacuation after a Tsunami Warning is issued

IV. HOTEL AS EVACUATION AREA

General Considerations on Hotel as Evacuation Area

Hotels have to decide on the location where they will evacuate the guests, visitors, and staff during tsunami emergency situation. The area of the hotel can be considered as an evacuation area, whether horizontally to a higher ground within the hotel premises or vertically inside the hotel's building. Multi-storey hotels located at the beach make an ideal evacuation structure. Thus the guests and other people in the area can easily and quickly reach these hotels. Hotel rooms, ballrooms, meeting rooms, restaurants, and parking garage that are located above the estimated tsunami inundation depth can be an ideal place for people to take refuge of during the tsunami. However, before deciding to designate the hotel as an evacuation area, there are criteria and measures to be consider. (Diagram 4.1.)

1. Hotel location

Location of the hotel will be the first consideration for tsunami evacuation. However, before considering this the hotel needs to make sure that the hotel is not located in a tsunami risk area. This can be confirmed by the local authority/agency that is responsible in developing tsunami risk map of the area. The tsunami risk map will indicate if the hotel is indeed located in a tsunami inundated area and what is the estimated tsunami inundation depth of the area. Hotel that is considering to use their premises as an evacuation area needs to make sure that the area is outside the estimated inundation area and/or higher than the estimated inundation depth. Multi-storey buildings in the hotel premises such as the hotel building, parking garage building are potential to be the evacuation place.

In some cases, although the hotel is located in a tsunami risk area, the hotel ground area and lobby is higher than the estimated tsunami inundation depth because it is elevated in such a way. Hotel ground that is above the estimated tsunami inundation depth can be considered as the area for horizontal evacuation (evacuation area that can be reach horizontally, including running to higher ground), people and guests should be easily evacuated to this place.

Should the hotel is not located in a tsunami risk area, the hotel might still want to consider to become a tsunami evacuation area to safe the life of the people evacuating from a tsunami.

2. Hotel design and structures

Multistory hotel buildings that are built on concrete frame and/or steel structures, and meet the seismic standard and building codes, are potential location to be a vertical tsunami evacuation building. As a vertical evacuation building, the hotel structure must not only withstand the preceding earthquake with minimal damage and remain functional but also has to withstand the tsunami wave and debris it carried. Therefore it is important to first assess the hotel structure to be sure that it can serves as an evacuation building. Commonly the third floor and above of an evacuation building can be consider as a save place to refuge, however, it depend on the the estimated tsunami inundation depth of the area.

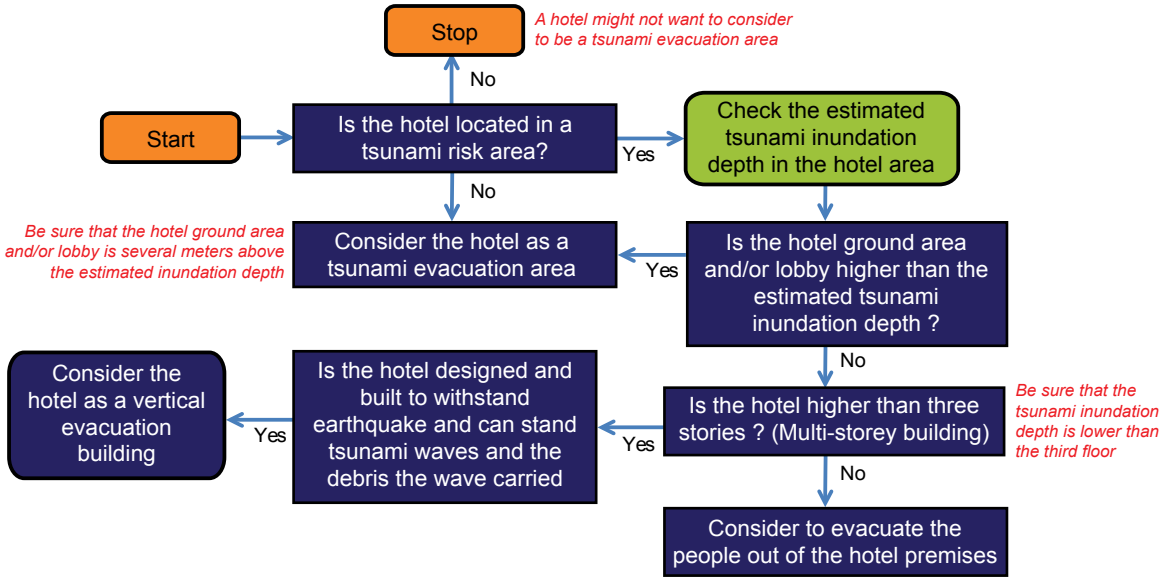


Diagram 4.1. Decision Making Process on Type of Tsunami Evacuation

Determining Evacuation Areas in Hotel Premises

1. On hotel a ground

Open spaces in the hotel premises, which are located on a higher ground above the estimated tsunami inundation depth, are potential to be tsunami evacuation areas. The advantages of using

these open spaces as a tsunami evacuation area are as follows:

1. Open spaces can be easily accessed by hotel guests or visitors. Furthermore if an earthquake happens in the area, many people (especially hotel guests) might be reluctant to reenter the hotel building again.
2. Open space at a higher ground level can accommodate a large number of people.
3. Open space can be use as park, sport area, and/or jogging area.
4. Open space in the hotel premises can be a safe evacuation process (no traffic and transportation are involved).

The main consideration for hotel ground/open space as an evacuation area is that the location does not directly face the beach/open sea where the tsunami wave will approach. In addition of a higher ground location the evacuation area also should be well covered and be saved from incoming wave as well as retracting waves.

Some modifications might be needed to designate an open space as an evacuation area:

1. Ensure that the open space is on a higher ground, above the inundation area and can withstand potential damage and/or erosion from the tsunami wave and the debris it carried.
2. Ensure there are clear access during day time and night time.
3. Ensure the safety and security of the people in this area during and after the tsunami strikes.
4. Ensure all the necessary equipments needed for emergency are available on the evacuation area.

2. On parking garage

Some hotels do not have open spaces on their premises, however there are parking garage/ building adjacent to their hotel. Parking garages are usually open space with vertical column as the structure. This allows for the water to flow over the building with minimal resistance. The parking garage should be designed and be built in accordance to the seismic standard and building codes and could withstand the tsunami wave and the debris it carried. The main disadvantage of a parking garage is when it is full of cars during the tsunami: it reduces the space, limits people circulation area and the cars can be a part of the destructing debris to the building structure.

3. Inside Hotel building

Evacuating vertically in the hotel has many advantages:

1. Evacuating to the upper floor in the hotel often is faster than evacuating to a higher ground outside of the hotel.

2. Evacuating within the hotel do not need vehicles therefore it is not affected by the traffic
3. Evacuation management will be easier
4. Evacuation routes and places are easy to mark

However, before deciding to use the hotel building as tsunami vertical evacuation building, the hotel has to make sure that:

1. The hotel has to withstand earthquake with minimal damages and can stand tsunami wave and debris carried by the water.
2. The evacuation location in the building should be as far as possible from the beach and are secured from the incoming tsunami waves.
3. The building must be strong, accessible in a short time and have enough capacity to accommodate all evacuees.
4. The evacuation location/floor should be higher than the estimated tsunami inundation depth.
5. The evacuation building should have the necessary equipment and infrastructure for emergency situation, wide enough emergency stairs, emergency electricity, and other requirements.

4. Evacuation out of the hotel premises

Saving lives of the hotel guests, visitors, and staff should be the main concern of the hotel. If the hotel is not qualified as a tsunami vertical evacuation building and there are no higher grounds in the premises of the hotel, the hotel should consider evacuating all of the people out of the hotel premises to higher ground or to a designated evacuation area.

Evacuating out of the premises would require a more thoughtful steps and procedures such as considering the traffic, security, and the safety of the people:

- The evacuation area should be out of reach of the tsunami waves either for horizontal or vertical evacuation. The evacuation area should consider the maximal expected wave height, the inundation area and inundation depth.
- The evacuation routes are free from the wave's path and are leading away from the incoming waves. If the evacuation area is out of the hotel premises, the evacuation routes should consider the traffic, road conditions and other obstacles that will affect the travel time needed to reach the evacuation area.
- The evacuation area should be able to accommodate the expected number of people that are supposed to use the evacuation area. The hotel needs to ensure that the hotel's number of guests can be accomodate in the evacuation area. If it is a public evacuation area the hotel

need to take into account the number of people from other hotels, the community and people from the streets

- The evacuation area should be reachable and can accommodate people with special needs (disabled, pregnant woman or parent with babies, and the elderly).
- The hotel needs to consider the time between the warning is issued and the time of the arrival of the first wave, The hotel needs to make sure that people can reach the evacuation area could be reach in time.
- The tsunami evacuation area could be an assembly place during the tsunami and/or could be an emergency shelter for a longer period of time.

5. Vertical evacuation structures

Hotels that are not qualified as a vertical evacuation building and are located in flat areas that are far away from higher grounds might want to consider to build a stand alone, simple and strong vertical evacuation structure. A vertical evacuation structure could be made of steel structure or concrete columns that are strong enough to withstand the tsunami wave. The hotels need to make sure that the evacuation structure can accommodate all the people in the hotel when the tsunami strikes.



Tsunami Evacuation Tower in Kushimoto Town, Wakayama Prefecture (http://www.icharm.pwri.go.jp/publication/newsletter/newsletter6_oct07_e.html)

Evacuation map, route, and signs within the hotel premises

If the hotel decides to use its premises as a tsunami evacuation area, the hotel will be responsible to ensure that guests, visitors, and staffs know where to go to in case of emergency. If the hotel decides to evacuate the people out of the hotel premises, to the guests, visitors, and staff should also know the information on the closest designated evacuation area.

The most visible way to let the guests, visitors, and staffs know about the evacuation area and routes are by providing hotel evacuation map that is readily available in each room and to posting signs in the hotel premises. Evacuation routes, safe locations, assembly points should be clearly marked on the hotel premises so those who evacuate will have no difficulties in finding where to go to the safe place.

There are different tsunami signs available however since 2008, UNESCO/IOC encouraged its member states to develop and use IOC-compliant tsunami signage and symbols in order to promote consistency in understanding and actions. Three are three basic signs within the ISO 20712 standard which provides specifications and guidance on safety sign for tsunami hazards:



Tsunami Hazard Zone Sign

This tsunami sign informs the hotel guests that they are in a tsunami hazard area as has been identified by the local authorities. It is important to have this sign be visible and posted in the hotel premises as well as in the surrounding areas of the hotel especially in the area where many people usually gather such as open space, parks and on the beach.



Example of ISO 20712 Tsunami Hazard Sign Placement



Evacuation Place in High Ground Sign

This sign should be placed on the site that has been designated as a safe high ground for evacuation. High ground evacuation place can be a natural open space that is located beyond the reach of the estimated tsunami wave height, or an artificially/engineered high grounds (which can function as open space, sport area, or park) that are build as a tsunami evacuation place.



Vertical Evacuation Building Sign

This sign should be placed in the hotel building if the building has been designated as a vertical evacuation building (meeting all the criteria to be a vertical evacuation building). This sign informs the hotel guests that in case of tsunami evacuation emergency they should go to this building. Inside the building there has to be signs which indicate the floor they should to go to as the safe place. This sign has to be visible from far away as well as from an eye level as the people get closer to the building.

These tsunami signage should be placed at the evacuation place, indicating to the evacuatee that they have reached the designated save place. It is equally important is to also place the evacuation routes signs. There are also different evacuation route signs. The ISO 20712 approved evacuation routes should use the same basic signs as the above complementing with directions where the evacuatee have to go.





Example of ISO 20712 Tsunami Evacuation Map

V. EVACUATION PLANNING AND PROCEDURES

Evacuation Planning

A tsunami evacuation plan is a plan that will be the reference when a tsunami warning has been issued and an evacuation need to be done. Tsunami evacuation plan involves deciding and preparing the tsunami evacuation area (chapter IV), the decision making procedures to do the evacuation, and the evacuation procedures. The purpose of hotel tsunami evacuation is to save the lives of hotel guests, visitors, and staff. Therefore, the planning should be able to guide the management to decide when to evacuate, to guide all people to the designated evacuation area through the evacuation routes and to conduct everything based on the agreed procedures and processes.

Decision to Evacuate

The decision to evacuate is the first step of the evacuation process. During emergency situations (either experiencing the earthquake or receiving tsunami early warning – chapter III), the hotel management needs to analyze, makes assessment of the situation and decide whether to evacuate the people or not. These decision criteria should be noted as part of the standard operating procedures. Several factors the hotel needs to consider in deciding to evacuate are:

1. **The earthquake**; the hotel needs to decide to evacuate the people immediately after the event, (especially for locally generated tsunami) for example the decision might be based on the intensity of the earthquake felt during the event or how long they feel the shaking.
2. **Timeline**; the hotel needs to consider the time needed to safely and effectively evacuate the people, for example to consider the location of the evacuation area, is it near or far, whether the evacuation involves heavy traffic or not.
3. **Location of the evacuation area**; is the evacuation area located in the hotel premises or outside of the hotel premises, will it be a vertical evacuation or using a high grounds?
4. **Evacuation routes**; special consideration might be needed for evacuation that is outside the hotel premises;
5. **Number of people to be evacuated**; the number of guests and visitors at the time of emergency;
6. **Hotel capacity and resources**; the personnel and recourses available at the time of the event.

Roles and Responsibilities

Tsunami evacuation is a complex process. Hotel tsunami evacuation also has its own complexity especially related to people it involves, for example the type of people (hotel guests might consist of people from different cultures with different languates) and the number of people to be evacuated. Hotel management has to clearly define the roles and responsibilities of their staff during emergency situation. The evacuation plan has to clearly designate specific tasks to the staff especially who will do what, when, and where. This tasks will be a part of the hotel's standard operating procedures. Due to the nature of emergency, a less time consuming procedures might need to be established. However, these procedures and processes should continue to be a part of the roles and responsibilities of the specific functions of the hotel units / departments.

The hotel needs to make sure that no guests remain behind, including those who might need special assistance to evacuate. To ease the process of checking if all guests have been safely evacuated, the hotel might want to consider setting up a task team (for example guest evacuation team) that will be responsible in evacuating the guests from their rooms.

*The task of the "**guest evacuation team**" is not only to evacuate all guests from their rooms, but also to mind the visitor to the hotel as well as public who might seek shelter in the hotel. Therefore the hotel should make sure of systematic and easy procedures and should make use of the existing resources available. Special attention needs to be placed on the evacuation of guest rooms since this task requires a lot of time and human resources. Members of the guest evacuation team can be drawn from employees from relevant departments and shifts like housekeeping, bell service, room service, stewarding, duty manger, and night manager etc. Please note that the composition of the guest evacuation team during night shifts and on public holidays might be different from regular shifts and days. Every member of the team should have a realistic designated number of rooms and/or floors to check. Ensure the safety of the team and be aware of the very limited time. Members of the evacuation team should at least be proficient in basic English (The Tsunami Ready Toolbox) .*

Tsunami Evacuation Procedures [1]

Room Evacuation Procedures:

1. Knock on the door of the guest room and shout: 'Tsunami Evacuation!'
2. If there are no response, enter the room. Make sure the guest evacuation team has the master key to enter the rooms.
3. Search the bedroom and bathroom areas and check the walk in cupboard.

[1] *The Tsunami Ready Toolbox, Alexander Kesper, Ministry of Culture and Tourism Republic of Indonesia, Bali Hotels Association, Centrum fur Internationale Migration und Entwicklung, 2008*

4. If the room is empty, mark that the room has been checked and is empty (see "all clear tags"). Proceed to the next room.
5. If the room is occupied, tell the guest to proceed to the evacuation area immediately. Point out the direction to the evacuation route.
6. Tell the guests to leave their luggage and bring only their valuables and identification cards.
7. As the guests leave the room, make sure they lock the door and mark the room as has been checked and move to the next room.
8. If there is a guest in the room who does not want to leave **DO NOT** mark the room as empty. However, do proceed to the next room.
9. When the whole floor has been checked, double-check the rooms without the mark and make sure the room is empty.
10. When all their designated rooms are check and clear, the evacuation team members should assist other team members or should proceed directly to the evacuation area.

*"**All Clear Tags**" can be placed on the doorknobs after a guest room is checked and cleared, or use a chalk mark on the door. This can avoid double checking and might help when searching for missing guests. All clear tags should be stored in fire hose cupboards, in room service trolleys as well as at the housekeeping department or wherever else the emergency keys are stored for collection. 'All Clear Tags' can also be used by other departments to mark those rooms and facilities are successfully shut down. Evacuation personnel should be informed about where 'All Clear Tags" are stored and make use of them wherever it makes sense (The Tsunami Ready Tookbox).*

Note: Some guests might also require physical assistance to evacuate

1. *Bring disabled guest or guests requiring additional assistance to evacuate to the emergency staircase.*
2. *Ask other guests to assist the person. If nobody could assist, leave these guests in the staircase area until all rooms on the whole floor are checked.*
3. *Return to assist the disabled guests to reach the evacuation area.*

Lobby, Restaurants, Bars, Ball Rooms, Meeting Rooms and Banquet Rooms Evacuation Procedures:

1. Cease all servings, stop any music, and turn on lights.
2. Inform the guests in the room of the tsunami alarm and tell them to proceed to the evacuation point. Point out the direction to the evacuation route or nearest emergency exit.
3. Direct all guests out of the room. Evacuate the guests sitting at tables closest to the exit first and then working down through the room.

4. If necessary inform all tables individually and tell the guests they must proceed immediately to the evacuation point.
5. If any guest needs assistance to evacuate, instruct other able persons to assist, if nobody could help, assist the guest once all the other people have been evacuated from the room.
6. If any guest refuse to leave the room, they must be escorted out by two waiters/employees.
7. Make sure to check public toilets, storage, or other enclosed rooms in the area.
8. Once all the guests have been evacuated, close the room and mark the room as has been checked and empty.

Beach and/or Swimming pool Evacuation Procedures

If the hotel is located on the beach and/or have swimming pool on the ground floor, the hotel is responsible to alert all the people on the beach and swimming pool of the tsunami warning and to continue with the beach and swimming pool evacuation procedures. Evacuating people on the beach and/or swimming pool could be the responsibility of the lifeguards or beach security.

As some of the guest might be swimming or do water sports (surfing or sailing), it is important for the lifeguards and/or beach security to be able to inform them using megaphones or other signals that can get their attention.

In the case that the earthquake is felt in the hotel area, make sure the beach personnel are familiar with the natural tsunami warning signs (see page 6) and to report any suspicious signs indicating a possible tsunami to the relevant decision makers

1. Get attention of the guest on the beach by shouting “Tsunami Evacuation!”
2. Make sure that the people on the water that a tsunami warning has been issued for the to get out of the water and start evacuating
3. Check all restrooms/toilets, changing rooms and showers in order to make sure that people are aware of the warning.
4. Guide the people around to the evacuation area.
5. Make sure that the beach and/or swimming pool is empty and nobody returns (for example to get their belongings or to watch the tsunami come)

Administration and Hotel Operation / Department Evacuation Procedures

Hotel management is also responsible to make sure that all staff is safely evacuated and all operations are securely close down in emergency. Most hotels probably have already established this department close down procedure for example in the case of fire emergency, weather emergency. These procedures can be adapted for tsunami emergency.

Guidelines for Guest on Tsunami Evacuation

To ensure all guests and visitors are familiar with the hotel policy on safety for tsunami evacuation procedures, in addition to providing an evacuation maps and evacuation routes and signs, the hotel should also provide information on practical steps for tsunami evacuation to their guests. Having these steps will ease the *guest evacuation team* in ensuring that all guests understand, willing, and be cooperative during the evacuation process. Example of steps to guide hotel guests in tsunami emergency are:

1. When you feel a strong earthquake and you can hardly stand, or you feel a slow shaking that continues for a longer time, a Tsunami may have been generated.
2. Stay calm and do not panic.
3. After the shaking stops, move calmly to the designated assemble area (always check evacuation area of the hotel), then wait for further instruction by the hotel officials / security.
4. If the sea level receded, exposing fishes and corals, then you should move quickly to higher ground (check if the hotel is a designated vertical evacuation building). Do not go to the beach to confirm or to watch the tsunami.
5. If you are swimming on the shore you might not feel the earthquake, always be mindful of what is happening on the beach. If you see people curiously gathered on the beach, move away from the sea and go to the assemble area.
6. Hotel officials/security will evacuate all guests to higher ground and/or safe area that have been officially designated as tsunami evacuation area. All instructions will be given using a microphone system and/or a megaphone. Listen, follow all of the instruction and move in an orderly manner to the evacuation area.
7. During a tsunami stay calm and do not panic. Do not leave the tsunami evacuation area until it is officialy announced by the authorities that it is safe to leave the evacuation area. Tsunami will come in several waves and there are time gaps between the waves.
8. During a tsunami emergency, the hotel staff, local disaster management office, police and other emergency organization will try to save lives please follow all their instruction and give your full cooperation

The guests need to be reminded that in case of tsunami evacuation they have to follow the procedures each step for the safety of themselves and other people, and all tsunami evacuation instruction has to be taken seriously even in the cases of non-destructive event.

Annex



This checklist gives an overview about the steps which are necessary in order to get a hotel tsunami ready. Supporting information is provided in the 'Tsunami Ready' fact sheets (www.tsunamiready.com). This list is only a suggestion. Please feel free to copy the list and alter it according to the needs. Should you have any comments or ideas for improvement please let them know so they can share your ideas with others (info@tsunamiready.com). Logo on the left is the certification branding use by the Tsunami Ready.

A. Information Source and Interpretation		
Task / Items	**Status**	**Follow up**
a. Hotel is connected to reliable early warning source		
b. Tsunami early warnings can be received despite power black outs		
c. There are at least two early warning sources available (e.g. SMS, TV, VHF)		
d. Early warning information can be received on a 24/7 basis		
e. Early warning information is monitored on a 24/7 basis		
f. Responsible staff knows how to interpret warnings in order to initiate evacuation		
g. Clear SOP's for interpretation of warning messages and decision making are in place and communicated		
h. Staff is familiar with natural early warning signs and general tsunami facts like likely arrival times etc.		
i. Communication devices like loudspeakers and/or sirens are available and operational to alert staff and guests, also on the beach (consider power outages)		
j. Staff knows how to communicate alarm to guests		
k. Staff and guests are educated on how to interpret tsunami alarm Guests are familiar with evacuation procedures		
l. Tsunami information material for guests is available in every room		

B. Evacuation Procedures		
Task / Items	**Status**	**Follow up**
a. Responsibilities and SOP's are clearly defined and communicated to all staff		
b. Guest and staff evacuation procedures are implemented and tested		
c. Department close down procedures are implemented and tested		
d. Beach Evacuation procedures are implemented and tested		
e. Official public evacuation routes are known and communicated		
f. Hotel management and staff are familiar with public emergency procedures and preparations		
g. Test alarms and evacuations are carried out on an irregular basis		

C. Evacuation Route and Shelter		
Task / Items	**Status**	**Follow up**
a. Decision on horizontal versus vertical evacuation has been made		
b. Internal evacuation routes are clearly marked		
c. Suitability of evacuation spot has been evaluated by expert		
d. Evacuation spot is easily accessible		
e. Evacuation spot is large enough for all guests and staff (at least 1 m^2/person)		
f. Shelter is equipped for emergency (water, food [for at least 3 days] communication devices, check lists, important contacts etc.)		
g. Shelter and equipment are checked at least every 2 weeks		

D. Community Relations		
Task / Items	**Status**	**Follow up**
a. Cooperation opportunities with the immediate general public have been explored		
b. Problem of how to deal with access demands of the general public to hotel has been addressed and a solution found		

E. Cooperation		
Task / Items	**Status**	**Follow up**
a. Hotel management consulted with neighbouring hotels, the local administration and relevant institutions on emergency cooperation and procedures		

F. Post Tsunami (the following questions need to be addressed)		
Task / Items	**Status**	**Follow up**
a. How can guests and staff be evacuated if transport infrastructure is destroyed		
b. Does it make sense to prepare post disaster plans with other hotels to share resources like equipment, emergency supplies, doctors etc.?		
c. Where can official disaster related information and instructions be obtained from?		
d. Which organizations can help and how can they be contacted? (e.g. US/Australian consulate/army, private organisations like Hills & associates etc.)		
e. Who are the official Indonesian search & rescue organisations and how can they be contacted?		
f. Who else needs to be informed (company headquarters etc.)?		
g. Where could the hotel evacuate to once the water receded if the building is not safe anymore and how can guests and staff be supplied with basic necessities?		
h. Does it make sense to collaborate with other hotels nearby		

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Appendix 8: Socio-Economic Assessment and Stakeholder Engagement Report

DEBORAH BROSNAN & ASSOCIATES



MURBEE RESORT INC.

SOCIOECONOMIC ASSESSMENT AND STAKEHOLDER ENGAGEMENT REPORT

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1. EXECUTIVE SUMMARY

The Murbee Resort Inc. is a luxury complex planned on the southwest coast of Barbuda. This zone will host a resort complex featuring a 50-suite hotel along with numerous amenities such as guest pools, an organic farm, world-class restaurants, a spa, fitness facilities, sports courts, and employee housing.

In addition to the hotel, the project will develop four distinct types of residences, catering to both tourists and potential long-term residents. These residences will include beachfront, dunes, and lagoon homes. While the resort's architectural design and luxurious appeal promise to attract significant tourism and investment, it is crucial to recognize the unique socio-economic context in which it will be built.

The development site presents a unique set of considerations due to its surroundings. To the north, there are light industrial activities like the Roberts concrete batch plant, and to the east, a sand mining facility. Additionally, the historic Martello Tower, a culturally significant site within the project boundaries, requires thoughtful planning to ensure its preservation alongside the development.

Given the multifaceted nature of the Project, the need for a comprehensive socioeconomic impact assessment. This Socioeconomic Impact Assessment was designed to explore the potential impacts—both positive and negative—that the project may have on the local community. A project of this scale can contribute to economic growth, but it may also impact local socioeconomic activities, traditions, and the environment. Understanding these broader social effects is important for developing a mitigation plan to make the project both sustainable and inclusive.

The socio-economic analysis conducted for the project was structured around primary field work and secondary data collection. Secondary data was gathered from authoritative sources such as government statistics, reports from international organizations including the World Bank and United Nations, and academic studies. This data provided a solid foundation for understanding key demographic trends, economic conditions, and social dynamics in Barbuda, serving as a backdrop for the more localized insights gathered through fieldwork.

Primary fieldwork played an essential role in grounding the analysis in the realities of the Barbuda community. Two field visits were conducted in Codrington and surrounding areas. These visits included site inspections, stakeholder interviews, and public consultations. The first visit (July 2024) focused on the socio-demographic analysis and initial stakeholder engagement. During this time, interviews were conducted with representatives from various sectors, including education, healthcare, construction, hospitality, fishing, and public services. These interviews provided qualitative data that offered a nuanced understanding of the potential impacts on different community groups. Observations of key community amenities and their usage patterns were also recorded.

The second visit (August 2024) aimed to validate initial findings through further public consultations and data verification. This stage of the research was vital for ensuring that the conclusions drawn from the analysis accurately reflected the experiences and concerns of the local population. By integrating public feedback into the assessment, the project team sought to build trust and engage meaningfully with the community, ensuring that local voices played a significant role in shaping the development's social strategy.

In addition to local data and fieldwork, the social impact assessment aligns to international regulatory frameworks, such as International Finance Corporation (IFC) Performance Standards. These standards are widely recognized as best practice guidelines for managing environmental and social risks in development projects. The project aligns with IFC Performance Standard 1, which focuses on the Assessment and Management of Environmental and Social Risks and Impacts. This standard requires a systematic approach to identifying, managing, and mitigating risks throughout the project lifecycle, from planning to construction and operation.

The socio-economic analysis for the Project aims to establish a thorough understanding of the demographic, social, and economic characteristics of the affected population. This baseline data is crucial for identifying potential impacts during both the construction and operational phases of the project. Key aspects of the socio-economic environment that were analyzed include population trends, employment patterns, income levels, and the structure of local economic activities.

Understanding the cultural and social dynamics of the Barbuda community was also a primary objective of the analysis. Barbuda's culture is deeply rooted in its natural environment, and the community has traditionally engaged in activities such as fishing and small-scale farming. These activities not only sustain livelihoods but also form the backbone of the island's social fabric. By analyzing these dynamics, the socio-economic assessment provides insights into how the resort project might influence local traditions, social networks, and cultural practices.

The assessment also includes a detailed identification of stakeholders, ensuring that all affected groups are considered in the planning process. Key stakeholders include local residents, business owners, workers in the fishing and sand mining industries, and representatives of cultural and historical institutions, such as those responsible for the preservation of the Martello Tower. Engaging with these stakeholders was critical for understanding their concerns and ensuring that their perspectives were integrated into the project's social management strategy.

The potential social impacts and risks of the project were evaluated. The key social impacts identified include:

- **Road and Traffic Impacts**: Increased traffic during both construction and operational phases could disrupt local mobility and access to essential services.
- **Occupational and Community Safety Risks**: Construction activities pose risks to both workers and the community, including the potential for accidents and safety hazards.
- **Cultural Heritage**: The presence of the Martello Tower within the project area raises concerns about potential damage to cultural and archaeological heritage.
- **Impacts on Utilities**: The project could interfere with essential services such as water and electricity, particularly during construction activities.
- **Impacts on Employment and Economic Activities**: While the project is expected to generate new jobs, it may also disrupt existing economic activities, particularly in sectors like fishing and sand mining.

To mitigate these potential impacts, the project will implement a comprehensive Social Management Plan (SMP). Key programs within the SMP include:

1. Monitoring and compliance control
2. Occupational and community health and safety programs
3. Traffic and pedestrian management strategies

4. Community information and participation initiatives
5. Grievance Redress Mechanisms to address community concerns.
6. Socio-environmental training for workers
7. Cultural heritage preservation and archeological contingency plan
8. Gender equity and inclusion programs
9. Fishermen livelihood restoration plans

The following table presents a matrix outlining potential impacts of the project on various receptors, along with corresponding impact evaluations, mitigation programs, and residual impacts.

Table 1. Summary of social Impacts and Mitigation.

Receptor	Potential Impact	Impact Evaluation	Mitigation Program[1]	Residual Impact
Community Safety	Road and Traffic Impacts	Construction phase: Negative Operational Phase: Positive	Traffic and Pedestrian Management Community Information and Participation	Negligible
Local Economy and Livelihood	Impacts on the River Dock	Negative	Community Information and Participation Program to mitigate impacts to economic activities	Moderate
Community safety	Interferences with main utilities (water or energy)	Negative	Coordination with Service Providers. Interferences	Minor
Community safety	Risk of accidents	Negative	Occupational and Community Health and Safety Traffic and Pedestrian Management	Minor/ Moderate
Local Economy and	Impacts on employment, business, and services	Positive	N/A	N/A

[1] For all impacts, Monitoring and Control of Compliance with Mitigation Measures Program is considered

Receptor	Potential Impact	Impact Evaluation	Mitigation Program[1]	Residual Impact
Livelihood				
Local Economy and Livelihood	Impacts on economic activities settled in the operational area (Sand mining, construction activities, fishers' activities)	Negative	Community Information and Participation Grievance Redress Mechanism Program to mitigate impacts to economic activities Fishermen livelihood restoration plan	Minor/ Moderate
Cultural heritage	Negative impacts on cultural and archaeological heritage	Negative	Cultural heritage preservation Plan Archeological Contingency Plan	Minor
Community safety	Landscape and public space	Positive	N/A	N/A
Local Economy and Livelihood	Economic development	Positive	N/A	N/A

These programs collectively ensure that the project balances development goals with the well-being of the Barbuda community, supporting a sustainable and socially responsible approach.

Finally, the project represents a significant investment in Barbuda's future, promising economic growth, job creation, and enhanced infrastructure. However, the success of the project will depend not only on its ability to deliver these benefits but also on its capacity to manage and mitigate the social risks associated with large-scale development. Through a thorough socio-economic assessment, adherence to international standards, and the implementation of a robust Social Management Plan (SMP), the project aims to foster sustainable development that respects the unique cultural and social fabric of Barbuda while enhancing the community's quality of life.

This Social Impact Assessment serves as a comprehensive tool to guide the project in balancing economic objectives with social responsibility, ensuring that the Rosewood Barbuda Resort

Development contributes positively to both the local community and the island's broader socio-economic landscape.

2. INTRODUCTION

The project, to be implemented in Barbuda's Southwest Coast, aims to introduce a high-end luxury resort complex designed to boost the island's economy and position it as a premier tourism destination.

This large-scale project encompasses the construction of a 50-suite hotel with a variety of world-class amenities, as well as a residence area with four distinct types of residential properties. The location, a zone designated for port development, situates the project amidst unique environmental and socio-economic conditions that require a comprehensive analysis of its potential impacts on the local community and culture.

In light of the project's scale and the sensitive nature of its surrounding environment—where industries such as sand mining and the historic Martello Tower coexist—understanding the social implications is essential. The Social Impact Assessment is designed to identify, analyze, and address the potential social effects of the project, ensuring that development progresses in a socially responsible and sustainable manner. The assessment examines the socio-economic landscape, anticipates risks and opportunities, and proposes strategic interventions to manage these impacts effectively.

The overall objective of this Socioeconomic Impact Assessment is to ensure that the project fosters positive social and economic outcomes while mitigating any adverse effects on the local population and their way of life. The study seeks to balance development goals with the preservation of Barbuda's cultural heritage, community safety, and socio-economic stability.

The primary objectives of this study are:

1. Assess the socio-economic conditions of Barbuda, specifically in the area surrounding the project site, providing a comprehensive understanding of local demographics, economic activities, and cultural dynamics;
2. Identify and analyze the potential social impacts and risks posed by the Rosewood Barbuda Resort Development during both construction and operational phases;
3. Engage with local stakeholders through interviews, consultations, and fieldwork to gather valuable insights and integrate community concerns into the project's planning and implementation;
4. Develop a Social Management Plan (SMP) with targeted programs aimed at mitigating negative impacts, promoting community well-being, and fostering sustainable development; and
5. Ensure compliance with national and international legal frameworks, including the International Finance Corporation's (IFC) Performance Standards, which guide the project's social risk management efforts.

This report is structured to present a detailed analysis of the social context, identify the potential impacts of the project, and outline a comprehensive management plan to address these impacts. It is divided into several chapters, each focusing on key aspects of the social impact assessment:

1. **Methodology:** This chapter details the methodological approach used for the assessment, combining secondary data collection and primary fieldwork. It outlines the key sources of data, including governmental statistics, international reports, and findings from site visits and stakeholder consultations. Two distinct field visits are described,

emphasizing the qualitative and quantitative research methods employed to capture the socio-economic realities of the affected community.

2. **Applicable standards and regulatory framework:** This chapter examines the legal context within which the project operates, focusing on national environmental licensing, labor legislation, occupational health and safety standards, and human rights protections. It also details the project's alignment with the IFC Performance Standards, which provide guidelines for managing social and environmental risks.
3. **Socioeconomic Baseline:** The socioeconomic baseline chapter presents an in-depth exploration of Barbuda's social, demographic, and economic characteristics. It defines the project's area of influence, and analyzes the impact on governance structures, housing, education, health, and economic activities. This section includes a focused analysis of Codrington, the main settlement on the island, and examines the potential effects of the project on the town's infrastructure and livelihood activities.
4. **Social Impacts and Risks:** This chapter identifies the key social impacts associated with the construction and operation of the Project.
5. **Social Management Plan:** This chapter outlines a series of programs designed to address the social impacts identified in the previous chapter. These programs include monitoring and compliance measures, community safety initiatives, stakeholder engagement strategies, and livelihood restoration plans for affected groups such as local fishermen. Each program is tailored to address specific social risks and promote long-term positive outcomes for the local community.
6. **Stakeholder Engagement Plan:** This section focuses on the project's stakeholder engagement efforts, detailing the objectives and methodology for maintaining transparent communication with the local population. It emphasizes the importance of equitable and inclusive engagement, ensuring that all community voices are heard and integrated into the project's decision-making processes.
7. **Stakeholder Participation Report:** This chapter presents the results and findings of the Stakeholder Engagement Process conducted by the consultants, including key questions, concerns, and areas of improvement were expressed by the local population.

To conclude, the Socioeconomic Impact Assessment of the Project offers a thorough and multi-faceted evaluation of the project's potential effects on the local community. Through a combination of rigorous data collection, stakeholder engagement, and alignment with international best practices, this assessment provides a roadmap for ensuring that the development not only achieves its economic objectives but also contributes positively to Barbuda's social fabric and long-term sustainability.

3. ASSESMENT METHODOLOGY

This section of the study presents the methodology used to conduct the social assessment. The methodology was designed to ensure a thorough understanding of the socio-economic context in Barbuda. The approach combines a detailed review of secondary data sources with comprehensive primary fieldwork, structured to capture both broad trends and localized impacts.

3.1. Desktop review

The initial phase of the study involved an extensive review of secondary data sources, providing a foundational understanding of the region's socio-economic landscape. This phase focused on gathering relevant demographic, economic, and social data from various established sources. Key documents and datasets reviewed include:

- Government Statistical Information:
  - ✓ Statistics Division, Ministry of Finance and Corporate Governance, Antigua and Barbuda. Provides detailed demographic and economic data
  - ✓ Surveys reports and census data. This documents were crucial for identifying population trends, economic conditions, and social dynamics.

- Reports and Studies by International Organizations, NGOs and Multilateral Agencies:
  - ✓ World Bank Group
  - ✓ United Nations Department of Economic and Social Affairs:
  - ✓ Pan American Health Organization (PAHO
  - ✓ International Monetary Fund
  - ✓ Caribbean Development Bank
  - ✓ United Nations Development Programme

- Academic Texts: Articles and books that offer theoretical frameworks and case studies relevant to the socio-economic context of small island developing states (SIDS), particularly in the Caribbean.

- Master Plans and design Briefs for the Project

- General Statistical and Sociodemographic profiles
  - ✓ CLAC (Economic Commission for Latin America and the Caribbean): Antigua and Barbuda: National Sociodemographic Profile. CEPALSTAT
  - ✓ Expansion Datos Macro: General data on Antigua and Barbuda. Expansion Datos Macro

3.2. Primary Fieldwork

Drawing upon the insights derived from secondary data, primary fieldwork was undertaken to substantiate the analysis within the lived experiences of the Barbuda community, with a particular focus on Codrington, the island's principal and only town.

For the purpose of conducting a comprehensive survey and analysis of the project's area of influence in social terms, two field visits were conducted.

3.2.1. Visit 1: July 10-12, 2024

The first field visit was conducted from July 10 to July 12, 2024. The primary objective was focused on a thorough reconnaissance of the project area, which involved:

- **Site Inspection:** Ground investigation of the project area and the community of Codrington. During this fieldwork key local amenities were documented, including hotels, restaurants, schools, government buildings, healthcare facilities, and various types of housing. This inspection was meticulously recorded through photographic documentation, which provides a visual record of the existing conditions.

- **Socio-Demographic Analysis:** A general analysis of the socio-demographic characteristics of the project's influence area was undertaken. This was essential for identifying potential negative impacts of the project on the local population. Non-participant observation was employed as a method to observe and record the community, providing a deeper understanding of the local social dynamics.

- **Stakeholder Interviews:** To capture a diverse range of perspectives, twelve semi-structured interviews were conducted with key stakeholders. These interviews provided qualitative insights into the community's views on the potential impacts of the project, helping to identify both opportunities and concerns. They included individuals from various sectors, such as:
    - Education primary and secondary school teachers)
    - Healthcare (a hospital director)
    - Construction (a construction worker)
    - Hospitality (a resort project manager, a hotel owner, and a restaurant worker)
    - Fishing (three local fishermen)
    - Public Services (a council worker)

- **Stakeholder Mapping:** Based on the interviews and observations, key actors were identified for stakeholder mapping. This mapping is crucial for facilitating meaningful public participation in the project's planning and decision-making processes of the project.

3.2.2. Field Visit 2: August 26-30, 2024

A second field visit was conducted to validate the findings from the initial visit and to engage in significant public consultations with relevant stakeholders. The objectives of this visit included:

- **Stakeholder engagement events:** These sessions were essential for gathering feedback from the community, addressing concerns, and ensuring transparency in the project's planning processes.

- **Verification of Data:** The second visit also served to verify the data collected during the first field visit and to cross-check it against secondary sources. This step was vital for ensuring the accuracy and reliability of the socio-economic analysis.

This comprehensive methodological approach, integrating both secondary data analysis and robust primary fieldwork, ensures a well-rounded and accurate socio-economic study. The findings from this study will provide a solid foundation for planning and implementing effective

mitigation strategies, minimizing potential negative impacts, and maximizing the benefits of the project for the Barbuda community.

4. APPLICABLE STANDARDS AND REGULATORY FRAMEWORK

The following sections present the key laws and regulations relating to social, occupational health and safety, community and participation aspects in Antigua and Barbuda that are applicable to the Project.

4.1. Environmental licensing

According to the Part III – Environmental Plans and Policies of the Environmental Planning and protection Bill (2019), despite the stipulations in any other legal provision, no individual should initiate any project work unless they have received a certificate of environmental clearance in line with the specified regulations following the approval of either an Environmental Impact Statement or an Environmental Impact Assessment by the Director. Alternatively, the project may be specifically exempt from the need for such a certificate.

The table below presents a summary of the main regulations related to environmental licensing:

Table 2. Environmental Regulations

Multilateral Regulations	
Revised Treaty of Chaguaramas	One of the objectives is to promote sustainable development through the use of economic and environmental policies that ensure the long-term welfare of the region's people and natural resources.
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	The Parties agree to take all necessary measures to prevent, reduce and control pollution of the Convention area (art. 4), particularly pollution from ships (art. 5), dumping (art. 6), land-based sources (art. 7), activities relating to exploration and exploitation of the seabed (art. 8) and airborne pollution (art. 9). They undertake to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other marine life in especially protected areas (art. 10). Parties are to cooperate in dealing with pollution emergencies in the Convention area (art. 11), in assessing environmental impacts in the Convention area (art. 12) and in exchanging data and other scientific and technical information (art. 13). The Convention establishes rules and procedures for the determination for liability and compensation for damage resulting from pollution of the Convention area (art. 14).
Protocol concerning Pollution from Land-Based sources and activities to the	The LBS Protocol, which was adopted in 1999 and entered into force in 2010, is one of three Protocols of the Cartagena Convention. This legal instrument consists of obligations to reduce the negative environmental and human health impacts of land-based pollution in the Wider Caribbean Region (WCR).

Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	
Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	In the planning process leading to decisions about industrial and other projects and activities that would have a negative environmental impact and significantly affect areas or species that have been afforded special protection under this Protocol, each Party shall evaluate and take into consideration the possible direct and indirect impacts, including cumulative impacts, of the projects and activities being contemplated. The Organization and the Scientific and Technical Advisory Committee shall, to the extent possible, provide guidance and assistance, upon request, to the Party making these assessments.
National Regulations	
Environmental Protection and Management Act No. 10 of 2019	This Act lays down rules for the establishment of an integrated system for the sound and sustainable management of the environment for the benefit of present and future generations; control and mitigation of all forms of environmental degradation or pollution including hazardous substances and wastes for the purposes of protecting human health and maintaining the quality of the environment; the implementation of environmental standards in compliance with various multilateral environmental agreement; sustainable financing for the management of the environment and conservation of natural resources; environmental awareness-raising; and the development of the legal, regulatory and institutional framework for environmental management. Therefore, this Act sets forth provisions on the establishment, administration and functions of the Department of Environment in Part II; powers of inspector and director in Part III; environmental management planning and development of National Environmental Policy Framework in Part IV; procedures for pollution control permits and registration of sources of pollution in Part V; Environmental Impact Assessment processes in Part VI; environmental management and monitoring and related standards, procedures and guidelines in Part VII; natural resources management in the fields of protected area, watershed, and international trade in endangered species of wild fauna and flora in Part VIII; access and benefit sharing of genetic resources in Part IX; registry, database and inventory related to environmental information in Part X; negotiation and accession to multilateral environmental agreements in Part XI; establishment, purpose, functions and duties of the Sustainable Island

	Resources Framework Fund in Part XII; compliance and enforcement in Part XIII; offences and penalties related to management and protection of water resources, atmosphere and wildlife in Part XIV; environmental information, research, education and training in Part XV; and miscellaneous provisions on Part XVI.
Antigua and Barbuda's Intended Nationally Determined Contribution	The Intended Nationally Determined Contribution is a national policy with a multi-sectoral approach. The period of implementation of this policy is Pre 2020 and 2020 – 2030. The main objective of this Policy is to make contributions by reducing GHG emissions in the energy, health, tourism, agriculture, land, waste, water, transportation, and forestry sectors.
Special Economic Zone Act No. 17 of 2015	This Act concerns the development, regulation, construction, management and control of Special Economic Zones in Antigua and Barbuda. This Act lays down rules for the determination of Special Economic Zones policy and strategy; establishment of the Advisory Board; establishment of the Special Economic Zones Fund to support the development of Special Economic Zones; designation, promotion, development, surveillance and management of Special Economic Zones; regulatory measures and incentives for Special Economic Zones in order to attract domestic and foreign direct investment; and the establishment of a single point of contact or one stop shop that delivers the required government services to businesses investing and operating in Special Economic Zones in order to lodge applications to various government authorities and agencies and to receive information on regulatory requirements from such authorities and agencies. The Special Economic Zones are categorized by the Minister, including free port; free trade zone; industrial development zone; sector development zone; industrial undertaking zone; financing and banking zone; tourism zone and corporate headquarters zone.
Special Economic Zone (Amendment) Act No. 27 of 2019	This Law amends the purpose of Special Economic Zones in Section 5 as: "A Special Economic Zone is an economic development tool for the promotion of economic growth by using targeted support measures to encourage and facilitate the development of and investment in manufacturing, technology and tradable services." Moreover, Section 21 of the principal Act regarding support measures is repealed in its entirety and replaced as indicated in Section 4 of this Law.
Physical Planning Act, 2003 (No. 6 of 2003)	An Act to make provision for the orderly and progressive development of land and to preserve and improve amenities thereof; for the grant of permission to develop land and for other powers of control over use of the land; for the regulation of the construction of buildings and other related matters; to confer additional powers in respect of acquisition and development of

	land for planning; and for purposes connected with matters aforesaid.

4.2. Rights to Environmental Information

Table 3. Regulations on access to environmental information

Multilateral Regulations	
"Escazu Agreement" Regional Agreement on Access to Information, Public Participation and Justice in Environmental Matters in Latin America and the Caribbean	The objective of the Escazu Agreement is to guarantee the full and effective implementation in Latin America and the Caribbean of the rights of access to environmental information, public participation in the environmental decision-making process and access to justice in environmental matters, and the creation and strengthening of capacities and cooperation, contributing to the protection of the right of every person of present and future generations to live in a healthy environment and to sustainable development.
National Regulations	
Constitution of Antigua and Barbuda	The Constitution of Antigua and Barbuda ensures access to information and participation within the framework of the freedoms of expression, peaceful assembly and association.
Physical Planning Act, 2003 (No. 6 of 2003)	An Act to make provision for the orderly and progressive development of land and to preserve and improve amenities thereof; for the grant of permission to develop land and for other powers of control over use of the land; for the regulation of the construction of buildings and other related matters; to confer additional powers in respect of acquisition and development of land for planning; and for purposes connected with matters aforesaid
Freedom of Information Act (No. 19 of 2004)	The Freedom of Information Act promotes maximum disclosure of information in the public interest, guarantees and facilitates the right of access to information of every person and provides for effective mechanisms to secure that right.
Environmental Protection and Management Act, 2019 No. 10 of 2019	This Act lays down rules for the establishment of an integrated system for the sound and sustainable management of the environment for the benefit of present and future generations; control and mitigation of all forms of environmental degradation or pollution including hazardous substances and wastes for the purposes of protecting human health and maintaining the quality of the environment; the implementation of environmental standards in compliance with various multilateral environmental

	agreement; sustainable financing for the management of the environment and conservation of natural resources; environmental awareness-raising; and the development of the legal, regulatory and institutional framework for environmental management. Therefore, this Act sets forth provisions on the establishment, administration and functions of the Department of Environment in Part II; powers of inspector and director in Part III; environmental management planning and development of National Environmental Policy Framework in Part IV; procedures for pollution control permits and registration of sources of pollution in Part V; Environmental Impact Assessment processes in Part VI; environmental management and monitoring and related standards, procedures and guidelines in Part VII; natural resources management in the fields of protected area, watershed, and international trade in endangered species of wild fauna and flora in Part VIII; access and benefit sharing of genetic resources in Part IX; registry, database and inventory related to environmental information in Part X; negotiation and accession to multilateral environmental agreements in Part XI; establishment, purpose, functions and duties of the Sustainable Island Resources Framework Fund in Part XII; compliance and enforcement in Part XIII; offences and penalties related to management and protection of water resources, atmosphere and wildlife in Part XIV; environmental information, research, education and training in Part XV; and miscellaneous provisions on Part XVI.

4.3. Labor Legislation

Table 4. Labor Legislation Regulations

International Regulations	
Forced Labour Convention, 1930 (No. 29)	It prohibits the use of forced or compulsory labor in all its forms, considering that the term “forced or compulsory labor” shall mean all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily.
Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87)	It states workers and employers, without distinction whatsoever, shall have the right to establish and, subject only to the rules of the organization concerned, to join organizations of their own choosing without previous authorization.
	It states workers shall enjoy adequate protection against acts of anti-union discrimination in respect of their employment.

Right to Organise and Collective Bargaining Convention, 1949 (No. 98)	
C100 - Equal Remuneration Convention, 1951 (No. 100)	It states men and women workers shall be equally remunerated for work of equal value. It refers to rates of remuneration established without discrimination based on sex.
Abolition of Forced Labor Convention, 1957 (No. 105)	It states the obligation to suppress and not to make use of any form of forced or compulsory labor-- (a) as a means of political coercion or education or as a punishment for holding or expressing political views or views ideologically opposed to the established political, social or economic system; (b) as a method of mobilizing and using labor for purposes of economic development; (c) as a means of labor discipline; (d) as a punishment for having participated in strikes; (e) as a means of racial, social, national or religious discrimination.
Discrimination (Employment and Occupation) Convention, 1958 (No. 111)	It states the obligation to declare and pursue a national policy designed to promote equality of opportunity and treatment in respect of employment and occupation, with a view to eliminating any discrimination in respect thereof. The term discrimination includes (a) any distinction, exclusion or preference made on the basis of race, color, sex, religion, political opinion, national extraction, or social origin, which has the effect of nullifying or impairing equality of opportunity or treatment in employment or occupation.
Minimum Age Convention, 1973 (No. 138)	It states the obligation to pursue a national policy designed to ensure the effective abolition of child labor and to raise progressively the minimum age for admission to employment or work to a level consistent with the fullest physical and mental development of young persons.
Occupational Safety and Health Convention, 1981 (No. 155)	The purpose of the Occupational Safety and Health Convention, 1981 (No. 155) is to promote a safe and healthy working environment for all workers by establishing a framework for occupational safety and health (OSH) and the working environment.
Worst Forms of Child Labor Convention, 1999	It states the obligation to take immediate and effective measures to secure the prohibition and elimination of the worst forms of child labour as a matter of urgency. For the purposes of this Convention, the term child shall apply to all persons under the age of 18, and the term the worst forms of child labour comprises: (a) all forms of slavery or practices similar to slavery, such as the sale and trafficking of children, debt bondage and serfdom and forced or compulsory labour, including forced or compulsory recruitment of children for use in armed conflict; (b)

	the use, procuring or offering of a child for prostitution, for the production of pornography or for pornographic performances; (c) the use, procuring or offering of a child for illicit activities, in particular for the production and trafficking of drugs as defined in the relevant international treaties; (d) work which, by its nature or the circumstances in which it is carried out, is likely to harm the health, safety or morals of children.
Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187)	The purpose of the Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187) is to enhance the level of occupational safety and health (OSH) in member states by promoting a preventative safety and health culture and by progressively achieving a safe and healthy working environment.
National Regulations	
The Antigua and Barbuda Labour Code Act, chapter 27	This Act aims at creating a framework Law and bringing together all legislation applicable to employment, employment standards, and industrial relations in Antigua and Barbuda, in order to provide employers and employees with information on their rights and responsibilities, and to offer persons inside and outside Antigua and Barbuda, who consider the investment of funds in enterprises, a centralized source of information, and to simplify the legislative review process. The Act creating the Labour Code is composed of the following Divisions, dealing with one or more aspects of employment and labour relations: Declaratory Division; Administration Division; Basic Employment Division; Employment Health, Safety and Welfare Division; Women, Young Persons, and Children Employment Division; Work Permits Division; Trade Unions Division; Bargaining Agents' Registration Division; Employee-Representation Questions (Resolution) Division; Industrial Relations (Regulation) Division. This Act applies to all employers operating or doing business in Antigua and Barbuda, including the Government and to all employees of employers operating or doing business in Antigua and Barbuda.
The Antigua and Barbuda Labour Code (Amendment) Act, no. 4 of 2022	This Act amends the Labour Code Act, chapter 27. The amendment concerns Section C20 and details the maternity leave.

4.4. Occupational Health, Hygiene and Safety

Table 5. Occupational Health, Hygiene and Safety regulations

International Regulations	
International Convention for the Safety of Life at Sea (SOLAS), 1974 and the Protocols of 1978 and 1988	The main objective of the SOLAS Convention is to specify minimum standards for the construction, equipment, and operation of ships, compatible with their safety. Flag States are responsible for ensuring that ships under their flag comply with its requirements, and several certificates are prescribed in the Convention as proof that this has been done.
Occupational Safety and Health Convention, 1981 (No. 155)	The C155 - Occupational Safety and Health Convention, 1981 (No. 155) is an international labour convention adopted by the International Labour Organization (ILO). The primary purpose of this convention is to promote a safe and healthy working environment for all workers through comprehensive policies and measures.
Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187)	The Promotional Framework for Occupational Safety and Health Convention, 2006 (No. 187) aims to promote continuous improvement in occupational safety and health (OSH) to prevent workplace injuries, diseases, and deaths.
Occupational Health Services Convention, 1985 (No. 161)	The purpose of the Occupational Health Services Convention, 1985 (No. 161) is to promote the establishment of occupational health services in workplaces. These services are aimed at ensuring the health and safety of workers by preventing occupational diseases and accidents, and by promoting safe and healthy working conditions. The convention outlines the role of these services, including health surveillance, advice on occupational health and safety, and the adaptation of work to the capabilities of workers.
	National Regulations
Public Health Act (Dangerous Infectious Disease) Regulations, 2020 (S.I. No. 16 of 2020)	These Regulations, made by the Minister of Health under the Public Health Act, empowers the Central Board of Health to take measures to contain the COVID-19 virus. The Board may, among other things, impose a closing of all non-essential businesses. The Board may enforce any Order given under these Regulations.
Public Health Act (Dangerous Infectious Disease) (Amendment) (No. 4) Regulations, 2020	These Regulations amend the Public Health Act (Dangerous Infectious Disease) Regulations, 2020 in provisions regarding special powers of the Central Board of Health to take measures to contain the COVID-19 virus and measures and exemptions regarding the lock-down. These Regulations specifically exempt registered livestock and vegetable farmers and licensed fishermen from restrictions on movement. They may operate during specified hours.

Public Health Act, Cap. 353	The Act makes provisions for various matters relating to public health in Antigua and Barbuda.
Public Health Act (Dangerous Infectious Disease) (Amendment) Regulations, 2020 (S.I. No. 24 of 2020)	These Regulations amend the Public Health Act (Dangerous Infectious Disease) Regulations, 2020 in provisions regarding special powers of the Central Board of Health to take measures to contain the COVID-19 virus. The Board may modify or adopt, with modifications, any special measures as the circumstances caused by the spread or the threat of the spread of the dangerous infectious disease may from time to time require. The Regulations also impose a closing of all non-essential businesses. Fish and meat markets, abattoirs, vegetable and livestock farming, vending of agricultural produce, wholesale or retail grocery stores, supermarkets and community shops and provision of water services, amongst other, may continue.
Animal Health Act No. 12 of 2017	An Act to control the movement of animals, animal products and animal-related items into and within Antigua and Barbuda in order to prevent the introduction and spread of notifiable animal diseases within Antigua and Barbuda and other countries; to safeguard animal health; to facilitate veterinary public health; to establish standards for animal welfare in Antigua and Barbuda; and for other incidental matters.
The Occupational Safety and Health Act, 2013	The Occupational Safety and Health Act (2013) provides additional obligations for employers in reporting workplace accidents and incidents, specifying the timeframe and type of information to be reported.
Labour Code	The Labour Code of Antigua and Barbuda, formally known as Chapter 27, encompasses comprehensive labour regulations designed to protect worker rights and ensure safe and fair working conditions.

4.5. Expropriations

Table 6. Expropriations Legislation

	National Regulations
Antigua and Barbuda Constitution Order 1981	The Constitution provides a basis for possible territorial acquisitions, expands upon fundamental human rights, recognizes and guarantees the rights of opposition parties in

	government, and provides Barbuda with a large measure of internal self-government.
Assessment of Compensation (Land of Alvan Camacho) Act (No. 8 of 1962)	This Act concerns the assessment, award and payment of compensation in relation with compulsory acquisition by the Government of land specified in the Schedule to this Act. It requires a Board of Assessment to be established in accordance with the Land Acquisition Act for purpose of assessing compensation. The Act also regulates some procedural matters in relation with the acquisition of the land specified in the Schedule.
Land Acquisition Act, CAP. 233	This Act concerns the procedures for the acquisition of land by the State for public purposes and various other matters relating to such acquisition such as assessment and award of compensation and abandonment of acquisition.
Land Adjudication Act (Act No. 16 of 1975)	This Act sets out the procedures, principles and criteria for the adjudication of land in an area declared to be an adjudication area by Order of the Minister made under this Act. The Act also declares all waste and unoccupied land to be Crown land.
Beach Control Act (Cap. 45)	The Act provides for the vesting of the foreshore and the floor of the sea in the Crown and regulates the use and control of those areas and related matters. The "floor of the sea" means the soil and subsoil of the sea off the coast of Antigua and Barbuda between the low water mark and so far out to sea as is deemed by law to be within the territorial sea (sect. 2). Use of the foreshore and the floor of the sea requires a license. Exempted from such obligation are agriculture, rights of fishermen in or over any beach or adjoining land before the Act came into operation and other rights specified in section 10. Licenses are granted by the Minister responsible for Crown land in accordance with section 5. The Cabinet shall from time to time determine needs and requirements of the public in relation to the foreshore, also in relation to fishing (sect. 6). Section 8 concerns the compulsory acquisition of land for purposes of sections 6 and 7. Section 8 defines regulation making powers of the Cabinet.
Physical Planning Act, 2003 (No. 6 of 2003)	An Act to make provision for the orderly and progressive development of land and to preserve and improve amenities thereof; for the grant of permission to develop land and for other powers of control over use of the land; for the regulation of the construction of buildings and other related matters; to confer additional powers in respect of acquisition and development of land for planning; and for purposes connected with matters aforesaid.

The Real Property Limitation Act	No land or rent to be recovered but within twelve years after right of action accrued.

4.6. Cultural Heritage, Archaeological and Historical Sites

Table 7. Cultural Heritage, Archaeological and Historical Sites Regulations

National Regulations	
The Cultural Heritage (Protection) Bill, 2016	An Act for the protection of cultural heritage, encompassing land- based as well as submerged immovable heritage as well as movable objects, in Antigua and Barbuda and for incidental and connected purposes.

4.7. Human Rights

Table 8. Human Rights Regulations

International Regulations	
Universal Declaration of Human Rights	All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood.
Inter-American Convention on International Return of Children	The purpose of this Convention is to secure the prompt return of children habitually resident in one State Party who have been wrongfully removed from any State to a State Party or who, having been lawfully removed, have been wrongfully retained.
Inter-American Convention against Racism, Racial Discrimination and Related Forms of Intolerance	Every human being is equal under the law and has a right to equal protection against racism, racial discrimination, and related forms of intolerance in any sphere of life, public or private.
Inter-American Convention on the Prevention, Punishment and Eradication of Violence against Women "Convention of Belem Do Para"	Every woman has the right to the recognition, enjoyment, exercise and protection of all human rights and freedoms embodied in regional and international human rights instruments. These rights include, among others: a. The right to have her life respected. b. The right to have her physical, mental and moral integrity respected.

	c. The right to personal liberty and security. d. The right not to be subjected to torture. e. The rights to have the inherent dignity of her person respected and her family protected. f. The right to equal protection before the law and of the law. g. The right to simple and prompt recourse to a competent court for protection against acts that violate her rights. h. The right to associate freely. i. The right of freedom to profess her religion and beliefs within the law. j. The right to have equal access to the public service of her country and to take part in the conduct of public affairs, including decision-making.
United Nations Convention on the Rights of Persons with Disabilities (CRPD)	The purpose of the present Convention is to promote, protect and ensure the full and equal enjoyment of all human rights and fundamental freedoms by all persons with disabilities, and to promote respect for their inherent dignity. Persons with disabilities include those who have long-term physical, mental, intellectual or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others.
Convention against Torture and Other Cruel Inhuman or Degrading Treatment or Punishment	The purpose of the Convention against Torture and Other Cruel, Inhuman or Degrading Treatment or Punishment, adopted by the United Nations in 1984, is to prevent and prohibit torture and other forms of cruel, inhuman, or degrading treatment or punishment worldwide.
Convention on the Elimination of All Forms of Discrimination against Women	The Convention on the Elimination of All Forms of Discrimination against Women (CEDAW), adopted by the United Nations in 1979, aims to eliminate discrimination against women and promote gender equality.
International Convention on the Elimination of All Forms of Racial Discrimination	The purpose of the International Convention on the Elimination of All Forms of Racial Discrimination (ICERD), adopted by the United Nations in 1965, is to eliminate racial discrimination and promote equality among all races.
OECS Policy on Rights Contingent on the Right to Freedom of Movement Within the Economic Union	Citizens of Protocol Member States shall enjoy in the Economic Union area the right contingent to the right of freedom of movement that is agreed by the Protocol Member States.

National Regulations	
The Constitution of Antigua and Barbuda, 1981	Whereas every person in Antigua and Barbuda is entitled to the fundamental rights and freedoms of the individual the right, regardless of race, place of origin, political opinions or affiliations, color, creed or sex, but subject to respect for the rights and freedoms of others and for the public interest, to each and all of the following, namely- a. life, liberty, security of the person, the enjoyment of property and the protection of the law; b. freedom of conscience, of expression (including freedom of the press) and of peaceful assembly and association; and c. protection for his family life, his personal privacy, the privacy of his home and other property and from deprivation of property without fair compensation, the provisions of this Chapter shall have effect for the purpose of affording protection to the aforesaid rights and freedoms, subject to such limitations of that protection as are contained in those provisions, being limitations designed to ensure that the enjoyment of the said rights and freedoms by any individual does not prejudice the rights and freedoms of others or the public interest.
The Sexual Offences Act	An Act to repeal and replace the laws of Antigua and Barbuda relating to sexual crimes, to the procuration, abduction and prostitution of persons and to kindred offences.
Law Revision (Miscellaneous Amendments) Act 2004	An Act to amend the provisions of certain Acts of Parliament.
Offences against the Person Act	This act outlines various criminal offenses against individuals, such as murder, manslaughter, assault, and related crimes, and stipulates the corresponding legal penalties.
Offences against the Person (Amendment) Act, 2013	An Act to amend the Offences Against the Person Act, Cap. 300.
Domestic Violence (Summary Proceeding) Act	An Act which defines what is domestic violence and the potential sentences for these crimes.
Act 12 - The Trafficking in Persons (Prevention) Act	The aims of this Act include: combating the trafficking in persons within and across the borders of Antigua and Barbuda; the definition of the crime of people trafficking and related matters; and the taking of measures to protect and support victims. The Act considers an aggravating circumstance actions taken against especially vulnerable populations such as pregnant women,

	among others. It establishes that past sexual behavior is irrelevant and inadmissible to be used against the victim in court.
Migrant Smuggling (Prevention) Act	This Act aims to combat migrant smuggling; to provide for migrant smuggling and other offences associated with migrant smuggling and for incidental and connected purposes.
Trafficking in Persons (Prevention) (Amendment) Act	The present act amends the Trafficking in Persons (Prevention) Act, No. 12 of 2010 and for incidental and connected purposes.
Migrant Smuggling (Prevention) (Amendment) Act	This Act strengthens the Migrant Smuggling Prevention Act 2010 and provides for increased penalties under the legislation.
Domestic Violence Act, No. 27 of 2015	The present act provides greater protection for victims of domestic violence and makes provision for the granting of protection orders and for matters incidental thereto and connected therewith.
The Evidence (Special Provisions) (Amendment) Act	This act allows vulnerable witnesses of crimes such as sexual assault and abuse to give evidence without having to face the perpetrator in court to reduce their potential re-victimization.
Trafficking in Persons (Prevention) (Amendment) Act	Strengthens the Trafficking in Persons Prevention (Amendment) Act from 2015 with provisions for the prevention of human trafficking and allows for protection of its victims.
Trafficking in Persons (Prevention) (Amendment) Act, 2019	An act to amend the Trafficking in Persons (Prevention) Act, 2010 to establish the Trafficking in Persons Prevention Unit and for connected matters.
Disabilities and Equal Opportunities Act, 2017	An Act to make provision for the protection of the rights of persons with disabilities and for connected matters.
Social Protection Act 2020 No. 22 of 2020	An Act to provide for the prevention, reduction and elimination of economic, discriminatory and social vulnerabilities as it relates to poverty and deprivation in Antigua and Barbuda; to establish a Social Protection Board, a Social Protection Commission and an Appeals Tribunal; to repeal the Poor Relief Act, Cap.332 and for related matters.

4.8. IFC Performance Standards

In this Environmental Impact Assessment (EIA), the performance standards established by the International Finance Corporation (IFC) will be utilized as the guiding framework.

The IFC Performance Standards are a set of guidelines designed to ensure that projects adhere to international best practices in managing environmental and social risks and impacts.

These standards provide a comprehensive approach to integrating environmental and social considerations into project planning and implementation, thereby promoting sustainability and reducing adverse effects.

The Performance Standards encompass a range of requirements that address various aspects of project management, from the assessment and management of risks to the protection of community health and cultural heritage. By adhering to these standards, the project aims to uphold high standards of environmental stewardship and social responsibility. This approach not only aligns with global best practices but also ensures that the project contributes positively to the local community and environment.

Incorporating the IFC Performance Standards into the EIA process helps to systematically evaluate potential impacts, engage with stakeholders, and implement measures that mitigate negative effects while enhancing positive outcomes. This commitment to good practices in socio-environmental management ensures that the project operates within a framework of accountability and transparency, ultimately supporting sustainable development and the well-being of affected communities.

4.8.1. Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts

Performance Standard 1 establishes the importance of (i) integrated assessment to identify the environmental and social impacts, risks, and opportunities of projects; (ii) effective community engagement through disclosure of project-related information and consultation with local communities on matters that directly affect them; and (iii) the client's management of environmental and social performance throughout the life of the project.

This Performance Standard applies to all projects that have environmental and social risks and impacts. It underscores the importance of managing environmental and social performance throughout the life of a project.

The objectives of the Performance Standard 1 are the following:

a. To identify and evaluate environmental and social risks and impacts of the project.

b. To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities, and the environment. Where environmental or social risks and impacts are identified, the client is required to manage them through its Environmental and Social Management System (ESMS).

c. To promote improved environmental and social performance of clients through the effective use of management systems.

d. To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately.

e. To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.

This Performance Standard applies to business activities with environmental and/or social risks and/or impacts.

Where the project involves specifically identified physical elements, aspects, and facilities that are likely to generate impacts, environmental and social risks and impacts will be identified in the context of the project's area of influence.

In the event of risks and impacts in the project's area of influence resulting from a third party's actions, the client will address those risks and impacts in a manner commensurate with the client's control and influence over the third parties, and with due regard to conflict of interest.

The client, in coordination with other responsible government agencies and third parties as appropriate, will conduct a process of environmental and social assessment, and establish and maintain an ESMS appropriate to the nature and scale of the project and commensurate with the level of its environmental and social risks and impacts. The ESMS will incorporate the following elements: (i) policy; (ii) identification of risks and impacts; (iii) management programs; (iv) organizational capacity and competency; (v) emergency preparedness and response; (vi) stakeholder engagement; and (vii) monitoring and review.

Where the identified risks and impacts cannot be avoided, the client will identify mitigation and performance measures and establish corresponding actions to ensure the project will operate in compliance with applicable laws and regulations and meet the requirements of Performance Standards 1 through 8. The level of detail and complexity of this collective management program and the priority of the identified measures and actions will be commensurate with the project's risks and impacts and will take account of the outcome of the engagement process with Affected Communities as appropriate.

4.8.2. Performance Standard 2: Labor and Working Conditions

Performance Standard 2 recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers. For any business, the workforce is an asset, and a sound worker-management relationship is a key ingredient in the sustainability of a company. Through a constructive worker-management relationship, and by treating the workers fairly and providing them with safe and healthy working conditions, clients may create tangible benefits, such as enhancement of the efficiency and productivity of their operations.

The objectives of the Performance Standard 2 are the following:

a. To promote the fair treatment, non-discrimination, and equal opportunity of workers.
b. To establish, maintain and improve the worker-management relationship.
c. To promote compliance with national employment and labor laws.
d. To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain.
e. To promote safe and healthy working conditions, and the health of workers.
f. To avoid the use of forced labor.

The applicability of this Performance Standard is established during the environmental and social risks and impacts identification process. The implementation of the actions necessary to meet the requirements of this Performance Standard is managed through the client's Environmental and

Social Management System (ESMS), the elements of which are outlined in Performance Standard 1.

The scope of application of this Performance Standard depends on the type of employment relationship between the client and the worker. It applies to workers directly engaged by the client (direct workers), workers engaged through third parties to perform work related to core business processes of the project for a substantial duration (contracted workers), as well as workers engaged by the client's primary suppliers (supply chain workers).

The requirements are the following:

a. Human Resources Policies and Procedures: the client will adopt and implement human resources policies and procedures appropriate to its size and workforce that set out its approach to managing workers consistent with the requirements of this Performance Standard and national law.

b. Working Conditions and Terms of Employment: where the client is a party to a collective bargaining agreement with a workers' organization, such agreement will be respected. Where such agreements do not exist, or do not address working conditions and terms of employment, the client will provide reasonable working conditions and terms of employment. The client will identify migrant workers and ensure that they are engaged on substantially equivalent terms and conditions to non-migrant workers conducting similar work.

c. Worker's Organizations: in countries where workers' rights to form and join organizations and to bargain collectively are recognized by law, the client must comply with these laws. If national laws restrict workers' organizations, the client must not prevent workers from establishing alternative grievance mechanisms and must not control these mechanisms. The client should not discourage or retaliate against workers seeking to elect representatives, from organizations, or engage in collective bargaining, even if national law is silent on these issues. The client must provide necessary information for meaningful negotiation and engage with workers' representatives fairly.

d. Non-Discrimination and Equal Opportunity: the client must ensure employment decisions are based on job requirements, not personal characteristics, promoting equal opportunity and fair treatment in all employment aspects. They must prevent and address harassment and exploitation, especially of women, and apply non-discrimination principles to migrant workers. Compliance with national non-discrimination laws is required; where laws are absent or inconsistent, the client should follow these standards. Special measures to remedy past discrimination are allowed if consistent with national law.

e. Retrenchment: Before any collective dismissals, the client must analyze alternatives and, if none are viable, develop a non-discriminatory retrenchment plan in consultation with workers, organizations, and the government, complying with collective agreements. The client must notify the authorities and inform workers as required by law. Workers must receive timely notice of dismissal and severance payments, with all outstanding payments and benefits settled by termination or according to an agreed timeline, providing evidence of payments to workers.

f. Grievance Redress Mechanism: The client must provide a grievance redress mechanism for workers and their organizations to raise workplace concerns. This mechanism should be communicated during recruitment, be easily accessible, involve appropriate management levels, and handle concerns promptly and transparently, ensuring timely

feedback without retribution. It must allow anonymous complaints and not obstruct access to other legal or arbitration remedies, nor replace mechanisms in collective agreements.

Regarding Occupational Health and Safety, the client must provide a safe and healthy work environment by addressing sector-specific hazards, including physical, chemical, biological, radiological threats, and specific threats to women. The client should prevent accidents, injuries, and diseases by minimizing hazard causes. This involves: (i) Identifying potential hazards, especially life-threatening ones. (ii) Implementing preventive and protective measures, including altering or eliminating hazardous conditions or substances. (iii) Training workers on safety protocols. (iv) Documenting and reporting occupational accidents, diseases, and incidents. (v) Establishing emergency prevention, preparedness, and response arrangements.

These measures should align with good international industry practices, such as those in the World Bank Group Environmental, Health, and Safety Guidelines.

The client must ensure that third-party contractors engaging workers are reputable, legitimate, and have an appropriate Environmental and Social Management System (ESMS) in place.

The client should establish policies and procedures to manage and monitor these third-party employer's performance. These requirements should be incorporated into contractual agreements with third-party employers.

Additionally, the client must ensure that contracted workers have access to a grievance mechanism. If the third party cannot provide one, the client must extend its own grievance mechanism to these workers.

Regarding the Supply Chain, if there is a risk of child or forced labor in the primary supply chain, the client must identify these risks and take steps to remedy any identified cases. The client should continuously monitor the supply chain for significant changes and new risks, addressing them appropriately. For significant safety issues in the supply chain, the client must implement procedures to prevent or correct life-threatening situations. The client's ability to address these risks depends on their control over suppliers. If remedying is impossible, the client should shift to compliant suppliers over time.

4.8.3. Performance Standard 3: Resource Efficiency and Pollution Prevention

Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels. This Performance Standard outlines a project-level approach to resource efficiency and pollution prevention and control in line with international disseminated technologies and practices. In addition, this Performance Standard promotes the ability of private sector companies to adopt such technologies and practices as far as their use is feasible in the context of a project that relies on commercially available skills and resources.

The objectives of Performance Standard 3 are:

a. To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities.

b. To promote more sustainable use of resources, including energy and water.

c. To reduce project-related GHG emissions.

Throughout the project lifecycle, the client must consider ambient conditions and use feasible resource efficiency and pollution prevention principles to minimize adverse impacts on health and the environment. These techniques should align with good international industry practices (GIIP), such as the World Bank Group Environmental, Health, and Safety Guidelines (EHS Guidelines). When host country regulations differ, stricter standards must be met. If less stringent measures are needed, the client must justify them, demonstrating consistency with the objectives of this Performance Standard.

The client will adopt feasible and cost-effective measures to enhance the efficiency of its energy, water, and resource use, focusing on core business activities. These measures will incorporate cleaner production principles into product design and manufacturing processes to conserve raw materials, energy, and water. When available, benchmarking data will be used to compare and establish the level of efficiency.

Regarding pollution prevention, the client will avoid the release of pollutants or, when avoidance is not feasible, minimize and/or control the intensity and mass flow of their release. This applies to the release of pollutants to air, water, and land due to routine, non-routine, and accidental circumstances with the potential for local, regional, and transboundary impacts. Where historical pollution such as land or ground water contamination exists, the client will seek to determine whether it is responsible for mitigation measures. If it is determined that the client is legally responsible, then these liabilities will be resolved in accordance with national law, or where this is silent, with GIIP.

To address potential adverse impacts on ambient conditions, the client will consider factors such as existing conditions, the environment's capacity to absorb impacts, current and future land use, proximity to biodiversity areas, and potential cumulative impacts. If the project is a significant emission source in a degraded area, the client will adopt additional strategies to avoid or reduce negative effects, such as evaluating alternative project locations and implementing emission offsets.

4.8.4. Performance Standard 4: Community Health, Safety, and Security

Performance Standard 4 recognizes that project activities, equipment, and infrastructure can increase community exposure to risks and impacts. In addition, communities that are already subjected to impacts from climate change may also experience an acceleration and/or intensification of impacts due to project activities. While acknowledging the public authorities' role in promoting the health, safety, and security of the public, this Performance Standard addresses the client's responsibility to avoid or minimize the risks and impacts to community health, safety, and security that may arise from project related activities, with particular attention to vulnerable groups.

In conflict and post-conflict areas, the level of risks and impacts described in this Performance Standard may be greater. The risks that a project could exacerbate an already sensitive local situation and stress scarce local resources should not be overlooked as it may lead to further conflict.

The objectives of this Performance Standard are the following:

a. To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances.

b. To ensure that the safeguarding of personnel and property is conducted in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.

This Performance Standard's applicability is determined during the identification of environmental and social risks and impacts, managed through the client's Environmental and Social Management System (outlined in Performance Standard 1).

Regarding Community Health and Safety, the client will evaluate the risks and impacts to the health and safety of the Affected Communities during the project life cycle and will establish preventive and control measures consistent with good international industry practice (GIIP), such as in the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) or other internationally recognized sources. The client will identify risks and impacts and propose mitigation measures that are commensurate with their nature and magnitude. These measures will favor the avoidance of risks and impacts over minimization.

Regarding Security Personnel, when retaining workers for security, the client must assess risks to those on and off the project site and follow principles of proportionality and good international practice in hiring, conduct, training, and monitoring, in line with applicable law. Security personnel must not have a history of abuses, must be trained in appropriate conduct and use of force, and can only use force preventively and defensively. A grievance redress mechanism must be available for Affected Communities.

The client must assess risks from government security personnel, ensure they act according to these principles, and encourage public disclosure of security arrangements. All allegations of unlawful or abusive acts by security personnel must be investigated, with actions taken to prevent recurrence and reports made to authorities.

4.8.5. Performance Standard 5: Land Acquisition and Involuntary Resettlement

Performance Standard 5 recognizes that project-related land acquisition and restrictions on land use can have adverse impacts on communities and persons that use this land. Involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or other means of livelihood) because of project-related land acquisition and/or restrictions on land use.

Resettlement is considered involuntary when affected persons or communities do not have the right to refuse land acquisition or restrictions on land use that result in physical or economic displacement.

This occurs in cases of (i) lawful expropriation or temporary or permanent restrictions on land use and (ii) negotiated settlements in which the buyer can resort to expropriation or impose legal restrictions on land use if negotiations with the seller fail.

Involuntary resettlement can cause long-term hardship and environmental and socio-economic damage, so it should be avoided. If unavoidable, it should be minimized, and adverse impacts on displaced persons and host communities should be mitigated through careful planning and implementation. Governments often play a key role in resettlement, but the client's involvement can lead to more efficient and innovative solutions. Clients are encouraged to use negotiated settlements to avoid forced relocations, even if they have legal authority to acquire land without consent.

The objectives of Performance Standard 5 are the following:

a. To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.

b. To avoid forced eviction.

c. To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected.

d. To improve, or restore, the livelihoods and standards of living of displaced persons.

e. To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.

The applicability of this Performance Standard is established during the environmental and social risks and impacts identification process. The implementation of the actions necessary to meet the requirements of this Performance Standard is managed through the client's Environmental and Social Management System, the elements of which are outlined in Performance Standard 1.

This Performance Standard applies to physical and/or economic displacement resulting from the following types of land-related transactions:

a. Land rights or land use rights acquired through expropriation or other compulsory procedures in accordance with the legal system of the host country;

b. Land rights or land use rights acquired through negotiated settlements with property owners or those with legal rights to the land if failure to reach settlement would have resulted in expropriation or other compulsory procedures;

c. Project situations where involuntary restrictions on land use and access to natural resources cause a community or groups within a community to lose access to resource usage where they have traditional or recognizable usage rights;

d. Certain project situations requiring evictions of people occupying land without formal, traditional, or recognizable usage rights; or

e. Restriction on access to land or use of other resources including communal property and natural resources such as marine and aquatic resources, timber and non-timber forest products, freshwater, medicinal plants, hunting and gathering grounds and grazing and cropping areas.

This Performance Standard does not apply to resettlement resulting from voluntary land transactions (i.e., market transactions in which the seller is not obliged to sell, and the buyer cannot resort to expropriation, or other compulsory procedures sanctioned by the legal system of the host country if negotiations fail). It also does not apply to impacts on livelihoods where the project is not changing the land use of the affected groups or communities.

Where project impacts on land, assets, or access to assets become significantly adverse at any stage of the project, the client should consider applying requirements of this Performance Standard, even where no land acquisition or land use restriction is involved.

The general requirements are the following:

a. Project Design: Consider alternatives to avoid/minimize displacement, focusing on the poor and vulnerable.

b. Compensation and Benefits for Displaced Persons: Provide compensation at full replacement cost and additional assistance for displaced persons to restore/improve living standards. Compensation must be transparent and consistent.

c. Community Engagement: Engage affected communities throughout the resettlement process, ensuring participation and transparency.

d. Grievance Redress Mechanism: Establish early to address compensation and relocation concerns impartially.

e. Resettlement and Livelihood Restoration Planning and Implementation: Conduct a census to identify displaced persons and determine eligibility. Monitor and evaluate plans to ensure compliance.

Regarding displacement, displaced persons may be classified as persons (i) who have formal legal rights to the land or assets they occupy or use; (ii) who do not have formal legal rights to land or assets, but have a claim to land that is recognized or recognizable under national law; or (iii) who have no recognizable legal right or claim to the land or assets they occupy or use. The census will establish the status of the displaced persons.

Project-related land acquisition and/or restrictions on land use may result in the physical displacement of people as well as their economic displacement. Consequently, requirements of this Performance Standard in respect of physical displacement and economic displacement may apply simultaneously.

The client must develop a Resettlement Action Plan for physical displacement, including compensation at full replacement cost and relocation assistance. The plan should mitigate negative impacts, consider the needs of the poor and vulnerable, and document all transactions. Displaced persons should have resettlement options with improved living conditions and respect for social institutions. Legal rights holders receive property or cash compensation; non-legal rights holders get adequate housing and asset compensation. Encroachers after the cut-off date are not compensated, and forced evictions must follow legal requirements.

For projects involving economic displacement, the client must develop a Livelihood Restoration Plan to compensate affected persons and communities. This plan should be transparent, consistent, and equitable, ensuring affected parties can reestablish their livelihoods. Economic displacement mitigation is complete when compensation and assistance meet the plan's requirements and the objectives of the Performance Standard.

When land acquisition and resettlement are the government's responsibility, the client will collaborate with the government to meet Performance Standard outcomes. If the government lacks capacity, the client will actively participate in resettlement planning, implementation, and monitoring. For land rights acquisition or physical displacement, the client will describe government resettlement measures and, if insufficient, prepare a Supplemental Resettlement Plan to meet Performance Standard requirements. For economic displacement, the client will identify government measures and develop an Environmental and Social Action Plan if needed to ensure compliance with the Performance Standard.

4.8.6. Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management

Performance Standard 6 recognizes that protecting and conserving biodiversity—the variety of life in all its forms, including genetic, species and ecosystem diversity—and its ability to change and evolve, is fundamental to sustainable development. The components of biodiversity, as

defined in the Convention on Biological Diversity, include ecosystems and habitats, species and communities, and genes and genomes, all of which have social, economic, cultural and scientific importance. This Performance Standard reflects the objectives of the Convention on Biological Diversity to conserve biological diversity and promote use of renewable natural resources in a sustainable manner. This Performance Standard addresses how clients can avoid or mitigate threats to biodiversity arising from their operations as well as sustainably manage renewable natural resources.

The objectives of this Performance Standard are the following:

a. To protect and conserve biodiversity

b. To promote the sustainable management and use of natural resources through the adoption of practices that integrate conservation needs and development priorities

The applicability of this Performance Standard is established during the Social and Environmental Assessment process, while implementation of the actions necessary to meet the requirements of this Performance Standard is managed through the client's Social and Environmental Management System. The assessment and management system requirements are outlined in Performance Standard 1.

Based on the Assessment of risks and impacts and the vulnerability of the biodiversity and the natural resources present, the requirements of this Performance Standard are applied to projects in all habitats, whether those habitats have been previously disturbed and whether they are legally protected.

To avoid or minimize adverse impacts on biodiversity, the client will assess the significance of project impacts on biodiversity levels as part of the Social and Environmental Assessment. This includes considering stakeholders' differing values on biodiversity and identifying impacts on ecosystem services, focusing on major threats like habitat destruction and invasive species. Qualified external experts will be retained to assist in the Assessment when necessary.

To protect and conserve Biodiversity, the requirements are the following:

a. Habitat destruction is the major threat to biodiversity. Habitats are categorized into natural habitats, formed largely by native species with minimal human modification, and modified habitats, which have been altered, often by introducing non-native species, like agricultural areas. Both types can support significant biodiversity, including endemic or threatened species.

b. In areas of modified habitat, the client will exercise care to minimize any conversion or degradation of such habitat, and will, depending on the nature and scale of the project, identify opportunities to enhance habitat and protect and conserve biodiversity as part of their operations.

c. In natural habitat areas, the client will not significantly convert or degrade such habitat unless specific conditions are met: no technically and financially feasible alternatives exist, the project's overall benefits outweigh costs to the environment and biodiversity, and any impacts are appropriately mitigated. Mitigation measures aim for no net loss of biodiversity, potentially including habitat restoration, creation of ecologically comparable areas managed for biodiversity, and compensation for biodiversity users.

d. In areas of critical habitat, the client will not implement any project activities unless the following requirements are met: there are no measurable adverse impacts on the ability of the critical habitat to support the established population of species or the functions of

the critical habitat; there is no reduction in the population of any recognized critically endangered or endangered species; any lesser impacts are mitigated.

e. If a proposed project is within a legally protected area, the client must adhere to the following: act in accordance with defined protected area management plans, consult with protected area sponsors, managers, local communities, and key stakeholders regarding the project, and implement additional programs as needed to support and enhance the conservation goals of the protected area.

f. The client will not intentionally introduce any new alien species (not currently established in the country or region of the project) unless this is carried out in accordance with the existing regulatory framework for such introduction, if such framework is present, or is subject to a risk assessment (as part of the client's Social and Environmental Assessment) to determine the potential for invasive behavior. The client will not deliberately introduce any alien species with a high risk of invasive behavior or any known invasive species and will exercise diligence to prevent accidental or unintended introductions.

Regarding Management and Use of Renewable Natural Resources, the client commits to sustainable management of renewable natural resources and, where feasible, seeks independent certification to demonstrate sustainability. For forests, natural forest harvesting and plantation development must avoid converting or degrading critical habitat. Plantations should ideally be on non-forested or already converted land. All managed forests and plantations should meet internationally accepted sustainability standards. Similarly, clients involved in fish and aquatic species harvesting must demonstrate sustainable practices through independent certification or thorough environmental assessments.

4.8.7. Performance Standard 7: Indigenous Peoples

Performance Standard 7 recognizes that Indigenous Peoples, as social groups with identities that are distinct from mainstream groups in national societies, are often among the most marginalized and vulnerable segments of the population. In many cases, their economic, social, and legal status limits their capacity to defend their rights to, and interests in, lands and natural and cultural resources, and may restrict their ability to participate in and benefit from development. Indigenous Peoples are particularly vulnerable if their lands and resources are transformed, encroached upon, or significantly degraded. Their languages, cultures, religions, spiritual beliefs, and institutions may also come under threat. Consequently, Indigenous Peoples may be more vulnerable to the adverse impacts associated with project development than non-indigenous communities. This vulnerability may include loss of identity, culture, and natural resource-based livelihoods, as well as exposure to impoverishment and diseases.

Private sector projects can offer opportunities for Indigenous Peoples to participate in and benefit from project-related activities, contributing to their economic and social development aspirations. Indigenous Peoples can also engage in sustainable development by managing activities and enterprises as development partners. Governments typically manage Indigenous Peoples' issues, and clients should collaborate with relevant authorities to address risks and impacts of their activities.

The objectives of Performance Standard 7 are the following:

a. To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples.

b. To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts.

c. To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner.

d. To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life cycle.

e. To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present.

f. To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.

The applicability of this Performance Standard is established during the environmental and social risks and impacts identification process. The implementation of the actions necessary to meet the requirements of this Performance Standard is managed through the client's Environmental and Social Management System, the elements of which are outlined in Performance Standard 1.

This Performance Standard applies to communities or groups of Indigenous Peoples who maintain a collective attachment, i.e., whose identity as a group or community is linked, to distinct habitats or ancestral territories and the natural resources therein. It may also apply to communities or groups that have lost collective attachment to distinct habitats or ancestral territories in the project area, occurring within the concerned group members' lifetime, because of forced severance, conflict, government resettlement programs, dispossession of their lands, natural disasters, or incorporation of such territories into an urban area.

The client may be required to seek inputs from competent professionals to ascertain whether a particular group is considered as Indigenous Peoples for the purpose of this Performance Standard.

The General Requirements are the following:

a. Avoidance of Adverse Impacts: the client will conduct an environmental and social assessment to identify Indigenous Peoples communities in the project area and assess expected economic, social, cultural, and environmental impacts on them. Adverse impacts on these communities should be avoided where possible. If unavoidable, the client will minimize, restore, and compensate for impacts in a culturally appropriate manner, developed in collaboration with the Indigenous Peoples' communities, possibly through an Indigenous Peoples Plan or community development plan tailored to their needs.

b. Participation and Consent: the client will engage with Affected Communities of Indigenous Peoples according to Performance Standard 1, including stakeholder analysis, planning, information disclosure, consultation, and participation in culturally appropriate ways. This process involves representative bodies and members of the communities, respecting their decision-making timeframes. Due to their vulnerability to land loss and exploitation, the client must obtain Free, Prior, and Informed Consent (FPIC) in specified circumstances, involving external experts to assess risks and impacts. FPIC entails a negotiated agreement documented between the client and the communities, recognizing that consent does not require unanimous approval.

Regarding Impacts on Lands and Natural Resources Subject to Traditional Ownership or Under Customary Use, if the client plans to develop projects or natural resources on lands traditionally

owned or used by Indigenous Peoples, and adverse impacts are expected, they must: document efforts to minimize project area and impacts on natural resources; review property rights and traditional resource use before land acquisition; assess resource use inclusively and inform communities of their legal rights; offer compensation and sustainable development opportunities, including land-based or in-kind compensation, continued resource access, fair benefit-sharing, and access rights during development.

Regarding Relocation of Indigenous Peoples from Lands and Natural Resources Subject to Traditional Ownership or Under Customary Use, the client will seek alternative project designs to avoid relocating Indigenous Peoples from their traditional lands. If relocation is necessary, the project requires Free, Prior, and Informed Consent (FPIC) and must comply with Performance Standard 5. Efforts will be made to enable relocated Indigenous Peoples to return to their lands if the reasons for relocation cease.

Regarding Critical Cultural Heritage, if a project may significantly impact critical cultural heritage essential to the identity or spiritual aspects of Indigenous Peoples, efforts will prioritize avoiding such impacts. If unavoidable, Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples is required. If the project involves using Indigenous cultural heritage for commercial purposes, the client must inform the communities of their rights, the project's scope, potential consequences, and obtain FPIC. Fair and equitable sharing of benefits from commercialization must align with Indigenous customs and traditions.

With relation to Mitigation and Development Benefits, the client and Affected Communities of Indigenous Peoples will identify mitigation measures following the Performance Standard 1 hierarchy and seek culturally appropriate sustainable development benefits. Measures will be delivered equitably and promptly. Compensation and benefit sharing will respect community laws, institutions, and customs, considering both individual and collective eligibility. Opportunities for community benefits should align with Indigenous goals, improve livelihoods in a culturally sensitive manner, and promote long-term sustainability of natural resources.

When government manages Indigenous Peoples issues related to a project, the client will collaborate to align outcomes with this Performance Standard's objectives. If government capacity is limited, the client will actively participate in planning, implementation, and monitoring where permitted. The client will prepare a comprehensive plan, coordinating with government documents, addressing Indigenous Peoples' engagement, Free, Prior, and Informed Consent (FPIC), entitlements, bridging gaps, and financial responsibilities.

4.8.8. Performance Standard 8: Cultural Heritage

Performance Standard 8 recognizes the importance of cultural heritage for current and future generations. Consistent with the Convention Concerning the Protection of the World Cultural and Natural Heritage, this Performance Standard aims to ensure that clients protect cultural heritage during their project activities. In addition, the requirements of this Performance Standard on a project’s use of cultural heritage are based in part on standards set by the Convention on Biological Diversity.

The objectives of Performance Standard 8 are the following:

a. To protect cultural heritage from the adverse impacts of project activities and support its prevention.

b. To promote the equitable sharing of benefits from the use of cultural heritage.

The applicability of this Performance Standard is established during the environmental and social risks and impacts identification process.

During the project life cycle, the client will consider potential project impacts to cultural heritage and will apply the provisions of this Performance Standard. The requirements of this Performance Standard apply to cultural heritage regardless of whether it has been legally protected or previously disturbed. The requirements of this Performance Standard do not apply to cultural heritage of Indigenous Peoples (Performance Standard 7 describes those requirements).

The client will protect cultural heritage by complying with applicable laws and international standards. They will identify and protect heritage using recognized practices and engage competent professionals if risks are identified. Consultation with affected Indigenous communities and regulatory agencies will occur to incorporate their views. Access to cultural sites will be maintained or alternatives provided. Replicable heritage will be minimized or restored in situ; non-replicable heritage will only be removed under strict conditions. Critical heritage will not be significantly altered without Informed Consultation and Participation (ICP). Projects within legally protected areas require compliance with local regulations and additional conservation programs.

Where a project proposes to use the cultural heritage, including knowledge, innovations, or practices of local communities for commercial purposes, the client will inform these communities of (i) their rights under national law; (ii) the scope and nature of the proposed commercial development; and (iii) the potential consequences of such development. The client will not proceed with such commercialization unless it (i) enters a process of ICP as described in Performance Standard 1 and which uses a good faith negotiation process that results in a documented outcome and (ii) provides for fair and equitable sharing of benefits from commercialization of such knowledge, innovation, or practice, consistent with their customs and traditions.

5. SOCIOECONOMIC BASELINE

5.1. Overview and scope of baseline study

The socioeconomic analysis for the proposed project aims to provide a comprehensive assessment of the current living conditions within the project's area of influence. This assessment will provide a detailed understanding of the demographic, social, economic, and cultural characteristics of the local population.

The analysis is essential for identifying both positive and negative impacts that the project may generate throughout its various stages, including construction and operation. By establishing a comprehensive baseline of the socio-economic environment, the analysis will help in developing strategies to maximize benefits and mitigate potential adverse effects.

The primary objectives of this socioeconomic analysis are to:

- **Establish a Baseline**: Develop a clear understanding of the current socio-economic conditions, including demographic trends, income levels, employment patterns, and local economic activities. This baseline will serve as a reference for evaluating the impact of the project.
- **Understand Cultural and Social Dynamics**: Examine the cultural practices and social dynamics within the local communities to assess how these might be influenced by the project. Understanding these factors is crucial for ensuring that the project aligns with local values and traditions.
- **Identify and Engage Stakeholders**: Identify key stakeholders who may be affected by or have an interest in the project. Facilitate their involvement in the processes to ensure their concerns and perspectives are adequately addressed.
- **Ensure Compliance**: Ensure that the project adheres to relevant social performance standards, particularly those outlined by the International Finance Corporation (IFC), including Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.

By meeting these objectives, the socio-economic analysis will provide a comprehensive framework for understanding the implications of the Murbee Resort Project and support informed decision-making throughout its development.

5.2. Definition of the Project's Area of Influence

For the purposes of the analysis, and in order to properly structure the Socioeconomic Assessment process, the following indirect, direct and operational areas of influence of the Project were defined.

5.2.1. Indirect Area of Influence

The indirect area of influence of the Projects includes the whole country of Antigua and Barbuda.

During the **construction phase**, positive impacts are expected throughout the country due to the labor required for the project, as well as an increase in secondary economic activity. Given that

Barbuda has a population of only about 1,645 people, it is likely that a considerable number of workers will need to be hired from Antigua and other countries.

During the **operational phase**, an increase in tourist activity and a higher demand for public services are anticipated. These and other impacts will be thoroughly analyzed in section 6. Additionally, the expected rise in tourism will not only impact Barbuda but also Antigua.

This will likely result in a broader impact on the country's overall economy and infrastructure, further enhancing the interconnected nature of the islands and potentially leading to an increase in economic opportunities for the entire nation.



Figure.1:. Indirect Area of Influence of the Project.

5.2.2. Direct Area of Influence

The direct area of influence proposed will include an area including **200 meters on each side of the project's construction zone.** Additionally, this area should include the **surroundings of the route to be constructed** (200 meters in each direction from the axis of the road)**, as well as the project-associated facilities**, such as excavation zones, quarries, and debris dumps.

The direct area of influence includes **Route 1** (existing main road) and the **town of Codrington** due to its proximity to the project and the anticipated impacts on traffic and increased economic activity during the construction phase.

Furthermore, the direct area of influence also includes the **River Dock**, given the potential for delays or disruptions in the usual exchange of goods and community transportation.

This inclusion ensures that any impacts on the flow of materials and the local community's transport needs are adequately addressed.

Figure.2 below presents the project's direct area of influence, which were covered during the field work.

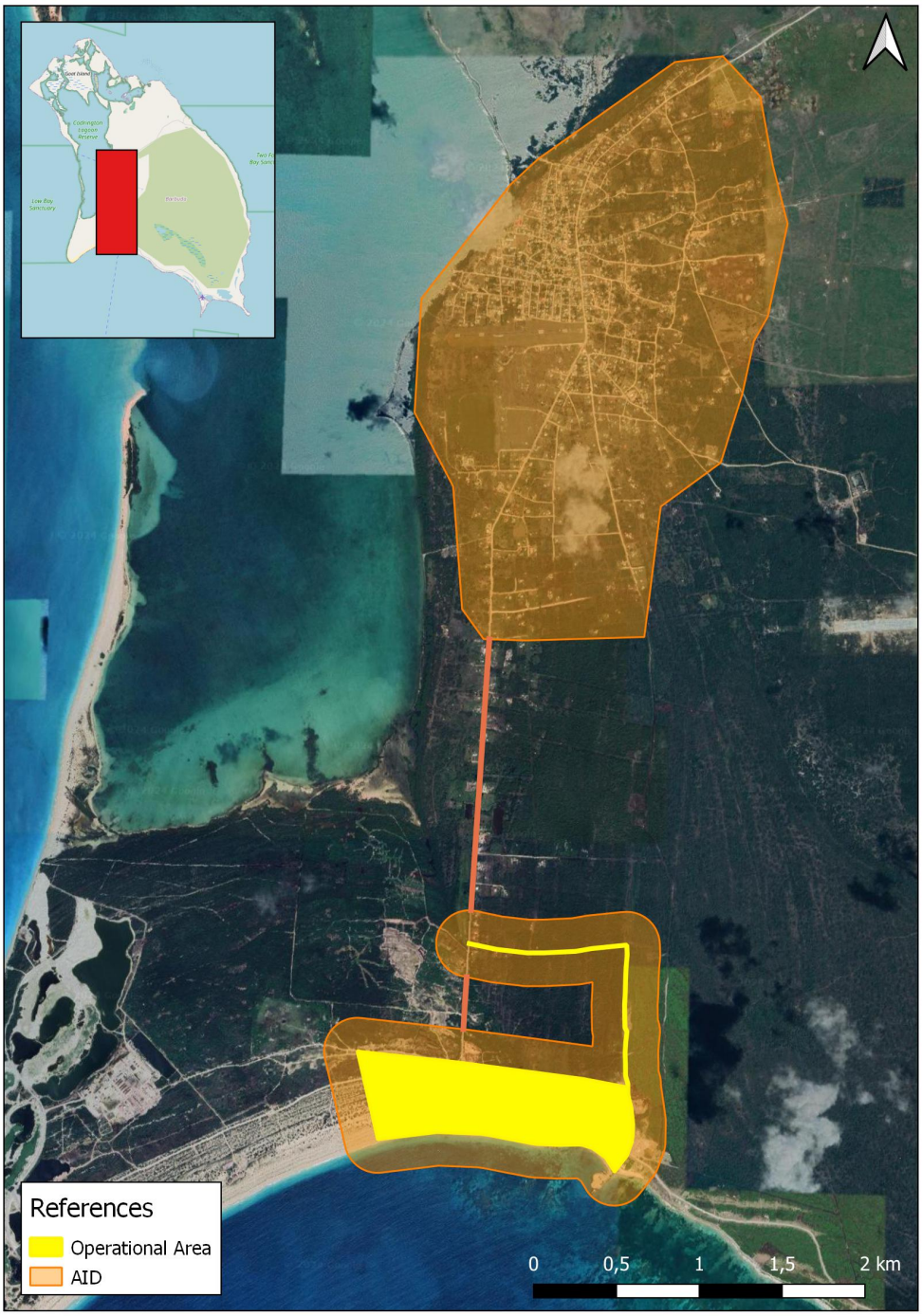

Figure.2:. Direct Area of Influence of the Project.

5.2.3. Operational Area of Influence

The operational area is located on the southwestern coastal edge of the island, adjacent to the Barbuda River Dock where the passenger and cargo ferries and barges arrive (figure 3).

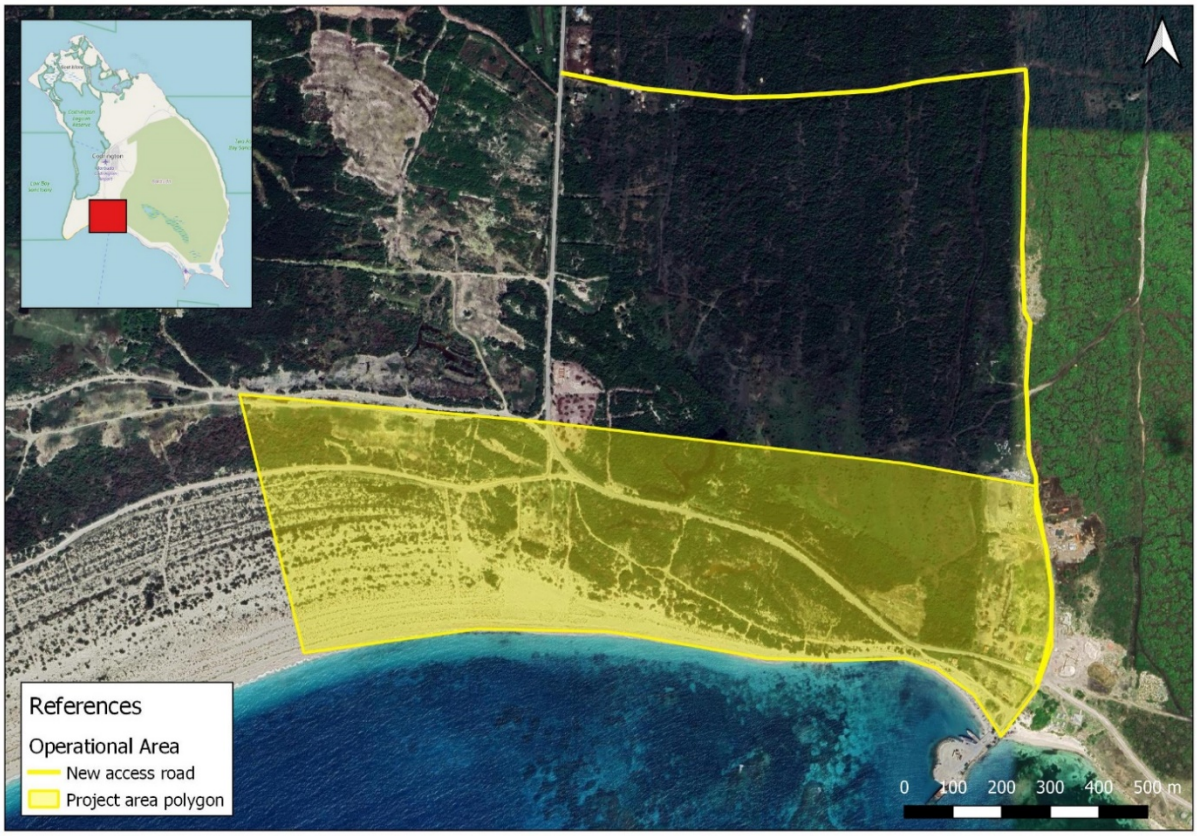

Figure.3:. Operational Area

5.3. Socio-Economic Baseline

5.3.1. Introduction

Antigua and Barbuda is a twin-island nation located in the Eastern Caribbean, part of the Lesser Antilles. Geographically, the islands lie east-southeast of Puerto Rico and north of Guadeloupe.

Antigua and Barbuda are part of various regional and international organizations, including the African, Caribbean, and Pacific Group of States (ACP), the Caribbean Community (CARICOM), the International Monetary Fund (IMF), the Organization of American States (OAS), and the United Nations (UN). The capital city is St. John's, and the official currency is the Eastern Caribbean Dollar.

English is the official language, although residents often communicate in a local dialect. The islands were colonized by the British in 1632 and gained independence on November 1, 1981. Today, Antigua and Barbuda is a constitutional monarchy with a parliamentary system and a Prime Minister as the head of government.[2]

[2] Antigua and Barbuda's Government Information and Services. https://ab.gov.ag/detail_page.php?page=7

Although politically unified, Antigua and Barbuda have distinct ecological, economic, and social characteristics. The islands' histories have long been linked, but their land use systems, class structures, demographic profiles, and ecological relationships have diverged significantly. Geographically, they are part of the Antilles, specifically the Lesser Antilles, and historically part of the former British Leeward Islands Colony, which included St. Kitts, Nevis, Montserrat, the British Virgin Islands, and Dominica. They remain part of the British Commonwealth Caribbean (Press, 1995). Historically and economically, they are part of Plantation America, a region deeply influenced by slavery and plantation production. Politically, they are part of the Caribbean Basin, where colonial status has only recently transitioned to independence.

5.3.2. Governance Structure

Antigua and Barbuda is a constitutional monarchy with a British-style parliamentary system, operating as a multiparty parliamentary democracy. The British monarch serves as the head of state and appoints a Governor General to act on their behalf.

The country's 1981 Constitution, which came into effect upon independence from Britain, guarantees life, liberty, privacy, and freedoms such as speech, association, and worship. It also provides a framework for territorial acquisitions, extends fundamental human rights, supports opposition party rights, and grants Barbuda substantial internal self-government.

The government is structured into three branches. The legislative branch comprises a bicameral Parliament, including a 17-member House of Representatives that introduces legislation, and a 17-member Senate that reviews and approves it. Representatives are elected by popular vote every five years, while Senators are appointed by the Governor General, with a majority chosen on the Prime Minister's advice.

The executive branch is led by the Prime Minister, who heads the Cabinet responsible for government policies and overall direction. The Governor General appoints other ministers on the Prime Minister's advice, although these ministers are not necessarily MPs.

The judicial branch is independent, with magistrates appointed by the Attorney General. It includes the Magistrate's Court for minor offenses and the High Court for major cases. Appeals from the High Court are heard by the Eastern Caribbean States Supreme Court, whose members are appointed by the Organization of Eastern Caribbean States (OECS).[3]

The executive government is organized into twelve ministries, including Finance & Corporate Governance, Legal Affairs, Public Safety and Labour, Public Utilities, Civil Aviation and Transportation, Tourism, Economic Development, Investment and Energy, Agriculture, Lands, Fishers and Barbuda Affairs, Education, Science & Technology, Works and Housing, Trade, Commerce & Industry, Sports, Culture & National Festivals, Social Transformation and Human Resource Development, Foreign Affairs and International Trade, Information, Broadcasting, Telecommunications & Information Technology, and Health and The Environment.

These ministries are supported by various statutory bodies such as the Antigua & Barbuda Investment Authority, Tourism Authority, Public Utilities Authority, among others. The Cabinet appoints the chairpersons and members of these bodies.

[3] Ibid.

On the local government front, the structure is divided into six parishes in Antigua and Barbuda. While Antigua does not have a local government structure, Barbuda has a **Barbuda Council** established under the 1976 Barbuda Local Government Act. This council, which includes nine elected members, national parliament representatives, and a government-appointed member, oversees local matters such as agriculture, public health, and utilities, and is accountable to the Prime Minister through the Minister of Agriculture, who oversees Barbuda Affairs.

5.3.3. Demographics

According to the Population and Housing Census[4], the population of Antigua and Barbuda was 85,567 in 2011. By 2023, this figure had risen to 94,298[5], representing a 25.6% increase. Antigua and Barbuda is one of the least populated countries in the region, with a population density of 230 inhabitants per square kilometer.

The country's demographic profile in 2023 shows that people over 65 years of age accounted for 11.1% of the total population, an increase of 3.9 percentage points compared to the year 2000. There were 109.3 women per 100 men and 61.1 older people (65 years or older) per 100 children under 15 years of age, as illustrated by the country's population pyramids distributed by age group and sex (PAHO, 2023).

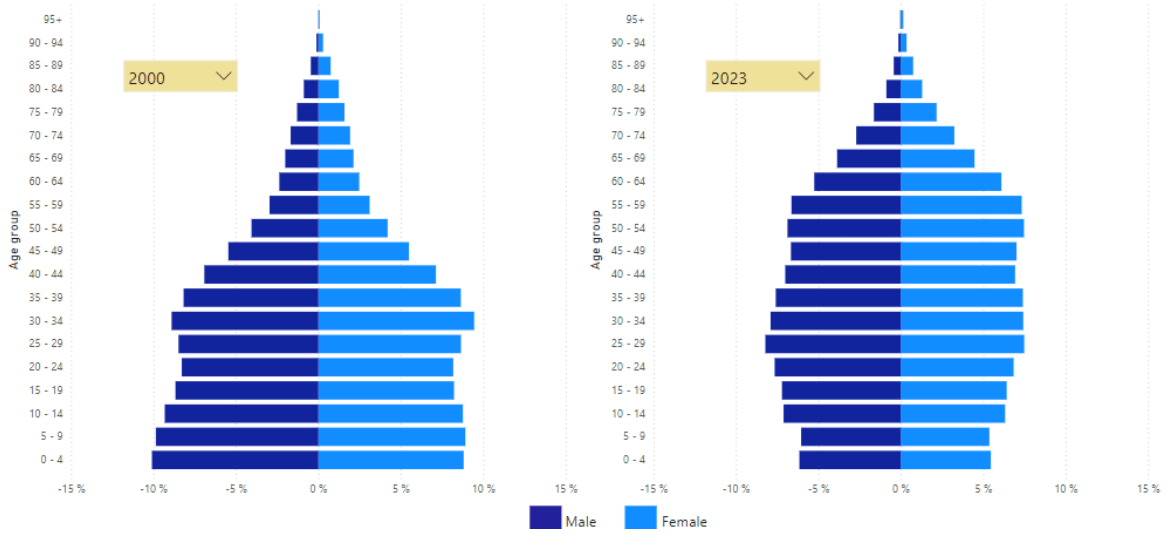

Figure.4:. Population pyramids, years 2000 and 2023. Data Source: United Nations, Department of Economic and Social Affairs. Population Division, World population Prospects 2022.

The median age of the population is 31 years (WHO, 2013). The population between 15 and 64 years of age, considered potentially active (i.e., potential participants in the labor force), represented 70.7% of the total population in 2023 (66,666 people). When combined with the potentially passive population (17,149 under 15 years of age and 10,484 over 65 years of age), the dependency ratio results in 41.4 potentially passive people per 100 potentially active people, down from 54.0 in 2000.

[4] The last census available for Antigua and Barbuda is from 2011. An update and a new population census should have been carried out in 2021, but given the pandemic context, it was postponed until 2024.
[5] Antigua and Barbuda Word Bank Group Data, link: Antigua and Barbuda | Data (worldbank.org)

The 1991 population census recorded that 30.5% of Antigua and Barbuda's population was under 15 years of age (youthful population) and approximately 6% was over 65 years. By 2001, census figures indicated a 2.5% decrease in the under-15 population to 28% and a slight increase in the population over 65. The percentage of the 15-64 age group remained virtually constant between 1991 and 2001. In 2011, there was a further decline in the percentage of the 0-14 age group and increases in both the 15-64 and 65+ cohorts. These changes reflect lower birth and death rates and higher life expectancy, indicating a growing economically active population and more individuals reaching retirement age, some of whom remain economically active.

The total population of **Barbuda** according to the 2011 Census was 1,615, representing a 15% growth over the previous decade. Barbuda maintained its unique demographic characteristic of having more male residents than female, 849 male residents to 766 female residents, equating to 110.3 males per 100 females.

According to the latest immigration data published by the United Nations (2022), 29.99% of Antigua and Barbuda's population are immigrants. In the 2011 census, 86% of migrants came from four main countries: Commonwealth of Dominica, Dominican Republic, Guyana, and Jamaica. This represented approximately 14.57% of the total Caribbean population, including Antiguans and Barbudans.

Table 9. Antigua and Barbuda Immigrant Population

Source country of immigrant population	Total	Male	Female
Dominica	1769	833	936
Dominican Republic	1347	481	866
Guyana	3710	4644	2067
Jamaica	3333	1281	2052
Total	**10159**	**4239**	**5921**

Data Source: Census 2011.

Additionally, 3,561 residents are from outside the Caribbean region, mainly from the United Kingdom (1,004) and the United States of America (2,596).

A significant portion of the population increase over the past 20 years is attributed to returning residents and migrants from CARICOM countries, drawn by the country's comparatively good economic performance in tourism and international business.

Table 10. Antigua and Barbuda Population Projections to 2030

Year	Population
1991	59.355
2001	76.886
2011	86.295
2015	91.295
2020	97.000
2025	102.000

Year	Population
2030	105.000

Data Source: Country Document for Disaster Risk Reduction, 2016

The population is expected to experience a steady increase, though at a slower rate due to declining fertility rates, higher life expectancy, and shifts in migration patterns.

5.3.4. Housing and urbanization

The 2011 Census in Antigua and Barbuda documented a substantial increase in the number of households compared to previous censuses. A total of 29,051 households were recorded in 2011, representing a significant growth from the 24,462 counted in 2001 and the 19,501 identified in 1991. A particularly notable trend emerged in St. John Rural, where the number of households surged from 6,861 in 2001 to 10,040 in 2011, marking a substantial 46.3% increase over the decade. While St. John Parish as a whole (including the city) experienced a 19.8% growth in households during the same period, St. John City itself witnessed a decline. On the neighboring island of Barbuda, a more gradual yet consistent household growth was observed. The number of households rose from 392 in 1991 to 456 in 2001, and further to 544 in 2011, representing a 19.3% increase between 2001 and 2011.

The 2011 Population and Housing Census revealed a substantial growth in dwelling units across Antigua and Barbuda. The number of housing units surged from 18,421 in 1991 to 30,213 in 2011, representing a significant 47.4% increase over the decade. Sixty one percent of these dwelling units were concentrated in the parish of St. John, with 26% located within St. John's City. In contrast, Barbuda reported a total of 545 dwelling units in 2011.

The urbanization rate in Antigua and Barbuda is high, with a significant portion of the population living in urban areas, especially St. John's. Urban areas generally have better infrastructure and services, compared to rural regions.

Antigua's population is primarily concentrated around St. John's City, extending along the All-Saints Road corridor. Despite a population decline in St. John's since 2001, the city remains the commercial, entertainment, and nightlife hub. Commercial growth has expanded outward, transforming residential areas into business districts. Consequently, many residents have relocated to suburban areas.

In contrast, Barbuda's population is centered in Codrington Village, where land ownership is more defined. However, the island's traditional land-use patterns, characterized by communal ownership, persist outside the village. While there has been a shift toward individual land ownership, common lands remain crucial for many residents.

5.3.4.1. Housing Characteristics

The 2011 Housing and Population Census indicated that wood is the primary construction material for approximately 60% of Antigua and Barbuda’s 30,213 dwelling units. This prevalence is particularly pronounced in St. John’s City, where three-quarters of buildings are wooden, often constructed with grooved plywood for economic and time efficiency. However, wood-framed structures are more susceptible to hurricane damage, fires, and termite infestation compared to

concrete. While most homes across the islands (nearly 90%) utilize sheet metal roofing, concrete roofs remain uncommon. In contrast to Antigua, Barbuda exhibits a higher proportion of concrete buildings (79%), with wooden structures representing only 21% of the housing stock.

Table 11. Material of outer walls and roofing 2011

Parishes	Total No of Dwelling Units Total No of Dwelling Units	Material of Outer Walls		Roofing Material		
		% Concrete, Block, Stone/Brick	% wood	% Concrete	% Sheet Metal and similar	% Shingle (Asphalt, wood and other)
St. John City	7.879	24	75	3	89	7
St. Jonh Rural	10.568	46	52	3	90	6
St George	2.932	50	48	3	88	8
St. Peter	1.829	37	62	2	93	4
St. Philip	1.139	53	46	1	88	9
St. Paul	2.809	40	59	4	86	9
St. Mary	2.512	38	61	3	82	14
Barbuda	545	79	21	2	94	4
TOTAL	30.213	40	60	3	89	7

Data Source: Census 2011.

Table 12. Source of lightning by parishes

Parishes	Private electricity generator	Public electricity	Gas lantern	Kerosene	Solar	None	Other	Do not Know/Not stated
St. John City	0,0%	94,6%	0,3%	0,6%	0,1%	0,8%	1,1%	1,2%
St. Jonh Rural	1,2%	93,6%	0,5%	0,7%	0,1%	1,2%	1,5%	1,3%
TOTAL	1,3%	95,3%	0,2%	0,5%	0,0%	0,5%	0,8%	1,5%
St George	1,1%	96,4%	0,2%	0,5%	0,0%	0,8%	0,5%	0,6%

Parishes	Private electricity generator	Public electricity	Gas lantern	Kerosene	Solar	None	Other	Do not Know/Not stated
St. Peter	0,9%	94,0%	0,3%	0,9%	0,1%	0,9%	2,3%	0,6%
St. Philip	1,4%	94,8%	0,2%	0,6%	0,2%	0,3%	0,7%	1,9%
St. Paul	2,5%	93,8%	0,2%	0,8%	0,2%	0,8%	1,2%	0,6%
St. Mary	1,9%	93,9%	0,2%	0,8%	0,1%	0,7%	1,2%	1,2%
Barbuda	0,2%	97,9%	0,4%	0,1%	0,0%	0,9%	0,4%	0,1%

Data Source: Census 2011.

Antigua and Barbuda exhibit a high dependence on publicly generated electricity, with 97.9% of Barbuda's and 95% of Antigua's households relying on this source. While Antigua's reliance on public electricity is generally consistent across its parishes (ranging from 96% to 94%), a small portion of households in both islands utilize alternative energy sources such as private generators, solar power, or hydrocarbons.

The 2011 Population and Housing Census of Antigua and Barbuda revealed significant disparities in access to adequate water and sanitation services. While 67% of households have piped water connections, 12% of households rely on rainwater harvesting systems, such as cisterns and tanks. Moreover, approximately 10% of households depend on public standpipes or private wells for their water supply.

Regarding sanitation, the data indicates that 82% of households have indoor toilet facilities, often connected to septic tanks. However, a substantial 15% of households continue to rely on outdoor sanitation, primarily cesspits or latrines. These disparities are more pronounced in urban areas like St. John's City, Barbuda, and St. Mary's, which exhibit higher rates of unsanitary conditions compared to rural parishes. The persistence of substandard sanitation practices, particularly in flood-prone regions, poses significant public health risks, as these facilities can contaminate water sources and facilitate the spread of waterborne diseases, including cholera and gastrointestinal illnesses.

5.3.5. Regional Economy and Community Livelihood

Antigua and Barbuda's economy is characterized by a diverse range of activities, with significant contributions from tourism, services, and agriculture. The primary economic sector is tourism, which plays a crucial role in the country's economic structure.

Tourism accounts for more than half of Antigua and Barbuda's Gross Domestic Product (GDP) and provides a substantial portion of employment opportunities, both directly and indirectly. The sector's growth has been bolstered by the country's natural beauty, including pristine beaches and favorable climate, which attract a steady influx of international visitors. According to the World Travel & Tourism Council, tourism also supports around 40% of total employment in Antigua and

Barbuda. The country, while a small and highly vulnerable open economy, is one of the larger and more prosperous nations among the member countries of the Organization of Eastern Caribbean States (OECS).[6]

Investment in new and existing tourist facilities, primarily fueled by foreign direct investment, has also spurred growth in the real estate and construction industries. In recent years, the economy has diversified to include sectors such as health and wellness, medical education, and medical tourism. Overall, the services sector now accounts for over 75% of GDP, while manufacturing and agriculture together account for only 3% as of 2017.[7]

The services sector, encompassing financial services, retail, and real estate, is another major contributor to the economy. Antigua and Barbuda have developed a robust financial services sector, including offshore banking and insurance, which benefits from favorable regulatory environments and tax incentives. This sector has seen growth due to the increasing interest in financial services from international investors. Additionally, the construction and real estate markets have experienced significant expansion, driven by both domestic and foreign investments in residential and commercial properties.

Agriculture, while less dominant compared to tourism and services, remains an important sector for employment and local consumption. Key agricultural products include sugar, bananas, and vegetables, though the sector faces challenges such as land degradation and competition from imported goods. Efforts are ongoing to enhance agricultural productivity and sustainability through various government and private sector initiatives.

Economic growth in Antigua and Barbuda has experienced fluctuations, with periods of expansion followed by economic slowdowns, and growth rates fluctuating due to external shocks and natural disasters. Recent data indicates that the country's GDP grew by 4.1% in 2022, recovering from the impact of the COVID-19 pandemic which had caused a sharp contraction in 2020 (IMF, 2023). The growth has been largely driven by the recovery of the tourism sector, increased consumer spending, and improved investor confidence. However, the economy remains vulnerable to external shocks, including global economic fluctuations and natural disasters.

The country remains highly dependent on remittances, tourism, financial and educational services, and foreign direct investment flows. As a result, it faces several challenges typical of Small Island Developing States (SIDS), such as a narrow resource base, heavy reliance on external markets, high costs for energy and infrastructure, and vulnerability to natural disasters.

Employment trends in Antigua and Barbuda reflect the dominance of the tourism and services sectors. The unemployment rate, which was 8.1% in 2022, has been a concern, with job creation lagging behind the growth in the working-age population (Statistical Office of Antigua and Barbuda, 2023). The government has implemented various policies to stimulate job creation, including incentives for investment in tourism infrastructure and support for small and medium-sized enterprises (SMEs).

In terms of economic rankings, Antigua and Barbuda is positioned 107th out of 190 countries in the World Bank's Ease of Doing Business Index for 2018, reflecting a decline from 71st in 2014.

[6] Antigua and Barbuda (2016) Country Document for Disaster Risk Reduction.
[7] International Monetary Fund (2023); Antigua and Barbuda. IMF Country Report No.23/184

The country's GDP (nominal) is approximately USD 1.6 billion as of 2023, with a GDP per capita of around USD 16,000.

Barbuda's economy differs significantly from that of Antigua. Historically, Barbuda's economy was not dominated by plantation agriculture but instead relied on subsistence and small-scale cash activities such as shifting cultivation, fishing, livestock rearing, and charcoal-making. The island's economy was maintained under a commons system that granted equal land rights to all Barbudans. In contrast, Antigua was historically dominated by a sugar plantation economy, which persisted into the 20th century and has now evolved into a high-impact tourism development sector, including luxury hotels and casinos.

In terms of employment, Barbuda has a labor force where 76.79% of the population is employed, with 2.83% actively seeking work. The island's economic activities include subsistence agriculture, fishing, and small-scale trade, with an emphasis on maintaining traditional practices and self-sufficiency.

5.3.6. Poverty

While relatively prosperous within the Organization of Eastern Caribbean States (OECS), the country faces significant challenges related to poverty and unemployment and a notable portion of the population in Antigua and Barbuda experiences economic hardship and vulnerability.

As of 2023, the unemployment rate in Antigua and Barbuda stands at approximately 8.4% (Statistical Office of Antigua and Barbuda, 2023). This rate highlights ongoing issues with job creation and economic stability. Youth unemployment is particularly concerning, with rates significantly higher among young adults compared to the general population. The country's economy, heavily reliant on tourism, remains vulnerable to global economic fluctuations and natural disasters, which exacerbates these employment challenges. The tourism sector, while crucial, has shown susceptibility to external shocks, impacting job availability and economic stability.

Poverty persists as a pressing issue despite the relatively high GDP per capita. The Caribbean Development Bank (CDB, 2022) reports that approximately 16% of the population lives below the national poverty line. This situation is influenced by factors such as the high cost of living, limited access to affordable housing, and disparities in income distribution. The Gini coefficient, which measures income inequality, indicates a moderate level of inequality in Antigua and Barbuda. As of the latest data, the Gini coefficient stands at around 0.40, reflecting a significant but not extreme level of income disparity (World Bank, 2023).

Barbuda exhibits higher levels of vulnerability compared to Antigua. The island's economy is less diversified, relying heavily on subsistence agriculture and small-scale trade. This economic structure, combined with frequent exposure to natural disasters, results in higher levels of poverty and unemployment on the island compared to Antigua. Data from the Statistical Office of Antigua and Barbuda (2023) show that 76.79% of Barbuda's population is employed, but the nature of employment often remains informal and unstable, contributing to economic vulnerability.

In response to poverty and unemployment, the government of Antigua and Barbuda has implemented various social protection programs. These include cash transfer programs, subsidies for basic goods, and housing assistance aimed at supporting low-income families. The

government has also focused on improving access to education and vocational training as part of broader poverty alleviation strategies. For instance, initiatives like the Social Protection Programme aim to address the needs of vulnerable populations by providing financial assistance and improving access to essential services (Government of Antigua and Barbuda, 2022). These programs include the Antigua and Barbuda Social Security Board (ABSSB), which implements a contributory pension scheme for formal sector workers providing numerous benefits, and the Civil Service Pension Scheme for public employees. Additionally, social assistance is provided through the Board of Guardians and several other institutions. The PDV Caribe Antigua and Barbuda Ltd. implements two social assistance programs: the People's Benefit Program, a conditional cash transfer program, and the Senior Citizens Utilities Subsidy (Country Document for Disaster Risk Reduction, 2016). These efforts aim to address the economic challenges faced by the nation's most vulnerable populations.

The Human Development Index (HDI) for Antigua and Barbuda, as of the most recent report, is 0.78, indicating a high level of human development relative to the global average (United Nations Development Programme, 2023), the global HDI index is 0,73, while in Latin America and Caribbean, it stands at 0.754. This reflects significant achievements in health, education, and income in Antigua and Barbuda. However, despite this relatively high HDI, disparities in living standards remain, particularly in rural and less economically developed areas such as Barbuda. The Gini coefficient, a standard measure of income inequality, is 0.48 for Antigua and Barbuda, indicating significant inequality within the region. Antigua and Barbuda's Gini coefficient is notably higher than those in many developed countries, reflecting a considerable degree of income disparity.

In 2015, the unemployment rate in Antigua and Barbuda was recorded at 14.1% according to the country's first Labour Force Survey, which covered individuals aged 15 to 64 years. The working population was estimated at 57,418, resulting in a labor force participation rate of 77.1%. The survey revealed that more women (20,217) are employed than men (17,844), but the employment-to-population ratio (EPR) was slightly higher for men (68.4%) than women (64.5%). Youth unemployment stood at 34.6%, more than double the overall unemployment rate. Individuals with tertiary education had the lowest unemployment rate at approximately 7.9%, while those with secondary education had the second lowest rate at 15.6%.

5.3.7. Education

The education system in Antigua and Barbuda is compulsory and free for children between the ages of 5 and 16, as mandated by The Education Act, Chapter 145 of 1973. The government has introduced an Education Levy that provides for a School Bus Transportation system, a School Meals Programme, a Uniform Assistance Programme, school infrastructure, and class materials to encourage and ensure compulsory attendance.

As of the latest data, Antigua and Barbuda have a total of 56 primary and 12 secondary schools. The majority of these schools are located on the island of Antigua, while Barbuda has 1 primary and 1 secondary school, both public. Most primary schools in Antigua are public, offering education to children aged 5 to 12. These schools are spread across various parishes, with the highest concentration in St. John's, the capital city. Additionally, several private primary schools offer more personalized education with better resources and facilities.

In Antigua, there is the Antigua State College, which offers various diploma and certificate programs, and the University of the West Indies (UWI) Open Campus, which provides higher education opportunities, including bachelor's and master's degrees, catering to the needs of students in Antigua and Barbuda. There are also five island campuses.

According to data obtained from the Human Development Report by UNDP in 2021, the average years of schooling in Barbuda are 9.3, while the expected years of schooling are 14.2. The global and regional averages for the average years of schooling are 8.6 and 9, respectively, while the global and regional averages for the expected years of schooling are 12.8 and 14.8, respectively. The literacy rate was 99% in 2015 (98.4% for men and 99.4% for women) (PAHO, 2023).

Table 13. Population 15 years and older by educational level

Education Level Attained	Total	Male	Female
None	0,7%	47,3%	52,7%
Primary/elementary (1-3)	1,5%	54,2%	45,8%
Primary/elementary (4-7)	12,9%	52,5%	47,5%
Junior Secondary	7,5%	56,4%	43,6%
Secondary (form 1-3)	7,1%	51,1%	48,9%
Secondary (form 4-5)	37,7%	43,7%	56,3%
Sixth Form ('A' Level) - Lower	0,9%	39,8%	60,4%
Sixth Form ('A' Level) - upper	1,9%	36,7%	63,3%
Post Secondary	1,6%	40,3%	59,7%
Post Sec/Pre-University/College	10,7%	40,7%	59,4%
Post Primary - Vocational/Trade	2,6%	59,9%	40,1%
Special School/Education	0,3%	44,1%	55,9%
University	8,7%	43,0%	57,0%
Other	1,4%	42,6%	57,4%
Do not know/not stated	4,5%	52,9%	47,1%
Total	100,0%	46,7%	53,3%

Data Source: Census 2011.

The data on education levels attained reveals several key insights. The highest percentage of individuals (37.7%) have completed Secondary (form 4-5) education, with more females (56.3%) than males (43.7%). University graduates make up 8.7% of the population, again with more females (57.0%) than males (43.0%). Post-secondary and pre-university/college education is attained by 10.7%, predominantly females (59.4%). Notably, a small fraction of the population has no formal education (0.7%) or only primary/elementary education (1.5% for 1-3 years and 12.9% for 4-7 years), with a slight male majority in these categories. Overall, females are more represented in higher education levels, while males dominate vocational/trade education at 59.9%.

In the 2011 census forty-eight percent of the population uses the Internet – penetration in the fifteen-to-nineteen-year age group is the highest at seventy-eight percent (78.1%). In Barbuda, only 36.46% of the population are internet users, and 31.89% of households have internet access. Finally, 77.46% of households have cable TV, while 2.16% have satellite TV.

The nation is served by at least twenty radio stations, the vast majority (17) of which broadcast in the FM band, two cable networks, and one broadcast TV station. There are also two daily newspapers.

5.3.8. Health

The healthcare system in Antigua and Barbuda includes both public and private hospitals. The main hospital is the Mount St. John's Medical Centre in Antigua. Additionally, the country has several smaller health centers and clinics.

Antigua and Barbuda have a combination of public and private healthcare facilities. The primary public healthcare institution is Mount St. John's Medical Centre, which provides a wide range of medical services. The private sector also offers several clinics and smaller hospitals that cater to various healthcare needs. The quality of care in both public and private hospitals is generally considered good, with the private sector often providing more personalized services due to better resources and facilities. Health insurance coverage in Antigua and Barbuda is not universal. There are options for private health insurance, which many residents and expatriates opt for to access better healthcare services. The government also provides some level of healthcare support for those unable to afford private insurance.

Life expectancy at birth in 2023 was 79.4 years, higher than the average for the Region of the Americas and 4.8 years higher than in 2000 (PAHO, 2023). Differentiating by gender, the life expectancy for women is 80.9 years, while for men it is 75.8 years.

In the six months before and after the 2010 census, 480 deaths and 1,252 births were registered in Antigua and Barbuda. With a population size of 85,567, this implies a death rate of 5.6 per thousand and a birth rate of 14.6 per thousand.

Between 2000 and 2020, infant mortality in Antigua and Barbuda decreased from 21.6 to 7 deaths per 1,000 live births, a decrease of 67.6%. The percentage of low-weight births (less than 2,500 grams) decreased from 7.6% to 4.6% between 2002 and 2020. The maternal mortality ratio for 2020 was estimated at 21.2 deaths per 100,000 live births, a reduction of 58.6% from the estimated value for 2000. In relation to fertility, it is estimated that in 2023 women had an average

of 1.6 children throughout their reproductive lives. In the specific case of adolescent fertility, there was a 50.8% decrease, from 63.4 live births per 1000 women aged 15 to 19 years in 2000 to 31.2 in 2023.

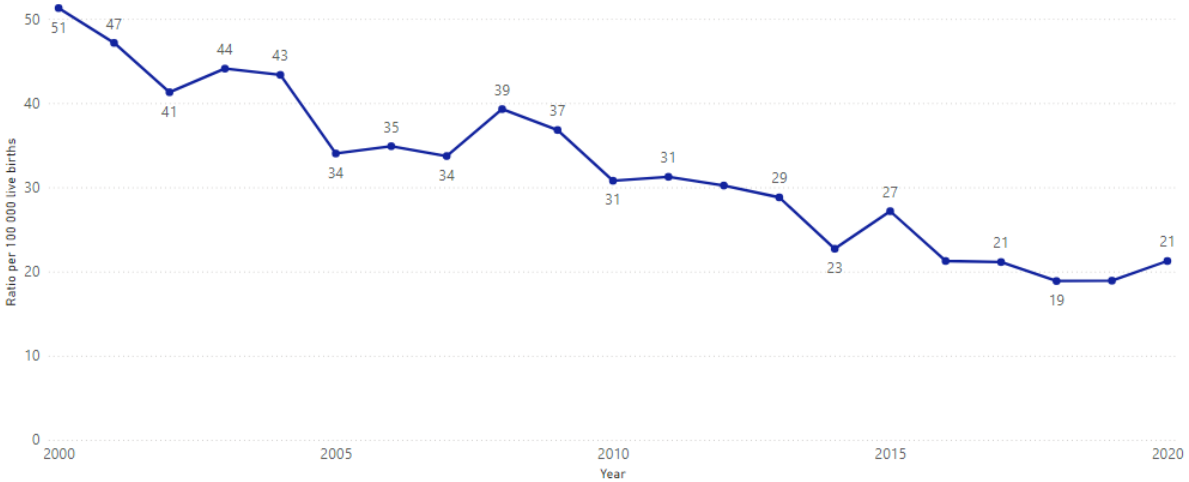

Figure.5:. Estimated Maternal mortality ration in Antigua and Barbuda 2000-2020.
Data Source: Estimates by WHU, UNICEF, UNFPA, World Bank Group/ Trends in maternal mortality.

Referring to major diseases, in 2021, there were 4 cases of tuberculosis per 100,000 population in Antigua and Barbuda. The mortality rate for tuberculosis in 2019 was 0.5 per 100,000 population. HIV incidence was significant, with 55.8 new cases per 100,000 population in 2021, and the mortality rate for HIV in 2019 was 5.2 per 100,000 population. Hypertension remains a prevalent condition, affecting 23.4% of adults aged 18 and older as of 2015. The prevalence of diabetes has also increased, rising from 7.7% in 2000 to 11.5% in 2014.

5.3.9. Culture and Society

In Antigua and Barbuda, the population is predominantly of African descent, comprising approximately 95.11% of the total population. The remaining population includes small minorities: 0.13% are Caucasian/White, 0.13% are East Indian/Indian, and 2.88% are of mixed Black/White heritage. Other mixed groups account for 1.00%, while 0.44% are Hispanic, 0.13% are Syrian/Lebanese, and 0.13% fall into other ethnic categories. There is also a small percentage, 0.06%, of individuals whose ethnicity is not known or not stated. (Census 2011).

Before the arrival of Europeans, Antigua and Barbuda were inhabited, although not continuously, for approximately four to five thousand years. It is likely that pre-ceramic peoples migrated from the Orinoco River area of South America to Trinidad and then moved up the Antillean chain. Additionally, other populations of lithic, hunting, and gathering peoples might have entered from North and Central America. Remains of these Archaic fisher-foragers have been discovered at Jolly Beach, Long and Guiana (or Guana) islands, and several other sites in Antigua.

These Archaic fisher-foragers were succeeded by Ceramic Age people who might have been connected to Arawakan speakers. They arrived from northeastern South America around two thousand years ago, bringing with them pottery, food gardens, and other cultural traits. Archaeological sites of these people have been found on both Antigua and Barbuda. When Europeans first attempted to settle on Barbuda and Antigua, they encountered horticultural and

fishing peoples who are conventionally called Caribs. The Caribs' visitations in Barbuda during the seventeenth century initially discouraged English settlers, but once the English began to settle and alter the landscape, Antigua and Barbuda diverged significantly in land use, agriculture, economy, and colonial roles, with Antigua focusing on sugar production. (Press, 1995).

Antigua, the larger of the two islands, boasts a range of significant cultural sites and traditions. The island is renowned for its historic sites such as Nelson's Dockyard, a UNESCO World Heritage Site. This 18th-century naval base, located in English Harbor, played a pivotal role during the British colonial era and remains a testament to Antigua's maritime history (UNESCO, 2023). The Dockyard, along with other historical structures like Shirley Heights and Fort James, provides a glimpse into the island's colonial past and its strategic importance in naval history.

In addition to its historical sites, Antigua is home to a number of vibrant festivals and cultural events that celebrate its heritage. The Antigua Carnival, held annually in late July and early August, is one of the most significant cultural events on the island. The carnival features colorful parades, music, dance, and costumes that reflect the island's African and Caribbean influences. It is a time of celebration and showcases the rich cultural traditions of the Antiguan people (Antigua and Barbuda Tourism Authority, 2023). Another notable event is the Antigua and Barbuda International Literary Festival, which highlights the literary contributions of local and regional authors and promotes a culture of reading and writing.

Barbuda, the smaller island, has its own unique cultural heritage and traditions. The island's history is marked by its distinctive approach to land ownership and community life. Barbuda's most essential resources have been managed efficiently through a system of communal land tenure, which has been central to its ecological structure. This system of communal land tenure is increasingly rare globally due to the introduction of crops and development. Culture and values have played a significant role in maintaining this system. Barbudans insist on community control over labor, ownership of the island by its inhabitants, and common rights to use unallocated lands for productive activities. They view their island as a source of livelihood, a special birthright, and land belonging solely to them. Until 1981, the island was regarded as an inalienable heritage for the common benefit.

Barbuda's cultural heritage is also reflected in its unique festivals and traditional activities. The annual Barbuda Day celebrations, held on November 1st, commemorate the island's history and cultural identity. This event includes traditional music, dance, and local cuisine, providing an opportunity for residents and visitors to engage with Barbuda's cultural traditions (Antigua and Barbuda Tourism Authority, 2023). Additionally, the island's traditional practices in agriculture and fishing continue to play a significant role in community life, highlighting the Barbudan commitment to preserving their heritage.

Language plays an essential role in the cultural identity of Antigua and Barbuda. English is the official language, reflecting the country's colonial history. However, Antiguan and Barbudan Creole, an English-based Creole language, is widely spoken and serves as an important cultural marker for the local population (Holm, 2023). This Creole language incorporates elements from African languages, reflecting the island's African heritage and the blending of cultures over centuries.

5.4. Direct Area of Influence. Socio-economic Analysis of Codrington

As part of the development of a Socioeconomic Assessment for the Murbee Resort Project in the island of Barbuda, a field visit was conducted from July 10 through 12, 2024.

The key objectives of the visit included **identification and characterization of the socioeconomic baseline**, and preliminary analysis of the potential socioeconomic impacts and risks of the Project.

The following sections describe the main characteristics identified in the field regarding housing, education, health, economic and tourism activities, transportation, relevant culture and heritage, as well as the main social conflicts identified by the residents.

5.4.1.1. Housing, Public Infrastructure, and Natural Disasters

The Barbuda Local Council, established under the Barbuda Local Government Act, is the governing body responsible for the administration of local affairs on the island of Barbuda. It consists of 12 members: nine elected by popular vote, two appointed by the elected members, and one designated by the central government of Antigua and Barbuda.

The council's primary objectives are centered around the implementation of local policies, governance, and the provision of public services. It comprises seven departments: Health, Education, Works, General Purpose, Finance, Agriculture, and Fisheries.

The council acts as a bridge between the central government and the residents of Barbuda, ensuring that local concerns are addressed while also implementing national policies at the local level. Its legislative powers enable it to pass bylaws and regulations specific to Barbuda, particularly in areas such as land management, environmental protection, and local taxation.

One of the key roles of the Barbuda Local Council is the management of communal land, as all land on Barbuda is traditionally held in common by the Barbudan people. The council oversees land use and ensures that it aligns with the community’s needs and sustainable development goals.



Figure.6:. Council building (Barbuda's Cultural Complex)



Figure.7:. Council building. Fisher and Tourism Departments



Figure.8:. Police Office

Finally, Barbuda has two police stations: one situated within the community and the other located at Rute 1, at the northern extremity of the urban area of Codrington.

English is the official language in Barbuda, although locals often communicate in a local dialect, developed by the indigenous population during the period of slavery and colonialism.

Most interviewees identified 2017 as a pivotal year for Barbuda, as Hurricane Irma caused significant social, economic, and housing changes on the island.

In September 2017, a Category 5 storm made landfall in Barbuda, causing unprecedented destruction of the island. With sustained winds reaching 185 mph, Irma severely affected nearly every aspect of life on the island. The hurricane decimated Barbuda's infrastructure, with 95% of homes and buildings either destroyed or severely damaged. The island's communication systems, electricity, and water supply were also compromised. The government ordered a mandatory evacuation of the island's entire population, which was approximately 1,800 people. Evacuees were transported to Antigua, where they were provided shelter in public facilities, churches, and with host families. (UNDP, 2019)

Following the hurricane, the United Nations initiated a program “Resilient restoration of pivotal public infrastructure for the recovery and sustainable development of the island of Barbuda post Hurricane Irma,” to reconstruct the houses. Over time, families expanded these houses to meet their needs.

Below are illustrative images of currently inhabited houses and some abandoned due to hurricane damage.



Figure.9:. Houses after Hurricane Irma

Moreover, repairs are ongoing for public institutions, the Barbuda's Councils Building, affected and destroyed by the 2017 hurricane, as depicted in the following image.



Figure.10:. Repairs at the council administration building

5.4.1.1.1. Electricity

Electricity generation and distribution in Barbuda are managed by the Antigua Public Utilities Authority (APUA), which serves both Antigua and Barbuda. According to 2011 census, approximately 98% of the population has access to electricity, through diesel generators primarily, though the infrastructure is vulnerable and frequently experiences disruptions, especially after natural disasters. During the field visit, all interviewees reported having electricity in their homes, although they commented that blackouts are common and climate contingencies can disrupt the supply, sometimes causing delays of months in restoring services.

With regards to renewable energy, there are ongoing efforts to incorporate renewable sources such as solar power, but progress has been slow.

Barbuda boasts the Green Barbuda Solar Hybrid, a solar energy facility managed by APUA. During a site visit, a tour of the facilities was conducted. At the site, there were 2 operators and a security guard. According to a worker, the sector typically employs two to three operators. Furthermore, the hospital possesses a solar panel system (Figure.11).



Figure.11:. Solar panels at the hospital

5.4.1.1.2. Water supply

Water supply in Barbuda is limited, primarily sourced from groundwater wells and rainwater harvesting systems. APUA manages the water supply, but the infrastructure is less developed than in Antigua.

According to 2011 Census data, 84% of households have some type of connection to the public water supply. Most homes (67%) receive water directly into their dwelling units, while a smaller percentage (5%) obtain it from public standpipes. Notably, 12% of Barbudan households rely on cisterns or tanks for water storage, suggesting greater vulnerability to potential droughts or supply interruptions.



Figure.12:. Desalination tanks near the river dock area

The primary source of potable water comes from a desalination plant operated by the Antigua Public Utilities Authority (APUA), which converts seawater into drinkable water. However, water from the desalination plant may not always be considered fully potable, as told in the interviews, some residents rely on bottled water for drinking During the field visit, it was observed that many citizens went to the supermarket to fill jugs of drinking water.

Rainwater collection through cisterns is another common practice, though this water is typically used for non-drinking purposes.

5.4.1.1.3. Wastewater disposal

For wastewater disposal most residents rely on individual septic tanks. Less than 40% of households have access to adequate wastewater management.[8]

According to the Master Development Plan and Draft Design Brief, Barbuda currently has a fragmented waste management system overseen by various authorities, primarily the Barbuda Council. The island lacks a comprehensive waste management strategy and has an insufficient waste collection service. As a result, waste, including hazardous materials, is often disposed of indiscriminately on open land near the closed landfill, especially – as informed by an interviewee - near coastal areas, as there is no advanced wastewater treatment facility. This issue is exacerbated by administrative uncertainties regarding responsibilities and the absence of effective cost recovery mechanisms. The lack of proper infrastructure increases the risk of environmental contamination, particularly impacting coastal ecosystems and groundwater.

[8] Citizenship By Investment Unit Antigua and Barbuda. https://cip.gov.ag/about-antigua-barbuda

According to the census 2011, a high percentage of households (79%) have bathrooms located inside the dwelling unit, indicating a relatively good level of sanitation. However, a significant minority (20%) of households still lack a bathroom inside, relying on shared facilities or having no bathroom at all.

5.4.1.2. Education

Barbuda's education system includes only two institutions, one primary and one secondary, both public and mandatory. As described in the previous section, the Education Act establishes a compulsory and free school education, between ages of 5 and 16 years.

An interview with the primary school Principal and a secondary school teacher was held during the field visit. The Primary School Principal estimated that there are approximately 160 students attending the primary school. Both interviewees highlight the high attendance rates in both levels. However, the teachers mentioned the challenges that the educational institutions suffer, such as insufficient human resources, materials, and lack of special programs. For example, the secondary school lacks a laboratory and necessary equipment for social sciences activities mandated by the national government.

Additionally, during the interviews, the primary school Principal and the secondary school teacher referred to the technological limitations of the school, with inadequate computers and no specialized IT teachers.



Figure.13:. Holy Trinity Primary School



Figure.14:. Sir McChesney George Secondary School

5.4.1.3. Health

In relation to the health system in the Island, Codrington has one public hospital and a private clinic. The private clinic, run by an NGO, offers basic services such as wound care, vaccinations, and blood pressure monitoring, with only a nurse on staff.



Figure.15:. Health and Wellness Center

The public hospital, located in the populated center, employs four general practitioners (three from Cuba and one local), approximately 13 nurses and personnel, and ten maintenance staff. It operates 24/7, with shifts ensuring continuous service.

A collaborative program between the governments of Antigua and Barbuda and Cuba allows Cuban doctors to serve in Barbuda for about six months. After this period, the doctors rotate, ensuring that there is at least one Cuban doctor available to support the medical staff at the hospital in Barbuda. According to the hospital director, currently three of the four general practitioners in the hospital are Cubans, while there is only 1 doctor from Barbuda in the Hospital.

The hospital charges a small fee for medical visits, varying based on the patient's citizenship, from Antigua and Barbuda, from CARICOM countries or from another country it will have a different fee.

Services are basic, without specialized departments, intensive care units, or surgical facilities. There is a simple system to do x-ray, a pharmacy and general attention available for the citizens. The maternity area is not well-equipped, and there are no specialized doctors in the island, leading to most women traveling to Antigua for childbirth.

People go to Antigua for most treatments needs or for other diseases, such as cancer. An emergency plane transports urgent cases to Antigua, with patients paying for the return trip. Furthermore, the Calvin Ayre Foundation provides emergency airlift services for medical evacuations.

According to the hospital director, admissions are low, about ten per month. Most of the patients visit the hospital for medication refills for chronic conditions. The most common illnesses are hypertension, diabetes, and asthma, where asthma is more common among vulnerable groups.



Figure.16:. Hannah Thomas Hospital

5.4.1.4. Economic Activity and Community Livelihoods

The primary sources of employment for Barbuda's population include government institutions, the Barbuda Council, tourism and fishing. According to the interviews, most people work from 7 AM to 3 PM.

The fishing activity departs primarily from the lagoon in the Barbuda Fisheries area, while some fishers depart near the port. The primary fishing activity is for lobsters, which are both exported and sold locally.



Figure.17:. Fisheries sector to the west of Codrington.



Figure.18:. Fisheries sector to the west of Codrington.



Figure.19:. Fisheries division building

Regarding tourism, many interviewees mentioned that after Hurricane Irma in 2017 and the subsequent reconstruction of housing, luxury hotel developments began to be established along the coast of Barbuda. Among them, the PLH project stands out. There are currently some hotels under construction on the beach and several small inns in the urban area.



Figure.20:. Palm tree guest House



Figure.21:. TimbukOne

This development generates significant employment in construction and secondary economic activities, such as gastronomy and cement production. A consequence of the current hotel construction is the increase in traffic, especially trucks carrying materials. Many interviewees commented that this causes disturbances in the community, and the amount of construction-related traffic further deteriorates the condition of the roads.



Figure.22:. Beach restaurant

According to the interviewees, most of the people working in these establishments are from other parts of the Caribbean or other countries, such as Cuba, Jamaica, and Guyana, although some local people are also employed in these ventures. Additionally, there are four smaller inns in the urban area where hotel workers are accommodated.

Compared to Antigua, the level of tourism in Barbuda is very low. Tourists do not stay or travel through Codrington. Apart from the construction of hotels, the locals commented that there is not much more tourism activity in the area. They described it as a "quiet place, nice getaway, with sand, but not much else." They highlighted a bird sanctuary, caves, snorkeling, tours across the lagoon, and ferries coming from other parts of the Caribbean for day tours, spending only the day on a Barbuda beach, without staying on the island.

Agriculture, primarily managed by the local government, has declined in importance post-hurricane, focusing mainly on crops and not highly developed. Livestock is privately owned, with goats and other animals that often foam freely. Hunting, including deer and pigs, is also noted.



Figure.23:. Livestock



Figure.24:. Livestock

Finally, the economic activity related to the port and the transportation of materials, cargo, and goods is significant. This generates considerable economic activity around the port, as well as traffic movement. There is also economic activity related to shops and basic needs, a pharmacy, among others. Interviewees find the island of Barbuda more expensive than Antigua.



Figure.25:.Greengrocers.



Figure.26:.Lil Linc's Supermarket



Figure.27:.Supermarket

5.4.1.5. Transport

Private transport is prevalent in Barbuda, mostly cars, with taxis used less frequently. There are also school and hospital buses and some buses for construction workers' transportation.

For travel outside the island, the ferry is the primary mean of transportation, with airplanes used less often by the locals due to the higher cost. Flights are limited and frequently do not run.



Figure.28:.Express Ferry Barbuda

The current airport is small, making only flights to Antigua. There is a second and bigger airport, but it is not operational, pending state approval of certain permits. Interviewees expect it to be operational soon.



Figure.29:.Airport operations.



Figure.30:.Airport.



Figure.31:.New Airport Building.

Road conditions are typically poor, with many dirt roads and asphalted ones damaged by heavy traffic and weather conditions.



Figure.32:. Road conditions.

5.4.1.6. Cultural activities, Cultural Heritage, Archaeological and Historical Sites

The people of Barbuda define themselves as a small, quiet, and peaceful community where everyone knows each other. They also state that their culture is not as influenced by others as in Antigua, maintaining a more insular cultural identity. They emphasize that Barbuda is a very peaceful place to live, with no violence or crime.

Among the significant cultural activities mentioned in the interviews, the Caravana stands out, featuring a queen show, a teenage competition, fishing tournaments, and performances by artists from around the Caribbean.

They note that there is not much underlying cultural activity; rather, it is a quiet town with specific Catholic activities, such as attending Pentecostal mass or Catholic events. They also mentioned certain clubs, like the Block Club, which conducts fundraising activities, and the Devotional Group, a non-profit organization that donates to the vulnerable and hosts community activities. In terms of religion, the majority are Christians.



Figure.33:.Comunity church



Figure.34:.Comunity church



Figure.35:.Abundant Life Ministries Barbuda

Additionally, they highlighted sports activities such as football, cricket, and basketball. Horse racing is a popular activity among the community, as well as fishing tournaments held in the fisheries sector.



Figure.36:. Barbuda Tennis and Basketball Court

Finally, they mentioned recreational activities like bars, casinos, gambling, restaurants, and the beach bar. They also enjoy going to Princess Diana Beach and spending time along the coast near the fisheries, especially the kids.

On the stakeholder event that took place during the 26 to 30th of August, one participant noted the absence of typical amenities found in other cities or towns worldwide. Specifically, she mentioned the lack of hair salons, cultural centers, public squares, and shopping malls. While she acknowledged that locals know where to go for specific services, such as car repairs or nail care, the absence of proper establishments, infrastructure, and signage makes the town less attractive to tourists.

5.4.1.7. Communication

Communication on the island is facilitated by the Barbuda Channel and a local radio station, both managed by the local church Abundant Life Ministries Barbuda. Most residents use social media, such as Facebook and WhatsApp, for news.

Additionally, as was underlined during an interview, a local resident known as “Giki” broadcasts news via speakers from his home, serving as a community news source. Personal conversations among neighbors and community members are also a primary source of information.

Finally, public gathering places are limited, mainly to school grounds or Caravana City.

5.4.1.8. Social Conflict

Residents identified several social conflicts, notably issues with the government.

The national government of Antigua and Barbuda and Barbuda's local government have different political ideologies, causing policy and problem-solving difficulties at the local level. Despite this, there is no violence or significant crime on the island. Barbuda is described as a quiet place without issues of robbery or violence, with few residents and a peaceful atmosphere.

A major issue revolves around **land ownership**. Historically, land in Barbuda has been communal, but according to a resident of Barbuda, recent parliamentary efforts aim to change this, requiring residents to pay for land held in common. This has caused significant concern among the locals, as traditionally, Barbuda residents have had the right to land based on ancestral ties.

Regarding the PLH and Barbuda Ocean Club developments projects, some interviewees expressed concerned about the communication between the Barbuda community and the local council with the project developers, as well as the local employability of the project. Additionally, there are observations about restricted beach access for locals and a perception of potential conflicts of interest, as PLH has contributed to the construction of the police station and sponsors school events. Some community members express uncertain about the ongoing developments and would like more inclusion in the process.

Moreover, while there is recognition that economic development brings benefits to the community and the overall growth of the island, residents are concerned about the need to preserve the island's peaceful nature as more investments and people arrive.

There is an understanding that these developments could bring significant economic opportunities, but also a desire to ensure that the island’s social fabric and tranquil way of life are not compromised. This sentiment reflects a careful balancing of the advantages of economic growth with the need to maintain the unique island’s social dynamics that the community values.

5.4.2. Characterization of the Project Area

The project area remains predominantly in its natural state, with limited human activity, as it will be described in this section. Figure 6 shows the social significance sites identified during the field work.

According to one interviewee, before 2017, the coastal and beach areas were recreational spots for the local population. However, after the impact of Hurricane Irma in 2017, the landscape of these coastal zones changed, with an increased presence of rocks and debris in these specific areas. This led to a decline in the community's regular visits.

During the field visit, no recreational use of the coastal and beach areas by the community was observed. However, it is essential to note that these observations were made during weekdays and in the daytime hours. It is possible that families who traditionally visit these areas on weekends or during the evenings were not present during the field visit.

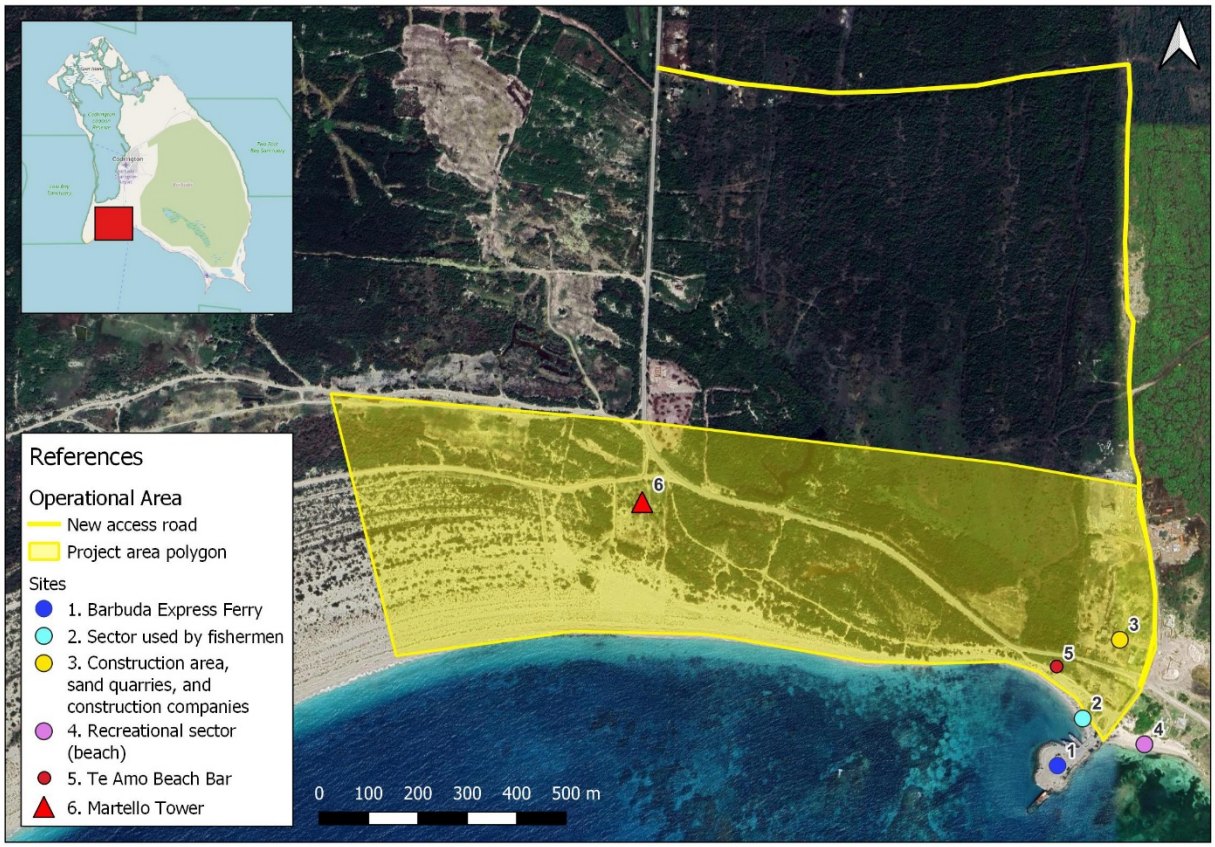

Figure.37:. Project Area polygon and points of interest.

1. Barbuda Express Ferry
2. Sector used by fishermen.
3. Construction area, sand quarries, and construction companies
4. Recreational sector (beach)
5. Te Amo Beach Bar
6. Martello Tower

5.4.2.1. Recreational Sector

There is a recreational sector, with some tables and recreational infrastructure on the east side of the ferry dock.

According to an interviewee, this area is generally empty, due to the amount of activity, cars, construction and transportation tanking place. However, on weekends there is less construction activity, making it a quieter area, and some people and families do visit.

During the field work, no use was observed – the area appeared empty the four times that this place was visited. However, it is important to note that the site was not visited by the project team on a weekend, when activity may be increased.



Figure.38:. Recreational Area on the east side of the River dock.

5.4.2.2. River Dock. Barbuda Express Ferry

To the east of the operational area of the project is the port, used for the exchange of goods and passenger transport, primarily to Antigua. Exchanges also occur with other Caribbean and Central American locations, such as Montserrat.

Heavy activity was observed in the port area, including the transport of construction materials, containers with products, and passenger movement. According to an interview, Wednesdays and Fridays are the busiest days in the port area due to the arrival of supply trucks from Antigua. It was verified that on Wednesdays, businesses in the center of Codrington were restocking merchandise transported by boat to Barbuda.



Figure.39:. Port Area



Figure.40:. Port Area



Figure.41:. Port Area



Figure.42:. Express Ferry Barbuda

5.4.2.3. Construction area, sand mining and construction companies.

Construction facilities and sand quarries were verified in the project's operational area. These will be affected by the project's activities, potentially requiring agreements to relocate these facilities to other sectors. The land for these facilities is leased from the state.

During the field work, an interview was conducted with a worker from a concrete facility. According to the interviewee, this was a new company with only four workers. He mentioned that there are three concrete companies on the island, servicing the hotels currently under construction. The construction boom began in 2018, and most construction workers are from outside Barbuda. According to the interviewee, most of the workers are from República Dominican or Jamaica, and in second place they come from other Caribbean Islands, like Cuba.

The following images depict the facilities located within the project's operational area.



Figure.43:. Sand Mining Operation



Figure.44:. Construction Companies



Figure.45:. Construction Companies



Figure.46:. Construction Companies



Figure.47:. Construction Companies

5.4.2.4. Fishermen Activities

The fishing community in Barbuda holds a significant position within the local economy, particularly for the male population, though it often serves as a secondary occupation. Fishing, primarily focused on lobsters, is a key activity that supplements other forms of income, such as work in tourism or local businesses.

During the first field visit in July 2024, attempts to interview fishermen in the project's operational area were unsuccessful, despite multiple efforts at different times of the day. At that field trip, interviews were conducted near Codrington, particularly at Barbuda Fisheries. An interviewee mentioned that while the operational area once hosted more fishing activity, over time, most fishermen have shifted their docking and activities closer to town, particularly around the fisheries near Codrington.

The second field visit in late August 2024 provided a more comprehensive view of the fishing community. Interviews were successfully conducted both in the project's operational area and at the fisheries, including an interview with the President of the Fisheries Association, Montique Core. His comments reflected growing concerns among the fishing community about the broader changes happening on the island.

Interviews suggest that around 30 fishermen utilize the dock in the southern part of the operational area of the project. However, the main fishing activities, including docking, are concentrated near Codrington. Despite this, a portion of fishermen continues to use areas near the project site, particularly those involved in activities closer to the Coco Point area.

Among the key findings, it was noted from interviews conducted with local fishermen, that a significant portion of the male population in Barbuda is engaged in fishing activities, Montique

Core and other fishermen expressed that nearly 80% of the male population engages in fishing activity even on occasional bases, with a notable portion being younger men. This demonstrates the ongoing cultural importance of fishing to the Barbuda community, despite the economic diversification taking place, as fishing, according to the interviewees, is not their primary economic activity, but a secondary one for most of the population.

This secondary fishing activity supplements their main sources of income and plays a crucial role in the local economy. Of the three interviews conducted on July, two fishermen had other jobs (one in tourism and another in a business) in addition to fishing. However, the lobster season attracts higher participation due to the financial opportunities it provides.

Most docking is concentrated in the area near Codrington town, at the fisheries near the state building, though fishing occurs at various coastal locations, fishermen dock their boats primarily around Codrington and secondarily in the project's operational area.

For fishing activities, fishermen venture 20 miles offshore into the open ocean. The fishermen reported primarily catching lobsters for export, along with several types of fish and conch. They primarily sell their catches locally but also export to Antigua, where lobsters are purchased at $18 per pound (according to an interview).

The docking of boats in the south of the island used by fishermen will be impacted by the project. Mitigation measures will be included in the Project's Environmental and Social Management Plan. A new space for docking the fishermen boats should be evaluated, and any necessary construction interventions in that sector will be considered to ensure the coexistence of the recreational sector for the community and a new docking area for the fishermen.



Figure.48:. Fishermen in the River Dock



Figure.49:. Fishermen sector to the west of River Dock, in the project area

5.4.2.5. Te Amo Beach Bar

The operational area of the Project includes an establishment named *Te Amo Beach Bar*, offering alcoholic beverages, which serves as a social gathering spot for the community. According to interviews made, the bar had been unused previously, but it recently changed ownership and has been operational for approximately two years.

The bar only became operational after the development was proposed. This bar will be affected by the project's construction and will require agreements with the business managers.

During the field work in July, a particularly busy event was observed at Te Amo Beach Bar, with approximately 30 people, featuring horseback riding and music. In the Field visit that took place on late August, an analysis of amount of people and ours was taken place by the team as shows the following table:

Table 14.Number of people at Te Amo Beach Bar

Day	Time	No of People
08/26/2024	10 AM	4
08/26/2024	06 PM	7
08/27/2024	11 AM	4
08/27/2024	06 PM	4
08/28/2024	10 AM	6
08/28/2024	06 PM	8
08/29/2024	01 PM	4
08/29/2024	06 PM	12

Additionally, during the second field trip, it was observed that the Te Amo Beach Bar area now features two distinct establishments. The original bar remains in place, while a new eatery has opened in the green and pink house situated to the east of the bar (Figure.51).



Figure.50:. Te Amo Beach Bar



Figure.51:. Te Amo Beach Bar

5.4.2.6. Martello tower

The Martello Tower (which is not part of the development) is a 19th-century defensive fort located near the Codrington Lagoon.

This tower is not only an architectural landmark but also a symbol of the island's colonial past. It was originally built by the British to defend the island from potential invasions. It was observed to be fenced and closed to the public, despite having an entry point for visitors. The path leading west to Palmetto Point is marked by fencing, "private property" signs, and an abandoned trailer. No residences or inhabitants were observed.



Figure.52:. Martello Tower

Appropriate mitigation measures are included in the Project's Social Management Plan (as developed in section 4), as well as communicated in the consultation events, to ensure the development activities in the areas surrounding Martelo Tower do not impact the heritage site.

Part of the project plan includes the restoration of Martello Tower as a historic, cultural, and tourism amenity. The project will contribute to the restoration, and mitigation measures will be implemented to ensure that the project activities do not impact the heritage site.

5.4.2.7. Road to the west of the island

West of the Martello Tower, no active human activity was observed. There is a dirt road flanked by fenced vacant spaces, as shown in the images below.



Figure.53:. Operational Area Road

Additionally, there is a "private property" sign and a container where no settlement or other activity was apparent.



Figure.54:. Private Property

5.4.2.8. New Access Road

Finally, in the area where the new road is planned, there are numerous constructions, material extraction, and asphalt companies, along with heavy vehicle traffic due to ongoing urban development on the island.



Figure 55: Area of the proposed new access road.



Figure 56: Economic activity near the proposed new access road.

Near the road, new homes are being constructed, and repairs are being made to homes damaged by hurricanes. It is important to note that no housing impacts are anticipated during the construction of the access roads.



Figure 57: Houses in construction in the adjacency of the proposed new access road.



Figure 58: Houses in construction.

6. SOCIAL AND HEALTH IMPACTS AND RISKS

6.1. Introduction

This chapter focuses on the identification and assessment of potential social impacts and risks that could be derived from the construction and operation of the Murbee Resort Project.

The following assessment process will consider typical activities associated with this type of projects to identify and evaluate the social impacts and risks.

6.1.1. Assessment Process

The steps involved in the impact and risk assessment are.

- **Identification of Impacts and Risks:** determine what could happen in the different social components, because of the project and its associated activities and facilities.
- **Assessment of Impacts and Risks:** evaluate the significance of the predicted impacts and risks, considering their magnitude and occurrence probability, and the sensitivity, value and importance of the factor or component of the impacted social environment.
- **Mitigation / Improvement**: identify appropriate measures to mitigate negative impacts and enhance positive impacts.
- **Residual Impact Assessment**: evaluate the significance of impacts assuming the effective implementation of mitigation and improvement measures.

For the identification of environmental and social impacts and risks, the time horizon for analysis was divided into three phases:

- Construction
- Operation and Maintenance
- Decommissioning or Abandonment

The project involves infrastructure that is considered to have a long service life. It is assumed that, when properly maintained, this infrastructure will be permanently incorporated into the island's infrastructure stock. Therefore, the decommissioning or abandonment stage was not considered relevant for the impact assessment.

6.1.2. Impact attributes

The impacts are rated according to the attributes detailed below:

1. **Impact Description:** Describes the specific impact to the socio-economic environment.
2. **Nature of Impact**: refers to the sign of the impact (whether it is a positive, negative or neutral impact)
3. **Magnitude of Impact (scale)**: whether the impact is of high, medium, or low significance (see Table 15)

4. **Impact Scope**: indicates whether it is a restricted impact (effect restricted to the Operational Area - OA), specific (effect located within the Direct Area of Influence - DAoI), or major (if it impacts neighboring areas, outside the Indirect Area of Influence - IAoI).
5. **Impact Duration (persistence)**: it is determined whether it is a transitory or permanent impact.
6. **Impact Probability: it** is a measure of the probability of the impact occurrence.
7. **Accumulation:** for the most significant impacts identified, the cumulative impacts of the execution and operation of the works with respect to existing or potential projects will be analyzed.

Regarding the **magnitude of the impact**, the definitions in the following Table as a basis for their determination.

Table 15 keys to determine socio-economic impacts magnitude.

Magnitude of Impact	Socio-economic Environment
High	It is defined as one of long duration (persisting over several generations), or one that affects a definable group of people to such an extent as to cause a significant change in the quality of life or in culturally established and socially valued positive or appropriate patterns of an activity that will not return to pre-project levels for at least several generations.
Medium	It is defined as one that affects a definable group of people in a significant magnitude, enough to cause an alteration in the quality of life or in culturally established and socially valued as positive or adequate patterns of an activity.
Low	It is defined as one of short duration or one that affects a reduced group of people in a localized area but does not imply an evident alteration in the quality of life or in culturally established and socially valued as positive or adequate patterns of an activity.

6.1.3. Identification of Mitigation Measures

Once the impacts have been identified and assessed, mitigation measures are identified to avoid, reduce, correct, or compensate for them.

All negative impacts identified in the impacts and risks analysis of this Study require preventive, mitigatory, corrective or compensatory measures, which must be incorporated to minimize social impact and ensure the sustainable performance of the project.

Within the mitigation hierarchy, preventive (pre-impact, avoid impact at source) and mitigatory measures (minimize impact, reduce impact at source, or on the receiving body) are preferred over measures involving treatment (post-impact), such as restoration and compensation.

6.2. Analysis of Impacts and Risks

6.2.1. Impacts - Construction Phase

6.2.1.1. Impacts on Roads and Traffic Patterns

Impact Assessment

Impact Description	Disturbance to local public roads and increased traffic due to increased vehicle movement during construction		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory	Permanent	
Probability	Low	Medium	High
Accumulation	Non-cumulative	Cumulative	

Impact Discussion

Throughout the entirety of the construction phase, impacts will be generated due to increased traffic and competition for the use of the road network, due to the transportation of materials, equipment, personnel, and machinery for project works and to the reduction of effective roadway areas (due to the presence of work installation zones, construction site fencing, trenching, and parked or operating machinery).

Moreover, the project is expected to generate potential disturbances for residents and construction companies along the affected roads, specially along the new access road as well as Route 1. These disturbances may include temporary inconvenience, and potential grievances due to noise, dust, restricted access, and construction-related activities. It is crucial to engage with the local community proactively to address their concerns and mitigate adverse impacts through effective communication and management strategies.

These identified impacts are considered negative, of medium magnitude, affecting the direct area of influence and of a transitory nature and affecting the direct influence area of the project. They are also a cumulative impact in that the damage to the road is exacerbated by the simultaneous presence of multiple large scale construction projects in the island.

Mitigation Measures

- Develop a comprehensive community information and participation program as part of the Social Management Plan (SMP). This program should keep residents informed about the project duration, work schedules, and the specific measures in place to mitigate risks and minimize impacts caused by construction activities.

- Establish a **Traffic and Pedestrian Management Program**: Implement a traffic and pedestrian management program designed to ensure the safety and convenience of all road users during the construction period. This program should include clear signage,

route diversions, and other necessary measures to manage traffic flow and pedestrian access effectively, minimizing disruptions and ensuring public safety.

Residual Impact

The residual impact is expected to result in medium negative impact.

6.2.1.2. Construction-related impacts on River Dock

Impact Assessment

Impact Description	Impacts on the River Dock		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory	Permanent	
Probability	Low	Medium	High
Accumulation	Non-cumulative	Cumulative	

Impact Discussion

Throughout the entirety of the construction phase, impacts will be generated use of the River Dock to import materials necessary for the construction of the Project, as well as the transportation of materials, equipment, machinery, and personnel.

Moreover, the project is expected to generate potential disturbances for people using the river dock, both for commercial purposes, such as transporting materials, and for the transport of passengers.

These disturbances may include temporary inconvenience and potential grievances due to noise, dust, restricted access, and construction-related activities.

It is crucial to engage with the local community proactively to address their concerns and mitigate adverse impacts through effective communication and management strategies.

These identified impacts are considered negative, of medium magnitude, high probability, and of a transitory nature, affecting the project's direct area of influence.

Mitigation Measures

- Implement a **community information and participation program** in the Social Management Plan (SMP), which provides information to neighbors about the works duration, scheduling and mitigation measures of risks and impacts produced by the works. The program must consider the necessarily communication to be engaged with the Barbuda Express Ferry authorities.

- **Program to mitigate impacts to economic activities** will be necessary to coordinate activities related to the commercial uses of the port.

Residual Impact

The residual impact is expected to result in low negative impact.

6.2.1.3. Interferences with Utilities (water, energy)

Impact Assessment

Impact Description	Interferences with main utilities (water or energy)		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory	Permanent	
Probability	Low	Medium	High
Accumulation	Non-cumulative	Cumulative	

Impact Discussion

Throughout the entire construction phase, activities such as transportation of materials and machinery through narrow access roads, site clearing, excavations, earthworks, and pipeline laying, among others, could cause interference with pre-existing service networks located in the intervention area, electricity. Given the nature of the work, no significant impacts on main utilities are expected.

This impact is negative, localized in the Influence Area, of low magnitude, low probability and of a transient nature (occurring only during the construction). It also exhibits cumulative characteristics: the incremental effect of this impact on services may be enhanced by concurrent activities associated with the Project.

Mitigation Measures

- Establish a **Coordination Program with Service Providers** within the Social Management Plan: Develop program to effectively collaborate with service providers. This program should focus on managing and mitigating the impacts of the project, ensuring seamless communication and cooperation to minimize disruptions and maintain essential services throughout the construction phase.

Residual Impact

The residual impact remains low.

6.2.1.4. Occupational and Community Safety

Impact Assessment

Impact Description	Risk of accidents (occupational and community safety)		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory	Permanent	
Probability	Low	Medium	High
Accumulation	Non-cumulative	Cumulative	

Impact Discussion

The execution of the project activities carries inherent risks, primarily of an occupational nature. These risks are attributed to the high-risk nature of various construction activities, encompassing excavations (with the potential for cave-ins and entrapment, especially with the characteristics of calcareous soils and the probability of sinkholes), electrical work, accidents involving heavy machinery welding, and hot work operations, as well as ergonomic hazards.

Additionally, there is a community risk because the residential area of both routes.

This impact is classified as negative, of high, and of a transitory nature (occurring during the work execution phase).

Mitigation Measures

- Implement an **Occupational Health and Safety Program** within the SMP that aligns with current national and local regulations and incorporates elements from globally recognized occupational health and safety management systems (such as ISO 45001:2018).
- Develop a **Socio-Environmental Training Program** for on-site personnel, encompassing comprehensive training on personal protective equipment, work-related risks, contingency planning, safe handling of chemical substances, and related subjects.
- Establish a **Road Traffic and pedestrian Management Program**, aimed at proactively preventing road accidents involving personnel and construction vehicles through measures such as safe driving practices and proper signage at work sites and detours.

Residual Impact

As a result of the effective implementation of the proposed mitigation measures, the residual impact associated with occupational safety is reduced to low magnitude.

6.2.1.5. Economic Development

Impact Assessment

Impact Description	Impacts on employment, business, and services		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory	Permanent	
Probability	Low	Medium	High
Accumulation	Non-cumulative	Cumulative	

Impact Discussion

The activities foreseen in the construction phase will require labor – skilled and unskilled – and acquisition of construction materials and construction-related services. This will have a positive impact on employment generation, and on the dynamization of the activity of trade in goods and services.

In particular, the sectors that will benefit include those related to the sale of construction inputs and materials, equipment, vehicles, machinery, spare parts and accessories, mechanical services, fuel, logistics, and food, among others.

These impacts are considered positive of low magnitude, of a transitory nature, and geographically distributed in the indirect influence area of the project.

Mitigation Measures

No measures were identified for this impact.

Residual Impact

The residual impact of the area revitalization by the action of the Project implementation remains positive.

6.2.1.6. Impacts on Economic Activities in the Operational Area

Impact Assessment

Impact Description	Impacts on economic activities settled in the operational area (Sand mining, construction activities, fishermen activities)		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory	Permanent	
Probability	Low	Medium	High
Accumulation	Non-cumulative	Cumulative	

Impact Discussion

The risk of economic displacement for business owners in the affected areas, as well as disruptions to livelihoods for informal workers, was identified due to the construction activities.

The project will be implemented in an area currently used for sand mining and construction activities, necessitating the relocation of these operations to another location.

Additionally, there is a possibility that fishermen who currently dock their boats in the coastal area where the project will take place may need to relocate to a different site. As will be detailed in the following section, it is proposed that the fishermen dock their boats on the opposite side of the river dock.

Moreover, the project is expected to cause potential disturbances for people using the river dock, both for commercial activities, such as transporting materials, and for passenger transport.

It is crucial to proactively engage with the specifically affected individuals to address their concerns and mitigate adverse impacts through effective communication and management strategies.

These identified impacts are considered negative, of high magnitude, and of a permanent nature, affecting the project's direct area of influence.

Mitigation Measures

- Implement a **Program to Mitigate Economic Impacts**: Develop and implement a program aimed at minimizing disruptions to economic activities within the operational area. This program should include tailored support measures to assist affected businesses and individuals in maintaining their livelihoods throughout the project.

- Develop a **Fishermen Livelihood Restoration Pla**n: Create a comprehensive plan specifically designed to restore and protect the livelihoods of fishermen. This plan should ensure that fishing activities and the overall well-being of the community are not adversely affected by the project.

- Establish **a Community Information and Participation Plan**: Implement a plan to ensure ongoing and transparent communication with the community, especially those directly affected by the project. This plan should facilitate active participation and keep the community informed throughout all phases of construction, addressing concerns and providing updates regularly.

- Create an Effective **Grievance Mechanism:** Establish a clear and accessible grievance mechanism that allows community members to raise concerns or complaints related to the project. Ensure that this mechanism is efficient, transparent, and provides timely and accurate responses to grievances, fostering trust and accountability between the project's owners and the community.

Residual Impact

The residual impact is expected to result in low negative impact.

6.2.1.7. Impacts on the Cultural and Archaeological Heritage

Impact Assessment

Impact Description	Negative impacts on cultural and archaeological heritage		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory		Permanent
Probability	Low	Medium	High
Accumulation	Non-cumulative		Cumulative

Impact Discussion

Martello tower is a major historical landmark and tourist attraction. While the developer has indicated the intention to ensure that the site remains accessible, the fact that the Martello Tower is located within the property creates issues of ownership, responsibility and liability. The Martello Tower faces potential risks during the construction phase.

These risks include accidental damage from heavy machinery, alterations to the visual integrity of these historical sites, and disturbances from increased noise and vibrations.

However, given the nature of the project, no work of significant magnitude is expected to damage these sites.

This risk is assessed as negative, of low magnitude, irreversible (permanent).

Mitigation Measures

- Develop and execute a comprehensive **cultural heritage preservation plan** to ensure the protection of historical landmarks during both the construction and operational phases. This plan should pay special attention to the Martello Tower, ensuring it remains unaffected during construction and that its use is carefully coordinated during the operational phase to preserve its historical value.

- Integrate an **archeological/paleontological contingency plan** within the Social Management Plan. This procedure should ensure that any discoveries with potential archaeological value are managed appropriately, preserving cultural heritage while maintaining project progress.

Residual Impact

The residual risk of negative impacts on the archaeological heritage remains low.

6.2.1.8. Landscape and Public Space

Impact Assessment

Impact Description	Visual and landscape impact		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory	Permanent	
Probability	Low	Medium	High
Accumulation	Non-cumulative	Cumulative	

Impact Discussion

The construction activities, including the presence of work camps, fences, construction machinery, and excavation, negatively impact the perception of the landscape (visual alteration), particularly as Route 1 and the river dock area serve as the main access points to Codrington, as well as to hotels, restaurants, and beaches.

Additionally, Barbuda operates under a communal property system, and all beaches within Antigua and Barbuda are public and must remain accessible to the public. The lease agreement for this development upholds this legal right by requiring the developer to ensure suitable public access to all beach areas. This reduces the risk of restricting public spaces for local residents.

This impact is valued as medium, negative, and transitory.

Mitigation Measures

- Ensure the necessary means are in place so that, concerning work organization and especially in the construction site and storage areas, there are no potential impacts on the aesthetic quality of the landscape (for example, continuously removing construction waste and debris).
- Install systems for the disposal and containment of construction waste, adequately protecting them to prevent dispersal by wind, thus avoiding environmental impact and landscape alteration.
- Implementation of visual barriers.
- Establish measures to minimize the blockage of access to housing, businesses, public facilities during construction.

Residual Impact

The residual impact is expected to be low.

6.2.2. Impacts - Operational Phase

6.2.2.1. Road and Traffic Impacts

Impact Assessment

Impact Description	Positive impacts on the use of the roads		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory	Permanent	
Probability	Low	Medium	High
Accumulation	Non-cumulative	Cumulative	

Impact Discussion

Throughout the operational phase, benefits are expected in the condition of the road and current traffic due to the construction of a new access road that will benefit the project as well as the community of Codrington by improving access from the river dock to Route 1, which leads to the town center of the island.

This impact is valued as medium magnitude, positive nature, and local scope, permanent duration and high probability.

Mitigation Measures

- Implement an **Information and Community Participation Program**

Residual Impact

The residual impact is expected to result in medium positive impact.

6.2.2.2. Occupational and Community Safety

Impact Assessment

Impact description	Risk of accidents in maintenance tasks		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory		Permanent
Probability	Low	Medium	High
Accumulation	Non-cumulative		Cumulative

Impact Discussion

It can be anticipated that maintenance activities involve a risk and probability of accidents, both occupational (due to the maintenance tasks themselves) and traffic-related (due to the circulation of vehicles and machinery assigned to these tasks).

During the execution of these tasks, accidents or risks to the community can also occur, affecting residents, neighbors, and pedestrians who need to navigate through these road areas, particularly if there are deficiencies in signage, reduced road widths, and machinery or materials obstructing passage in the area.

Based on this, the impact is classified as negative, occurring in the direct area of influence, of medium magnitude, and permanent.

Mitigation Measures

- Reinforce signage and occupational health and safety measures in the project.
- Establish an **Occupational Health and Safety Program** in the **Social Management Plan** for the operational phase, which complies with the requirements of current national and local regulations and is nourished by elements of internationally recognized occupational health and safety management systems (such as ISO 45001: 2018).
- Establish a **Contingency Plan** in the operational phase, which ensures the response to medical emergencies, as well as weather-related emergencies (tropical storms).
- Establish a **Road Safety and Traffic Management Program** in the operational phase, aimed at preventing road accidents involving construction personnel or vehicles, through measures such as sage driving practices, proper site signage, detours, etc.

Residual Impact

As a result of the proper implementation of the proposed mitigation measures, the residual impact associated with occupational safety is considered of low magnitude.

6.2.2.3. Impacts on Landscape and Public Spaces

Impact Assessment

Impact Description	Visual and landscape impact		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory		Permanent
Probability	Low	Medium	High
Accumulation	Non-cumulative		Cumulative

Impact Discussion

During the operation phase, the projected infrastructure will significantly improve the area, both functionally and visually. The implementation of the project not only provides aesthetically pleasing landscapes but also contributes to the sustainability of the island environment.

This impact is valued as high, positive, and permanent.

Mitigation Measures
No mitigation measures are identified for this impact.

6.2.2.4. Economic development

Impact Assessment

Impact Description	Impacts on employment, business, and services		
Impact Nature	Negative	Positive	Neutral
Magnitude	Low	Medium	High
Scope	Restricted (OA)	Direct Area of Influence	Local (IAoI)
Duration	Transitory		Permanent
Probability	Low	Medium	High
Accumulation	Non-cumulative		Cumulative

Impact Discussion

The operation of the hotel will generate jobs for the local population, ranging from management positions to service and maintenance roles. This will contribute to reducing unemployment and improving the standard of living for residents.

Furthermore, the hotel will attract both tourists, leading to increased visitor numbers on the island. This influx of tourists will boost the local economy through spending on accommodation, dining, tours, and other leisure activities.

Finally, the presence of the hotel will create demand for local products and services, such as food supplies, arts and crafts, transportation, and entertainment. This will provide a steady income stream for local entrepreneurs and small businesses.

These impacts are considered positive of medium magnitude, of a permanent nature, and geographically distributed in the indirect influence area of the project.

Mitigation Measures

No mitigation measures are identified for this impact.

6.3. Summary of social impact assessment and programs proposed

Table 16 Summary of social impacts and mitigation measures proposed- Construction phase.

Impacts	Mitigation Measures Proposed
Road and Traffic Impacts	Programs 1, 3 and 4 of the SMP
Impacts on the River Dock	Programs 1, 4, 11 of the SMP
Interferences with main utilities (water or energy)	Programs 1, 6 of the SMP
Risk of accidents (occupational and community safety)	Programs 1, 2, 3 of the SMP
Impacts on employment, business, and services	Programs 1, 4, 5 of the SMP
Impacts on economic activities settled in the operational area (Sand mining, construction activities, fishermen activities)	Programs 1, 4, 5, 11, 12. of the SMP
Negative impacts on cultural and archaeological heritage	Programs 1, 8, 9 of the SMP
Visual and landscape impact	Programs 1, 4, 5 of the SMP

7. SOCIAL MANAGEMENT PLAN (SMP)

The Social Management Plan (SMP) is a tool that guides the environmental and social management of the construction works under the Murbee Resort Project.

This Plan will guide the Contractor Firm and its subcontractors, as well as the Supervision Firm, in the correct environmental and social management of the works, by outlining necessary environmental and social mitigation measures during the implementation stages of each project.

Mitigation measures were grouped into two different SMPs, each one targeting different phases of the project:

- **Construction SMP**: aimed at mitigating the impacts and risks of construction activities.
- **Operational SMP:** aimed at mitigating the negative impacts and risks of the operational stage (regular operation and maintenance of the resort infrastructure).

7.1. Construction Social Management Plan

This SMP presents the minimum environmental and social guidelines that must be implemented during the construction activities of the project's infrastructure. The table below presents the programs to be included on the ESMP.

Table 17 SMP Programs of the construction phase.

Program Number	Program
1	Monitoring and Control of Compliance with Mitigation Measures
2	Occupational and Community Health and Safety
3	Traffic and Pedestrian Management
4	Community Information and Participation
5	Grievance Redress Mechanism
6	Coordination with Service Providers. Interferences
7	Socio-environmental Training Program
8	Cultural heritage preservation Plan
9	Archeological Contingency Plan
10	Gender Plan
11	Program to mitigate impacts to economic activities
12	Fishermen livelihood restoration plan

Below, the guidelines for each of the Construction SMP programs are presented.

7.1.1. Program 1: Monitoring and Control of Compliance with Mitigation Measures

Program 1: Monitoring and Control of Compliance with Mitigation Measures	
Social effects to be prevented or corrected:	Deviations in implementation of mitigation measures
Management Measures	
To ensure effective oversight of compliance with the identified mitigation measures, the contractor will establish and maintain a comprehensive "compliance monitoring system." This system will serve as a mean to oversee the implementation of each mitigation measure during the construction stage. The compliance monitoring system will include, but is not limited to, the following elements. • **Actions to be Implemented**: A detailed description of specific actions and steps to be taken to execute each mitigation measure. • **Necessary Material Resources**: An inventory of the materials, equipment, and resources required to conduct mitigation measures effectively. • **Responsible Staff**: Identification of personnel responsible for execution and supervision of each mitigation measure, including their roles and responsibilities. • **Indicators of Compliance**: Establishment of clear and measurable indicators that will be used to assess the degree of compliance with each mitigation measure. • **Goals and Frequency of Monitoring**: Defined objectives for achieving compliance, along with the frequency and methodology for monitoring progress towards these goals. This structured compliance monitoring system will ensure that the construction project adheres to the established mitigation measures and operates in a manner that minimizes potential social impacts.	
Monitoring and Compliance	
Indicators • Number of non-conformities identified. • Number of non-conformities closed on time.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.2. Program 2: Occupational and Community Health and Safety

Program 2: Occupational and Community Health and Safety	
Social effects to be prevented or corrected:	Accidents and incidents that affect occupational and community health and safety.

Management Measures

The contractor shall regularly ensure compliance with relevant standards and regulations, including international best practices (such as the International Finance Corporation guidelines). This will involve retaining a team of professional advisors.

All personnel are required to receive training on equipment operation, machinery use, and vehicle operation in accordance with prevailing regulations within protected areas.

Clear and permanent identification of all available elements must be conducted, alongside the use of signage and instructional materials for educational purposes.

The contractor must supply Personal Protective Equipment (PPE) and provide comprehensive induction training to workers, covering PPE types, proper usage, characteristics, and limitations.

Occupational Health and Safety Subprogram
A comprehensive assessment of risk factors associated with each job role, including an enumeration of the workforce exposed to these risks, must be conducted. The following measures are **recommended** to enhance workplace safety:

- Conduct **Daily 5-Minute Safety Talks** before commencing work. Topics should be tailored to the specific risks associated with ongoing activities.
- Develop and implement **Safe Work Procedures** for the safe execution of activities. Emphasize adherence to established safety protocols.
- Regularly **inspect and ensure the proper functioning of equipment, machinery**, and essential safety apparatus such as fire extinguishers.
- Apply **Safety Data Sheets** for hazardous products, ensuring that relevant information is readily accessible to workers.
- Provide necessary **Personal Protective Equipment** (PPE) to all workers on the construction site in accordance with the specific requirements of their tasks.
- **Demarcate work** areas and storage zones using appropriate signaling in order to promote awareness and help prevent accidents.
- Develop a comprehensive **Contingency Plan** and ensure that all workers are proficiently trained in its implementation to address unforeseen circumstances.
- Conduct proper **Waste Management** by exercising control over the collection, treatment, and disposal of residues and waste, while adhering to basic sanitation standards.
- Verify that personnel operating equipment possess the necessary **licenses and certifications**.
- **Training in Environmental, Health, Hygiene, and Occupational Safety.**

Community Health and Safety Subprogram
This subprogram is designed to address potential risks and impacts on the health and safety of communities affected by the project. The Contractor is required to conduct a comprehensive evaluation of the project's potential effects on the health and safety of the affected communities, with specific attention to individuals facing vulnerability due to their unique circumstances, such as children. Subsequently, the Contractor is expected to propose mitigation measures in strict adherence to the mitigation hierarchy. The assessment will encompass the following key aspects:

- Thorough evaluation of the impact on **traffic and road safety**, with the aim of minimizing any adverse effects on the community.
- Implementation of clear and effective **signaling** and delineation measures at work sites to enhance safety and minimize potential hazards.
- Rigorous management and safety protocols for handling **hazardous materials** to prevent any harm to the health and safety of the affected communities.
- Examination of the project's **impact on natural habitats** and the potential risks and adverse effects on the health and safety of the affected communities.
- Development and implementation of a comprehensive **emergency preparedness and response plan**, ensuring swift and effective actions in the event of unforeseen circumstances.

The Contractor is expected to integrate these measures into the project's execution, reflecting a commitment to responsible and conscientious project management.

Labor Management Procedure Subprogram
The contractor is required to formulate a comprehensive Labor Management Procedure designed to articulate a structured framework governing the actions and responsibilities of both the employer and the workforce. This protocol is applicable to individuals employed directly by the contractor and extends to personnel engaged through third-party entities (sub-contractors).

The primary objective is to establish and maintain employment relationships grounded in the principles of equal opportunities and equitable treatment. The employment of child or forced labor is strictly prohibited. The contractor, along with its subcontractors, is expressly prohibited from engaging individuals below the minimum age of employment as prescribed by relevant legal statutes, with a minimum threshold of no less than 15 years of age.

The Procedure will include the creation of a **grievance redress mechanism**. This mechanism is designed to provide a channel through which workers, and where applicable, their affiliated organizations, can voice concerns related to the workplace. Additionally, it serves as a platform for the lodging of complaints pertaining to instances of sexual and gender-based violence. The contractor is tasked with ensuring the effectiveness and accessibility of this grievance redress mechanism to facilitate a transparent and responsive resolution process.

The Contractor shall prioritize the hiring of local labor, both skilled and unskilled, for the execution of the work.

Program 2: Occupational and Community Health and Safety	

Protection of Community Critical Infrastructure
For all works, the following measures will be implemented to protect sensitive receptors in the area of works (such as hospitals, schools or residents).
 	
• **Identification and Mapping:** Clearly identify and map all sensitive receptors in the project area, including hospitals, schools, and residences.
 	
• **Communication and Notification:**
  ○ Inform affected communities and institutions about the project timeline, potential impacts, and planned mitigation measures.
  ○ Provide regular updates through community meetings, flyers, and digital platforms.
 	
• **Noise and Vibration Control:**
  ○ When applicable, implement noise barriers and schedule noisy activities during less sensitive times (e.g., avoiding school hours and hospital visiting hours).
  ○ Use low-vibration equipment and techniques to minimize disturbances.
 	
• **Dust and Air Quality Management:**
  ○ Employ dust suppression measures such as water spraying and covering of materials.
 	
• **Traffic and Access Management:**
  ○ Develop traffic management plans to ensure safe and uninterrupted access to sensitive receptors.
  ○ Coordinate with local authorities to manage traffic flow and minimize congestion.
 	
• **Emergency Response Planning:**
  ○ Establish emergency response protocols.
  ○ Ensure clear access routes for emergency vehicles at all times.	

Monitoring and Compliance	
Indicators • Number of OH&S non-compliances identified. • Number of OH&S non-compliances closed on time.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.3. Program 3: Traffic and Pedestrian Management

Program 3: Traffic and Pedestrian Management	
Social effects to be prevented or corrected:	Accidents and incidents that affect occupational and community health and safety
Management Measures	
The Master Contractors will prepare the Traffic and Pedestrian Management Program. Consultation with key stakeholders will be conducted prior to Program finalization. The Contractors will ensure implementation of this Program. The Traffic and Pedestrian Management Program shall: • Identify the sensitive location along the roads. • Identify the road conditions, traffic congestion areas and peak traffic load period. • Identify the traffic hotspots like road junctions, market areas, school areas. • Identify any major road repairing requirement along the site access road. • Prepare the Traffic and Pedestrian Management Program based on local sensitivity (religious gathering, market timing, ferry timing and peak traffic timings). • Implement procedure to follow road safety requirements by the drivers & helpers. • Monitor road conditions to identify any damage of road or structures and remedy immediately to reduce the potential for significant impacts to the local communities. Contractors will provide instructions to drivers to maintain the speed as per Traffic and Pedestrian Management Program. Contractors will provide induction/training to all drivers for safe driving. Contractors will require drivers to follow all legal and project related safety requirements applicable in respect of road safety.	
Monitoring and Compliance	
Indicators • Number of work sites marked with signs in accordance with the approved Traffic and Pedestrian Management Program / Number of work sites that require signage in accordance with Traffic and Pedestrian Management Program. • Number of road accidents. **Monitoring** • Inspection program • Road safety accident records	
Responsible for the measure implementation	Contractor (Works Director)

7.1.4. Program 4: Community Information and Participation

Program 4: Community Information and Participation	
Social effects to be prevented or corrected:	Misinformation of the public regarding the progress and tasks of the project.
Management Measures	

The Contractor shall implement a comprehensive Community Information and Participation Program to ensure effective, transparent communication with adjacent communities and the general public throughout the project's development.

This program will establish a formal and documented communication procedure, enabling community members to provide opinions, suggestions, complaints, or claims related to the project.

The Contractor will submit a communication report outlining the strategy for the correct implementation of the Community Information and Participation Program during both the pre-construction and construction phases. This report will detail the content to be communicated, communication channels, frequency, and a detailed schedule of activities. The report will consider the social baseline.

Key aspects of the Community Information and Participation Program include:

- **Community Involvement:** Encourage active participation from the community in identifying and evaluating alternative solutions to detected issues. Ensure access to all project-related documentation, including the Environmental and Social Impact Assessment (ESIA), Environmental and Social Action Plan (ESAP), and Social and Environmental Management Plan (SEMP). These documents will be made available in public locations and during accessible hours.

- **Equal Access to Information:** Information will be presented in a manner that ensures equal access for all interested social sectors, with a strong emphasis on promoting gender equity. The Contractor will ensure that communication methods and materials are accessible and inclusive.

- **Advance Notifications:** Provide timely advance notifications to authorities, neighbors, businesses, and organizations located near the project site. This will include information on upcoming actions that could impact surrounding activities. Any potential conflicts with third-party activities will also be communicated in advance to the relevant authorities or affected parties.

- **Public Signage:** Install signage at each work front displaying key project information, including the project name, client name, contractor name, and contact details for inquiries and complaints. Signage will also be placed along routes used by heavy vehicles involved in the project to inform the public.

- **Public Outreach Materials:** Develop and display non-technical, easy-to-understand public outreach materials (e.g., posters or signs) at the project site to inform the community about the work.

Program 4: Community Information and Participation	
• **Project Reporting:** Maintain timely and updated records on project implementation and progress. Promptly address queries, complaints, and claims from the Works Inspection and the community, while proactively identifying and implementing solutions to identified issues.	
Monitoring and Compliance	
Indicators • Percentage of complaints managed properly during the month according to the defined mechanism over the total number of complaints generated. • Percentage of public consultations conducted over the total number of public consultations required.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.5. Program 5: Grievance Redress Mechanism

Program 5: Grievance Redress Mechanism	
Social effects to be prevented or corrected:	Concerns from the workers and the community not managed

Management Measures

The Contractor will implement a comprehensive Grievance Redress Mechanism (GRM) to address concerns, claims, complaints, and suggestions from both workers and the community during the project. This GRM will outline clear and accessible processes for receiving, evaluating, and resolving grievances in a timely and efficient manner.

Key channels for submitting grievances include:

- **Contractor Offices:** Workers and community members can submit their concerns directly at the designated contractor offices.
- **Suggestion Box/Complaints Book:** Available at the worksite for the submission of feedback.
- **Dedicated Telephone Line and Email Address:** These will be created specifically for receiving complaints and inquiries related to the project.
- **Municipal Offices:** Complaints can also be submitted through local municipal offices.

The Contractor will be responsible for receiving, systematizing, processing, and responding to complaints arising during the construction phase. If a complaint cannot be resolved at the contractor level, it will be referred to the Supervision for further analysis and resolution. In cases where grievances cannot be resolved within the project's mechanisms, the affected parties may seek recourse through administrative offices, the Ombudsman, or the judicial system.

The GRM will adhere to the following key guidelines:

- **Proportionality:** The mechanism will consider the level of risk and potential negative impacts on the affected areas in a proportionate manner.
- **Culturally Appropriate:** The process will consider local customs and cultural practices to ensure it is contextually relevant.
- **Accessibility:** The GRM will be designed in a clear and simple manner to ensure that it is understandable and accessible to all individuals, with no associated costs.
- **Anonymity:** Complainants may submit anonymous grievances if desired, provided anonymity does not interfere with resolving the issue.
- **Confidentiality:** Confidential grievances will be managed with discretion, with information shared only when necessary to coordinate with authorities.
- **Transparency:** The GRM will be transparent and predictable, ensuring that all parties understand how to use the mechanism and what to expect during the resolution process.

The process begins with the submission of a grievance (either orally or in writing) and concludes with the resolution and agreement between the complainant and the project. The entire process will be documented through a grievance log, which will be maintained in both physical and digital formats. This log will include details such as:

- The date the grievance was received.
- The person responsible for managing the grievance.
- Information on corrective actions proposed or taken.
- The date the grievance was closed.
- The date the complainant was informed of the resolution.

Program 5: Grievance Redress Mechanism	
The timeline for responding to grievances will be proportional to the severity of the issue: • **Low-importance claims:** Resolved within a maximum of 30 calendar days. • **Medium-importance claims:** Resolved within 15 calendar days. • **High-importance claims:** Resolved within 7 calendar days. These deadlines may be adjusted as needed by the project oversight team. After a complaint has been addressed, the situation must be monitored for a reasonable period, typically six months, to ensure that the issue has been effectively resolved. The GRM will be dynamic, with procedures and processes refined and strengthened throughout the project's life cycle to ensure it remains responsive to the needs of all stakeholders.	
Monitoring and Compliance	
Indicators • Percentage of complaints managed properly during the month according to the defined mechanism over the total number of complaints generated.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.6. Program 6: Coordination with Service Providers Interferences

Program 6: Coordination with Service Providers interferences	
Social effects to be prevented or corrected:	Disruption of services due to breakages during construction activities.
Management Measures	
The Contractor will establish coordination with utility service providers to address the interferences that the execution of the Work will cause with existing infrastructure. To comply with this, and with the agreement of the Supervision, they will plan and propose the most appropriate solution and reach consensus with the respective company responsible for executing it, minimizing inconvenience to users. Additionally, actions will be scheduled so that the Contractor promptly resolves any unforeseen interference that may jeopardize service provision. From the outset of the project, the Contractor will manage the appropriate permits, coordinating with the technical teams of the service providers. The Contractor shall inventory existing public utility networks in accordance with the contract specifications and plans to identify and locate lines that may be affected. Each utility company shall appoint a coordinator to attend project oversight committees, ensuring cordial management of all expansion, repair, or replacement work within the project intervention area. If removal or relocation of structures is required, the Contractor shall first locate the axes of different public utility lines within the intervention area, as indicated by the project design plans and information provided by the utility companies. Simultaneously, approval of the plans by the respective utility companies shall be obtained. In the case of interventions on bus routes, diagram tasks so as not to interrupt the usual service. If this is not possible, establish alternative routes that generate the least possible impact on users.	
Monitoring and Compliance	
Indicators • Number of network service interruptions caused by construction activities with interferences / Number of network service interruptions caused by construction activities with interferences coordinated with network service providers.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.7. Program 7: Socio-environmental Training Program

Program 7: Socio-environmental Training Program	
Social effects to be prevented or corrected:	Lack of knowledge regarding the personnel's role in preserving, protecting, and conserving the environment, as well as ensuring occupational safety in the performance of their duties

Management Measures

Socio-Environmental Training

To conduct the training process, informative sessions will be conducted prior to the commencement of work. Subsequently, ongoing exchange and training meetings will be organized, tailoring content to meet the specific requirements of diverse projects with environmental implications. Additionally, drills addressing emergency response protocols will be conducted.

The planning and execution of these training sessions will be conducted under the oversight of safety, hygiene, and environmental professionals employed by the contractor. The training program encompasses a comprehensive agenda, including, but not limited to, the following topics:

- Basic induction in environmental protection.
- Evaluation and control of risks with a focus on personnel safety.
- Management of environmental contingencies such as spills and fires.
- Fire prevention and control measures.
- Comprehensive waste management procedures.
- Protection and management of plant species in the immediate environment.
- Safe handling of chemical substances.
- Familiarization with the company's Code of Conduct and addressing gender-related issues.
- Protected Areas and Threatened Species
- Flora and Fauna Protection
- Soil, Air, and Water Pollution
- Waste Management
- Environmental Incidents
- Spill Response
- Archaeological, Cultural, and Paleontological Resources, and Procedures for Chance Finds
- Communication and Community Engagement
- Contingency Program
- Code of Conduct
- Gender Equity
- Health, Hygiene, and Safety
- First Aid
- Use and Conservation of Personal Protective Equipment (PPE)
- Basic Environmental Protection Induction

Program 7: Socio-environmental Training Program	
• Risk Evaluation and Control with a Focus on Personnel Safety • Management of Environmental Contingencies (Spills and Fires) • Fire Prevention and Control Measures • Comprehensive Waste Management Procedures • Safe Handling of Chemical Substances The implementation of this program will ensure a thorough understanding of essential environmental and safety protocols, contributing to the effective management of potential risks and emergencies. **Code of Conduct** The Contractor is required to develop and implement a comprehensive Code of Conduct for Site Personnel. This code shall be incorporated into employment contracts for both the Contractor and Subcontractors, adhering to the guidelines outlined in the Labour Management Procedure and the contractors will conduct a training of workers on the code of conduct. To mitigate the risk of gender, social, political, cultural, or racial conflicts, and to maintain order, the Contractor must take necessary measures and precautions. This includes preventing tumult or disorder among construction personnel, employees hired by them, or Subcontractors, while ensuring the preservation of order, protection of inhabitants, and the security of public and private property within the project's area of influence. The Code expressly prohibits harassment, violence, exploitation, and racism. Its application is mandatory for all individuals involved in the project, both during and outside of working hours. Non-compliance or infringement of the established rules of conduct will result in sanctions, fines, or dismissals, depending on the severity of the violation. All construction personnel, irrespective of their hierarchical level, are required to participate in training sessions and discussions related to the Code. Furthermore, the Contractor is obligated to conduct a minimum of two activities addressing non-discrimination and gender equity for all personnel affected by the project. These activities will focus on 1) the prevention of sexual exploitation of children and adolescents, including labor and criminal consequences; and 2) fostering positive relationships between men and women in the workplace. Prior to these activities, the Contractor must submit an Action Plan for approval by the Construction Management. This plan should outline the responsible parties for implementation, the methodology, and the schedule. Upon completion, a comprehensive evaluation report must be submitted.	
Monitoring and Compliance	
Indicators • Percentage of personnel trained in accordance with the Training Program. • Percentage of training sessions delivered of the total training sessions required according to the Training Program.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.8. Program 8: Cultural Heritage Preservation Plan

Program 8: : Cultural Heritage Preservation Plan	
Social effects to be prevented or corrected:	Negative impacts on Cultural Heritage caused by project actions.
Management Measures	

The Contractor must ensure compliance with local, national, and international legislation regarding the conservation of cultural heritage in the project area. Protective measures will be applied to safeguard historical elements (monuments, worship sites, etc.) that are located near the area and access routes, to preserve cultural heritage potentially impacted by the movement of machinery and equipment.

Detailed plans must be developed to prevent, mitigate, or manage potential risks and impacts on cultural heritage, particularly for activities that could affect the sacred value or tranquility of culturally significant sites, including the Martello Tower.

If additional historical or cultural artifacts are discovered on-site during e.g., groundwork, the Contractor must notify the relevant authorities to facilitate their relocation under a properly planned process that ensures all necessary precautions (see Program 9, Archeological Contingency Plan).

Should religiously shrines, images, or other cultural elements be located near or within the operation zone, the Contractor will implement approved protection measures to prevent any damage. If relocation is unavoidable, the Contractor will develop and execute the necessary actions, including prior consultation and communication with the community, and secure approval from the inspection authorities before moving the items.

If the project's communication and outreach program identify potential impacts on cultural heritage important to local communities, the Contractor must address these concerns even if the heritage is not legally recognized or protected. Continuous access to cultural heritage sites must be maintained, or alternative access routes provided to traditional users of these sites.

During religious festivals or popular celebrations, the Contractor will avoid closing streets or routes near such events to ensure the free movement of vehicles and people.

Program 8: : Cultural Heritage Preservation Plan	

For all works under the Program, the following measures will be implemented to protect historical sites, such as Martello Tower.
 	
• **Physical Protection Measures:**
  ○ Install protective barriers around historical sites to prevent accidental damage during construction.
  ○ Restrict construction activities within a defined buffer zone around each site.
  ○ Properly document the status of the facility prior to the start of works.
• **Monitoring and Reporting:**
  ○ Regularly monitor the condition of historical sites throughout the construction process.
  ○ Document any changes or damages and report them to relevant authorities.
• **Stakeholder Engagement:**
  ○ Involve local heritage organizations and community groups in the planning and monitoring process.
  ○ Provide opportunities for stakeholders to give input on protection measures.
• **Training and Awareness:**
  ○ Train construction personnel on the importance of preserving historical sites and the specific measures in place.
  ○ Raise awareness among workers about the cultural significance of these sites.	

Monitoring and Compliance	
Indicators • Absence of fines/penalties arising from non-compliance with current regulations on heritage protection. • Absence of complaints from local residents.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.9. Program 9: Archeological Contingency Plan

Program 9: Archeological Contingency Plan	
Social effects to be prevented or corrected:	Impacts on archaeological or paleontological accidental discoveries.
Management Measures	
Prior to the commencement of vegetation clearing and earthmoving activities, a review of the physical area to be affected must be conducted to detect the presence of any paleontological or archaeological heritage remains. Reporting these findings to the relevant authorities is mandatory, and they must notify the Provincial Heritage Directorate. In the absence of any elements or minerals of interest, a written record must be made. Special attention should be paid to areas that are prone to this type of discovery. Written consultations will be made with the competent authority on the matter, analyzing the responses, and incorporating them into the reports. If, during the works, archaeological, paleontological, historical, architectural, religious, or aesthetically significant material is found, the immediate suspension of any activities that could affect these sites must be ordered. Additionally, access to the discovery zone must be restricted to unauthorized personnel. In cases of findings of interest by contractor companies, they must notify the Supervision and the appropriate authorities. The environmental and social focal point for the contractor firm is responsible for ensuring that the discovered goods are not affected, prioritizing supervision during excavation operations. Personnel must be assigned to guard the site to prevent potential looting, and the relevant authorities must be notified to assess the situation and determine the time and manner of continuing the work in that area. If technically and economically feasible, alternative work fronts must be opened, or the archaeological site bypassed, among other possible alternatives. A procedure must be developed for subcontractors and site personnel, including rules and guidelines for the proper handling of chance discoveries, and training will be provided to personnel on the subject. Protection measures must be applied, and perimeter fencing installed to delineate the discovery area to preserve its value and/or prevent possible looting. A photographic record of the discovery must be made, its location identified (georeferenced), and a written description must be provided. The maximum amount of available information must be gathered, including location, description of the situation, description of the site and materials found, photographic record, etc. The discovered items must not be moved from their original location to preserve their evidence and contextual association. The Contractor will cooperate in the transportation of the items to the site designated by the Supervision and/or the relevant heritage preservation authority.	
Monitoring and Compliance	

Program 9: Archeological Contingency Plan	
Indicators: • Absence of fines/penalties arising from non-compliance with current regulations on heritage protection. • Absence of complaints from local residents.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.10. Program 10: Gender Plan

Program 10: Gender Plan	
Social effects to be prevented or corrected:	Gender based violence
Management Measures	

The Contractor shall comply with national legislation and international agreements related to gender equity. The program will identify and assess the risks, threats, and impacts that the project may have on gender equality and on women.

A differentiated analysis will be conducted on the roles, responsibilities, needs, and opportunities of men and women within the system to better understand the role of women in the cultural context of the project.

The Contractor must implement a Gender Equity Plan and hire a gender specialist to reduce detected inequalities, promoting gender equality through the empowerment of women. The plan should include measures aimed at preventing, minimizing, or compensating for negative impacts on women. It must evaluate the roles women play in the community.

The Contractor must design its information and participation strategy for each phase of the project based on the differential conditions of men and women, considering:

- Access to information
- Barriers to public participation
- Direct and indirect project beneficiaries
- Negatively affected groups
- Who will actively participate in the project?
- Who will make decisions about the project's resources and benefits?

Gender equity training will be provided to all contracted and subcontracted personnel, including the management staff of the contractor companies. Information sessions about the project must be open to the entire population, ensuring gender equity in access to the information provided, and expressly inviting and encouraging women to apply for job opportunities generated by the project.

The Contractor must approach its recruitment process with a gender perspective, aiming to ensure equal opportunities. Additionally, personnel with criminal records related to sexual offenses, harassment, prostitution, or human trafficking shall not be hired to protect the integrity of the population, especially women and children.

Additionally, the Contractor is required to establish, within an agreed-upon timeframe with Construction Management, a protocol addressing sexual harassment constitutes sexual exploitation and abuse (SEA) in the workplace.

Additionally, the Contractor is required to establish a protocol within an agreed timeframe with Construction Management addressing sexual harassment, exploitation, and abuse in the workplace. Clear definitions of sexual harassment will be provided, and all personnel will be trained in identifying, preventing, and reporting such incidents.

Program 10: Gender Plan	
Regular gender-based violence prevention trainings will be conducted, and a zero-tolerance policy will be enforced to ensure a safe and respectful work environment for all workers and the community.	
Monitoring and Compliance	
Indicators • Percentage of women in the project workforce. • Percentage of gender training sessions delivered • Information with gender equity considerations disclosed. • Documentation confirming the Contractor's efforts to recruit women for the project workforce.	
Responsible for the measure implementation	Contractor (Works Director)

7.1.11. Program 11: Economic Activities Program

Program 11: Economic Activities Program	
Social effects to be prevented or corrected:	Impacts on economic activities
Management Measures	
Minimize disruptions to local economic activities, particularly those related to the river dock and neighboring businesses, during the resort construction phase. The key components are the followings: **Detailed Impact Assessment**: Identify all businesses potentially impacted, directly or indirectly, by the project, including those near the river dock and estimate potential economic losses for each affected business, considering factors like revenue decline, increased costs, and customer loss. **Strategic Communication Plan**: Establish a two-way communication channel with all stakeholders, including business owners, employees, business associations, and local authorities. Provide detailed information about the project, potential impacts, and mitigation measures. **River Dock Management**: Minimize disruptions to the river dock's operations, including cargo and passenger ferry services: • Conduct a detailed analysis of current dock operations, including cargo types, vessel schedules, peak usage periods, and potential bottlenecks. • Identify key stakeholders who utilize the dock (e.g., fishermen, local businesses, tourists) and their specific needs. Conduct a thorough study of current dock operations, identifying goods and passenger flows, peak hours, and critical points and develop a detailed plan to minimize disruptions to the river dock's operations, including cargo and passenger ferry services. • **Coordinate construction activities** to minimize simultaneous impacts on multiple areas of the dock. • **Provide temporary storage areas for construction materials away from active dock areas** to minimize interference with operations. • **Provide regular updates to dock users**, local businesses, and government agencies regarding construction progress and its impact on dock operations. • **Develop a comprehensive emergency response plan** to address any unforeseen incidents that may occur during construction. • If necessary, install temporary infrastructure such as additional lighting, signage, or fencing to improve safety and visibility.	
Monitoring and Compliance	

Program 11: Economic Activities Program	
Indicators • Percentage of affected businesses reporting minimal disruption • Compliance with legal and regulatory requirements guaranteed. • Number of grievances for river dock related activities	
Responsible for the measure implementation	Contractor (Works Director)

7.1.12. Program 12: Fishermen Livelihood Restoration Plan

Program 12: Fishermen Livelihood Restoration Plan	
Social effects to be prevented or corrected:	Impacts on fishermen activities
Management Measures	

The aim of this Livelihood Restoration Plan is to mitigate the adverse effects of the project on the local fishermen in Barbuda, ensuring minimal disruption to their fishing activities. The plan focuses on relocating docking activities to the east side of the port while implementing measures to enhance the fishermen's livelihoods and promote sustainability.

Key Components:

1. **Relocation Assistance:** To reduce disruptions to fishing operations, the project will identify a suitable relocation site on the east side of the port for docking. This new site will be designed to meet safety and operational standards, considering factors such as water depth, proximity to fishing grounds, and accessibility for local fishermen.
2. **Engagement with Fishermen:** Fishermen will be actively involved in the decision-making process regarding the relocation of docking areas. This participatory approach will ensure that the needs and concerns of the fishermen are addressed, fostering a sense of ownership over the new docking area and promoting cooperation throughout the transition.
3. **Training and Capacity Building:** To adapt to the new circumstances and promote sustainable fishing practices, training programs will be offered to the fishermen. These programs will cover sustainable fishing techniques, advanced technologies, and business management skills, allowing fishermen to enhance their productivity and income generation. Access to new markets will also be facilitated.
4. **Monitoring and Evaluation:** A comprehensive monitoring system will be established to track the health of fish stocks, assess environmental impacts, and evaluate the effectiveness of the relocation measures. Continuous assessment will allow for necessary adjustments to the restoration plan to ensure long-term sustainability.
5. **Community Involvement and Co-Management:** The fishermen's organization, which plays a significant role in coordinating fishing activities in Barbuda, will be a key partner in implementing this plan. The organization will participate in the public consultation process and contribute to the management of the new docking area, ensuring that their interests are protected and promoting long-term sustainability.

Monitoring and Compliance

Indicators:

- Percentage of fishermen using the new docking site
- Percentage of formal complaints or grievances lodged by fishermen regarding the relocation that area resolved within a specified period of time.
- Percentage of fishermen who complete the offered training programs on sustainable fishing practices.

Responsible for the measure implementation	Contractor (Works Director)

8. STAKEHOLDER ENGAGEMENT PLAN

8.1. Introduction

This Stakeholder Engagement Plan (SEP) was developed to describe the socialization process of the Murbee Resort Project.

This Plan sets out the general principles of participation and a collaborative strategy to identify stakeholders and plan a participatory process, which was conducted in the field mission on August 26th to August 30th, 2024.

It serves as a social management mechanism allowing active participation from the population, social organizations' representatives, and public institutions in the project's development. This is facilitated through appropriately scheduled participatory mechanisms, fostering constructive dialogue between stakeholders and the project proponent. The SEP serves as a tool to understand the perspectives and specific needs of the population in the project's area of influence and enhances the exchange, dialogue, and enrichment of technical efforts deployed for project development.

The plan's goal is to generate meaningful processes resulting in concrete actions, considering the concerns and interests of stakeholders. The SEP should be considered a living document, updated as more information becomes available, and disclosed to stakeholders whenever relevant changes are introduced.

The purpose of this process is to ensure stakeholders understand the objectives, scopes, environmental and social impacts identified in the Social Assessment, and the measures to avoid and/or mitigate them.

It also allows stakeholders to express opinions and queries, with information provided about the Grievance Redress Mechanism to address concerns throughout the project's lifecycle.

The stakeholder engagement process involves efforts to raise awareness of the project. It will target members of Barbuda civil society, institutional groups, government agencies, and the general public, with emphasis on individuals and businesses within the project's area of influence.

The process also provides the opportunity to collect information from key stakeholders on potential risks and concerns related to the project.

8.2. Objectives and Outcomes

The overall objective of the SEP is to promote the involvement of affected and interested stakeholders from the initial stages of the project cycle, and throughout its entire lifecycle. This aims to facilitate access to information about the Project for the general public, address any questions or concerns that may arise, and manage grievances.

The specific objectives are:

- Gather the perceptions and opinions of the citizenry represented by all sectors of the direct area of influence with a participatory approach.

- Inform stakeholders and populations within the influence area about the scope of the main technical characteristics of the project and collect their concerns and contributions.
- Present the potential environmental impacts, as well as measures for the prevention, mitigation, or correction of environmental impacts.
- Understand the perceptions, opinions, and attitudes of the population regarding the project and its impacts.
- Address questions, perceptions, opinions, concerns, and contributions raised by populations, representatives of interest groups, and key stakeholders regarding the final study of the Project.
- Systematize the results obtained from participatory processes related to the project to extract important aspects that can positively contribute to the project's development.
- Establish the general guidelines for managing the grievances.

8.3. Methodology

The Stakeholder Engagement Plan is divided into two central components.

The first seeks a detailed characterization, identifying all relevant actors with a direct or indirect interest in the project.

Secondly, based on the analysis of the specific social environment where the project will be implemented, specific activities have been planned to ensure that consultations are genuinely meaningful.

For the development of the stakeholder analysis and engagement plan, data were gathered from various sources:

- Desktop research and literature review of available secondary data
- Analysis of Google Maps and aerial imagery
- Preliminary and prior consultations held as part of the Social Impact Assessment field work. They included some interviews to key stakeholders.

8.4. General Guidelines

The involvement of stakeholders includes the following steps:

- Identification and analysis of stakeholders.
- Planning of how interaction with them will be conducted.
- Disclosure of information.
- Consultation with these parties.
- Addressing and responding to complaints and claims submitted through the Complaints and Claims Handling Mechanism.
- Presentation of information to stakeholders.

The entire participation process must be properly documented as part of the Environmental and Social Assessment of the projects. Measures to maintain confidentiality when required and when necessary to protect personal data must be guaranteed.

The documentation will include the following:

- Date and location of each participation activity (e.g., public meetings, surveys, distribution of brochures), including a copy of any notification/invitation to stakeholders, or records of orally made invitations.
- Purpose of the participation activity (e.g., informing stakeholders of a planned project, consulting them on changes to traffic circulation patterns, providing information on how to access the complaint and consultation mechanism).
- Participation scheme (e.g., public meetings or workshops, focus groups, written consultations, online consultations, disclosure of information before a formal consultation process, delivery of documentation in paper format, door-to-door survey, etc.).
- Number of participants and their affiliation (e.g., community leaders, local businesses, rural establishments, etc.). It is crucial not to disclose the names of participants without their explicit authorization.
- List of materials disclosed or distributed to participants, including any instruction that materials must be reviewed before a consultation.
- Copies of any photographs or recorded videos.
- Summary of the main points discussed, ideas, issues, or concerns raised by stakeholders, and any agreements or commitments adopted.
- Summary of how stakeholders' ideas, issues, or concerns were addressed and considered in the project or mitigation design, or in the management of activities.
- Any issues or activities that require follow-up and how they will be addressed.

8.4.1. Participation Instances According to Program Stage

The nature, scope, and frequency of stakeholder participation are established in accordance with the nature and scale of the project, its development and execution schedule, and its potential risks and impacts.

8.4.1.1. Program Preparation

During the preparation stage, participation should include at least:

- Consultations with stakeholders to substantiate the process of identifying and analyzing stakeholders.
- Disclosure of relevant information about the project, including the design of the project and any associated activity, environmental and social risks and impacts related to the project, proposed mitigation measures, and action plans (or management plans), as well as explanations of the anticipated benefits of the projects.
- Responses to any claims or concerns raised.
- Information to stakeholders, especially those affected by the project, on how stakeholders' opinions were incorporated into each project and in the design and mitigation activities, and in environmental and social action plans, to enhance the quality, sustainability, and acceptability of the projects to be financed.

8.4.1.2. Program Execution

During the execution stage, participation should include at least:

- Regular efforts to keep stakeholders informed about what is happening in the implementation of the project.
- Consultations with stakeholders regarding any changes in the project's design, or in environmental and social risks of impacts, in the continuous implementation of environmental and social mitigation measures, and any new aspect that arises in connection with the Program's implementation or during it.
- Timely and consistent responses regarding claims and inquiries received through the Grievance Redress Mechanism (GRM)
- Review of the Stakeholder Participation Plan, including the adequacy of stakeholder identification, in light of any issues that have arisen during the project's implementation.
- Proactive solicitation of stakeholder opinions, prioritizing two-way dialogue in addition to one-way information exchange.

During the execution stage, the project owner will continue to interact with those affected by the project and other stakeholders, providing them with information throughout the life cycle of the operation, adjusting the form according to the nature of their interests and potential environmental and social risks and impacts.

If the project undergoes significant changes resulting in additional risks and impacts, especially if they subsequently affect those affected by the operation, there will be provided information on such risks and impacts and consult with those affected on how to mitigate them at any stage of the projects' life cycle.

Likewise, if required, an updated action plan will be developed and disclosed, stipulating any additional mitigation measures and their implementation period.

8.4.2. Equitable and Inclusive Stakeholder Engagement

In the development of the Stakeholder Engagement Plan, individuals of all genders and groups at risk of marginalization (ethnicity, race, age, and immigration status, persons with disabilities) will have effective interaction and participation through the following actions.

- Ensure that the consultation process reflects the concerns of individuals with diverse sexual orientations and gender identities, from different ethnicities, immigration statuses, etc.
- Ensure that there is no gender-based discrimination that could undermine a group's ability to influence decision-making in the consultation process.
- Identify and address obstacles preventing women and individuals with diverse sexual orientations and gender identities from participating in consultations (e.g., lower education, time and mobility constraints, limited access to information, language barriers, lower decision-making power and participation experience, security issues, etc.). Women and individuals with diverse sexual orientations and gender identities may be less able to speak in public settings or may face mobility limitations (such as those related to caregiving responsibilities) that hinder their attendance at consultations held in locations somewhat distant from their homes.
- Facilitate the adoption of measures to ensure meaningful participation of women and individuals with diverse sexual orientations and gender identities in consultations,

including appropriate meeting hours, transportation, childcare services, and convening separate meetings when necessary.

- Facilitate inclusive participation by involving all stakeholders, including individuals or groups with disabilities, marginalized or vulnerable populations (migrants, rural populations, indigenous communities), fostering an empowerment process that encourages the involvement of all individuals in the participation process.

8.5. Stakeholder Analysis and Mapping

For this analysis, the environmental and social impact assessment for the project was used as input, along with interviews conducted with key stakeholders as a strategy for data gathering for the impact assessment.

Codrington is a diverse area featuring a mix of infrastructure representing residential housing, commercial activities, industrial estates, as well as other services. Analyzing the area of influence, a preliminary general characterization can be undertaken as follows, broadly differentiating the type of actor that may be potentially impacted and/or interested in the project:

1. Affected communities including community adjacent to the construction works – families, individuals and social structures and networks including formal or informal community organizations.
2. Sensitive human receptors in the vicinity of the construction works, including schools, health facilities (hospitals), nurseries and early childhood care and educational facilities, care facilities for older adults, persons who at home during the day, etc.
3. Local businesses and their representative organizations.
4. Local persons seeking employment.
5. Tourist Interests.
6. Heritage Interests.
7. Local Government
8. Politicians (Local Government Councilors, Members of Parliament and Representatives of the Opposition).
9. Residents of Codrington.
10. Project contractors and sub-contractors.
11. Central government agencies (including regulatory agencies).
12. National civil societies (e.g., environmental NGOs).
13. The media.
14. The general public.

Having identified the category of actors involved, it becomes feasible to categorize them based on their varying degrees of concern regarding the project's outcome. This differentiation allows for a nuanced understanding of the stakeholders' perspectives and levels of engagement in the project's development and eventual fruition.
By delineating these distinctions, one can better comprehend the diverse interests, expectations, and potential impacts each set of actors may bring to the overall project dynamics can be better understood. This granular categorization aids in **tailoring communication strategies** and engagement approaches to **address the specific needs and considerations of each group**, fostering a more inclusive and effective project management process.

It is necessary to analyze the stakeholders in the project, distinguishing between those groups affected positively or negatively by the project, as well as groups that can influence the project outcomes, either favoring or opposing it.

Additionally, based on the level of positioning and interest they have in relation to the project under analysis, their perspectives, and the analysis of potential benefits or harms, will enable the executing agency to define possible facilitators and identify difficulties with their counterparts. It is recommended that the mapping of actors or interest groups emphasizes being highly inclusive, which will help reduce complaints and claims during the execution stage.

Since the primary objective of meaningful consultations is to clearly inform and listen to opinions from all stakeholders involved and affected by the project, the creation of an actor mapping is essential to identify all stakeholders, front-line individuals, affected and benefited parties, institutions with a social role or function, local authorities, grassroots organizations, educational and healthcare institutions, etc.

For the compilation of the stakeholder mapping, the entire population with direct or indirect interest was considered, as well as those actors who may be affected positively or negatively by the project's actions. The following criteria were considered:

- **Direct connection** (considering the condition of front-line individuals / regular users)
- **Role or social function**: governmental institutional, private sector institutional, education, etc.
- **Stakeholders** from the localities affected by the project.

Table 6 presents the preliminary stakeholder mapping of the Project. This list will be updated prior to the development of the consultation process in late August 2024.

Table 18. Stakeholder mapping

Stakeholder	Type	Relationship with the program	Degree of influence
Agriculture Department	Government Agencies	Interest Party	Medium
Agriculture Development Corporation (ADC)	Civil society	Interest Party	Low
Airport authorities	Private Sector Agencies	Interest Party	Low
Antigua and Barbuda National Defense Force	Government Agencies	Interest Party	Low
Antigua and Barbuda Workers Union (ABWU)	Civil society	Interest Party	Low
Antigua Commercial Bank	Private Sector Agencies	Interest Party	Low
Artsy Yaadie Art Studio	Civil society	Interest Party	Low

Barbuda Basketball Court	Civil society	Interest Party	Low
Barbuda Blue Halo Initiative	Civil society	Interest Party	Low
Barbuda Chamber of Commerce	Private Sector Agencies	Interest Party	Low
Barbuda Cottages	Private Sector Agencies	Interest Party	Low
Barbuda Cultural Complex	Civil society	Interest Party	Low
Barbuda Devotional Group	Civil society	Interest Party	Low
Barbuda Express Ferry	Civil society	Affected party	Low
Barbuda Falcons Athletic Club	Civil society	Interest Party	Low
Barbuda Fire Service	Civil society	Interest Party	Low
Barbuda Fisheries	Civil society	Interest Party	Medium
Barbuda Fishers Association	Civil society	Affected party	Medium
Barbuda GO	NGO	Interest Party	Medium
Barbuda Hillside Bar and Grill	Private Sector Agencies	Interest Party	Low
Barbuda Local Council	Government Agencies	Interest Party	High
Barbuda Ocean Club	Private Sector Agencies	Interest Party	Medium
Barbuda Recovery and Rebuild Committee (BRRC)	Private Sector Agencies	Interest Party	Low
Barbuda Seventh Day Adventist Church	Cultural heritage	Interest Party	Low
Barbuda Taxis & Tour Operators	Private Sector Agencies	Interest Party	Low
Barbuda Tennis Court	Civil society	Interest Party	Low
Barbuda Turf Club	Private Sector Agencies	Interest Party	Low
BK Fuel Depot. Gas station	Private Sector Agencies	Interest Party	Low
Block Club (Fundraising and Community Activities)	NGO	Interest Party	Low
Board of Education	Government Agencies	Interest Party	Low
Caribbean Union Bank	Private Sector Agencies	Interest Party	Medium
CD Café	Private Sector Agencies	Interest Party	Low
Construction companies	Private Sector Agencies	Interest Party	Medium

D&D Poultry Farm	Private Sector Agencies	Interest Party	Low
D. Gisele Isaac-Arrindell Construction	Private Sector Agencies	Interest Party	Low
Data Management Unit	Government Agencies	Interest Party	Low
Devotional Group (Non-profit supporting vulnerable populations)	Cultural heritage	Interest Party	Low
Directorate of Gender Affairs (Antigua and Barbuda)	Government Agencies	Interest Party	Low
Education Department	Government Agencies	Interest Party	Medium
Environmental Awareness Group (EAG) Antigua and Barbuda	Civil society	Interest Party	Low
Environmental Department	Government Agencies	Interest Party	Medium
Escape to Barbuda	Private Sector Agencies	Interest Party	Low
Fancy's Way Supermarket	Private Sector Agencies	Interest Party	Low
Ferry authorities	Private Sector Agencies	Affected party	High
Finance Department	Government Agencies	Interest Party	Low
Fishermen	Civil society	Affected party	Low
General Purpose Department	Government Agencies	Interest Party	Medium
Green Door Bar	Private Sector Agencies	Interest Party	Low
Hannah Thomas Hospital	Civil society	Interest Party	Low
Harry's beach bar	Private sector	Interest Party	Low
Health and Wellness center	Civil society	Interest Party	Low
Health department	Government Agencies	Interest Party	Medium
Highway Supermarket	Private Sector Agencies	Interest Party	Low
Historic Dulcina Apartments	Private Sector Agencies	Interest Party	Low
Holy Trinity Anglican Church	Cultural heritage	Interest Party	Low

Holy Trinity Primary School	educational establishment	Interest Party	Low
Internacional and Nacional NGOs	NGO	Interest Party	Medium
Isoya Basanlar Dernegi (hostel)	Private Sector Agencies	Interest Party	Low
Land owner Purcell	Civil society	Affected Party	High
Lighthouse Bay Resort	Private Sector Agencies	Interest Party	Low
Lil Linc's Supermarket	Private Sector	Interest Party	Low
Living Faith Church	Cultural heritage	Interest Party	Low
Local and regional businesses	Private Sector Agencies	Interest Party	Low
Local environmental conservation groups	Civil society	Interest Party	Low
Local Fishermen's Associations	Civil society	Interest Party	Medium
Local Transport Services and Freight Companies	Private Sector Agencies	Interest Party	Low
MyKa's Guesthouse	Private Sector Agencies	Interest Party	Low
National Government Representatives from Antigua and Barbuda	Government Agencies	Interest Party	High
National Office of Disaster Services (NODS)	Government Agencies	Interest Party	High
National Solid Waste Management Authority	Government Agencies	Interest Party	Medium
New Millenium Administration	Private Sector Agencies	Interest Party	Low
Nobu Barbuda	Private Sector Agencies	Interest Party	Low
Palm Tree Guest House	Private Sector Agencies	Interest Party	Low
Post Office	Civil society	Interest Party	Low
Princes Foundation International	ONG	Interest Party	Low
Radio Codrington (Local Radio Station)	Civil society	Interest Party	Medium
Royal Antigua and Barbuda police force	Government Agencies	Interest Party	Low
Shak A Kai Restaurant	Private Sector Agencies	Interest Party	Low

Secondary School	educational establishment	Interest Party	Low
St. John's Pentecostal Church	Cultural heritage	Interest Party	Low
Summer Breeze Ferries	Private Sector Agencies	Affected party	Low
Te Amo Beach Bar Barbuda	Private Sector Agencies	Affected party	Low
The Barbuda Research Complex (BRC)	Private Sector Agencies	Interest Party	Low
The Sage Table Barbuda	Private Sector Agencies	Interest Party	Low
TimbukOne	Private Sector Agencies	Interest Party	Low
United Nations Development Programme in Antigua and Barbuda	International organizations	Interest Party	Medium
Wa'Omoni's Best Burgers & Water	Private Sector Agencies	Interest Party	Low
Wing Spot	Private Sector Agencies	Interest Party	Low
Women's Advocacy Groups	Civil society	Interest Party	Low
Works department	Government Agencies	Interest Party	Medium
Xtra's Bar & Nightclub	Private Sector Agencies	Interest Party	Low

8.6. Communication and Engagement Strategies

Communications and engagement strategies are a two-way process by which the needs, values, and concerns of the public are identified, providing a genuine opportunity to influence decision-making. This process utilizes a variety of tailored interaction methods that promote and sustain a fair and open dialogue.

In the context of this project, consultation will be conducted through a set of smaller consultation and participation events.

The extent and degree of participation required for the consultation process should be proportional to the risks and adverse impacts of the Project, as well as the concerns raised by those affected and other stakeholders.

The engagement aims to inform stakeholders about the socio-environmental impacts (both negative and positive), mitigation measures, and the mechanism for addressing complaints and claims.

Moreover, the process includes a space for stakeholders to express their opinions, concerns, and share opportunities for improvement in the socio-environmental aspects of the projects financed under the Program. The process must be conducted continuously throughout the life cycle of the projects.

The consultation instances seek to add value to the projects by:

- Gaining insights into the perspectives and perceptions of individuals (ensuring gender and opportunity equality) who may be affected or have an interest in a development project, providing a means for these opinions to be considered as contributions to an improved Project design and implementation, thereby avoiding or reducing adverse impacts and increasing benefits.
- Serving as a crucial source of validation and verification of data obtained elsewhere, enhancing the quality of environmental and social impact assessments.
- Helping individuals understand their rights and responsibilities concerning a project.
- Promoting greater transparency and stakeholder participation, fostering trust, project acceptance, and local ownership—critical aspects for the sustainability of the Program and development outcomes.
- Being essential for the credibility and legitimacy of the executing body.
- Preventing external manipulation, interference, coercion, discrimination, retaliation, or intimidation.

8.6.1. Participation Stages

The planning and dissemination of the participation, consultation, and information process must be conducted in a way that ensures the involvement of stakeholders. Efforts should be made to facilitate the attendance of groups that may be adversely affected by the project´s activities and those groups identified as stakeholders, even if they do not belong to the affected population.

The consultation process should consider, at a minimum, the following elements:

- Identification of stakeholders
- Definition of culturally appropriate criteria and procedures that enable participatory and informed consultation.
- Documents to be shared and the availability of relevant information for the consultation.
- Timely and contextually sensitive preparation of the events, considering the socio-economic context, accessibility of the meeting site, and suitable dates and times.
- Maintaining proper records of participants, agenda, topics discussed, as well as agreements and/or conclusions reached (content, dynamics, documentation, etc.).
- A report on the consultations containing a description of the participants, potential absence of key actors, participant registry, and results of the process.

The consultation process must be documented. To achieve this, information should be systematized, organized, and the main conclusions and agreements reached should be drafted and documented in a consultation report.

Below is a brief description of the principal actions to be considered at each stage, to ensure that the consultation process is meaningful.

8.6.2. Stakeholder Mapping and Analysis

The stakeholder mapping and analysis is presented in the preceding section. It is recommended that the mapping is review and, if necessary, update to ensure accurate identification of all parties interested and/or affected by the project.

8.6.3. Preparation and dissemination of material

Information regarding the project must be available to stakeholders.

Given the fact that the public participation in going to take place early in the project preparation process, information will be published and disseminated to the population once the Environmental Assessment is completed.

These materials will also include information about the significant public consultation process that will take place, with details such as date, mode, schedule, registration, location, etc. They should be visible through various physical and virtual channels and tailored to the characteristics and diversity of the targeted groups.

8.6.4. Design of the Events

Given the social context and framework in which the public participation events will be executed, the consultation events will be held in person, in the **week of August 26-30, 2024.**

It is important to highlight that the chosen method for these events includes different meetings or focus groups with various actors and social groups. This approach is due to the nature of the proposed project and the fact that the population is small and concentrated in a single populated center.

The events will be organized with different social groups:

- Fishermen groups and fishermen social organizations.
- Meeting with private sector agencies (construction companies, local businesses, tourism sectors, etc.)
- Social groups, NGOs, gender organizations, environmental organizations.
- Government agencies, council members, and representatives from the health and education sectors.

To invite participants to the event, calls, and visits will be made to the various institutions and actors to propose meeting times, ensuring maximum attendance. Since most residents work until 3 PM, it would be advisable to schedule the meetings in the afternoon to ensure their participation.

During the meetings, the first step will be to explain the purpose of the participation and consultation process, clarifying that while these spaces are not binding, questions and proposals from attendees will be analyzed and addressed. In cases where relevant, proposed modifications will be incorporated into the Program and its constituent projects.

Subsequently, a description of the project under consultation will be provided, including its objectives, main characteristics, considered alternatives, environmental and social impacts during construction and operation phases, as well as mitigation measures designed for proper environmental and social management of the interventions.

Ensuring clear explanations with non-technical language, which allows attendees to understand the main aspects of the projects and their impacts, is crucial. This explanation should be supported by graphic material to facilitate comprehension.

Next, time will be allocated for **questions and comments from attendees**. The option to submit written questions will be offered.

A specific time for community consultations will be allocated. The concerns, questions, and requests from the population will be recorded and included in the participation report. Whenever possible, these questions should be addressed during the event; otherwise, they will be recorded and included in the impact study documents available to the public.

Finally, a private communication channel (e-mail) will be provided for the public to submit specific questions about the project and address any grievances occurring during the construction period.

The coordination of the meetings will be overseen by social specialists with experience in public consultations and participation processes.

8.6.5. Participation Report

Instances of public consultation will be systematized in the Participation Report, which will include the main concerns raised (both during different events and any prior or subsequent requests received), indicating how they were addressed at the time or, when applicable, what responses were formulated afterward and how they were communicated to stakeholders and the general public.

Although consultations are not binding, proposals received will be evaluated, and an explanation of their relevance or lack thereof should be included in the reports. If deemed relevant, proposals for changes in the project and/or in the assessment approach will emerge from the consultation reports, specifically recommendations for the project design, mitigation measures, and grievance redress mechanism.

The participation report will also include a photographic record of each event and meeting, a list of registered attendees (with name and email – redacted prior to disclosure of final documents), as well as any evidence or documentation supporting the process.

It will include environmental and social documentation socialized, a description of the consultation mechanism used, the attendance sheet for the consultation meetings (distinguishing attendance by gender), publications in local media, and other dissemination materials used.

Below is an outline of the contents of the Participation Report to which specific elements can be added as needed, based on the development of the particular consultation:

1. Participation strategy: Description of the consultation process planning.

2. Stakeholder mapping (groups, institutions, or individuals who were invited) and criteria for selecting invited actors.
3. Dates, times, and venue of the events.
4. Analysis of attendees at activities (compared to invitees). Information disaggregated by gender and participating institution.
5. Materials used during consultations.
6. Summary of presentations made.
7. Queries made and responses (proposals, complaints, or questions from attendees and how they were addressed). Indicate responses given at the time and those that, due to the nature of the question or comment received, were formulated after the event.
8. Indication of how attendees' proposals and/or complaints were incorporated or will be incorporated into the project design. Specify if there were formal agreements reached with those consulted.
9. Main conclusions about the positive or negative perception of the project by participants.

9. STAKEHOLDER PARTICIPATION REPORT

9.1. Introduction

Stakeholder participation plays a critical role in the successful development and implementation of projects that have a significant impact on local communities.

As a social management mechanism, it enables the active involvement of a wide range of stakeholders, including members of the population, representatives of social organizations, and public institutions, in shaping the project's trajectory. The primary aim of this process is to foster open communication and dialogue between the stakeholders and the project owner, ensuring that their concerns, expectations, and needs are considered.

In the context of the current project, a stakeholder participation process was established to facilitate a two-way dialogue between the project owner and the various stakeholders involved. To that end, a stakeholder engagement activity was organized and developed from August 26 to August 30, 2024.

This mechanism enables a deeper understanding of the diverse perspectives within the project's area of influence and serves as a platform to address the specific concerns of individuals and groups directly affected by the project. Through the use of participatory methods, the project seeks to engage with both interested parties, such as workers, community members, and business owners, as well as affected parties, including fishermen, healthcare workers, and public sector employees.

The process of stakeholder participation further ensures that crucial information regarding potential risks and concerns is collected from key actors. For instance, fishermen and community members, who are directly impacted by changes to their environment and livelihoods, have provided important feedback on how the project may influence their activities.

Similarly, input from workers in sectors such as hospitality, education, and public services has allowed the project to identify both positive and negative perceptions of its potential outcomes. These contributions not only enhance the technical efforts deployed for the project's development but also help in crafting tailored strategies to mitigate any adverse effects.

The objective of the stakeholder engagement process is to raise awareness of the project, particularly among the most impacted groups. The goal was not only to inform stakeholders but also to gather their input on potential economic, social, and environmental impacts. This participatory approach was vital for ensuring that the project's development is sensitive to local realities and aligned with the interests of the Barbuda community.

The main objectives for the participation strategy were as follows:

1. Increase project transparency by sharing up-to-date information about its status, timeline, and expected impacts.
2. Gather feedback from affected parties, focusing on economic disruptions, changes in land use, and environmental concerns.

3. Encourage dialogue between different sectors, including private sector representatives, civil society, and government agencies, to foster cooperation and build trust in the consultation process.
4. Address specific concerns raised by vulnerable groups, including fishermen, local businesses, and landowners, ensuring their voices were heard and integrated into project planning.

9.2. Stakeholder Mapping and criteria for selecting invited actors.

The stakeholder mapping process is a crucial step to ensure the representation of diverse perspectives and interests in the project's development. In selecting the invited participants, the focus was to include a broad range of actors that could either be directly affected by the project or possess influence in areas related to its development.

Key criteria for selection included:

1. Affected Parties: Individuals, businesses, and organizations directly impacted by the construction works, such as nearby residents, local businesses, and fishermen operating near the project site.
2. Interested Parties: Stakeholders with a professional or organizational interest in the project, including government agencies, private sector representatives, and civil society groups.
3. Community and Social Structures: Formal and informal community groups, particularly those in Codrington, which could provide valuable insights into the social and economic dynamics of the area.
4. Influence: Entities with the ability to influence public opinion or decision-making processes, such as local government representatives, media, and key political figures.

By considering these factors, the selection process aimed to create a balanced dialogue, ensuring all relevant voices were heard and represented during the consultations.

The initial stakeholder mapping categorized participants based on their relationship with the project, their degree of influence, and their type (government agencies, civil society, private sector, etc.). The intention was to ensure representation from a wide cross-section of society, including:

1. Affected Communities: Families, individuals, and community organizations adjacent to the construction works, who would be directly impacted by the project.
2. Sensitive Receptors: Schools, health facilities, and care facilities for vulnerable populations.
3. Local Businesses: Including representative organizations that could provide insight into economic impacts, local employment, and tourism interests.
4. Heritage and Cultural Groups: Organizations concerned with cultural preservation.
5. Government Agencies: Local and central government agencies, including those involved in regulatory functions or directly connected to the project.
6. Civil Society Organizations: Environmental NGOs and community advocacy groups that could raise concerns regarding environmental impacts and social wellbeing.
7. Media and the General Public: Ensuring transparency and public awareness of the project’s scope, impacts, and mitigation strategies.

The goal was to ensure a broad and inclusive dialogue, capturing a wide range of perspectives from those directly impacted, to those with broader interest in the project's social, environmental, and economic dimensions.

In practice, the actual stakeholder engagement evolved from the original plan as the exercise in the field progressed. While some key stakeholders attended and participated, many of the invited parties, especially those from the government, did not. The stakeholders who were effectively consulted were mostly those with direct ties to the project's operational area and those with an immediate economic stake. These included fishermen and fisheries associations, local business owners and employees (such as those from the retail sector, restaurants, and hotels in the immediate vicinity of the project), health and education representatives (to understand how they may foresee the project's influence on the demand for public services) and few government representatives, including a member of Barbuda's Council and workers from the Department of Tourism and Department of Lands.

9.3. Participation Strategy

The stakeholder engagement process involves efforts to raise awareness for the project. It targets members of Barbuda civil society, institutional groups, government agencies, and the general public, with emphasis on individuals and businesses within the project's area of influence.

The participation strategy for the project was designed to ensure a broad and inclusive consultation process, accommodating the diverse needs of stakeholders in Barbuda. This involved a combination of planned meetings and impromptu consultations, given the logistical challenges of contacting certain groups in advance. The strategy aimed at gathering input from various sectors, including civil society, local businesses, government representatives, and community members, with a focus on smaller, more focused meetings to foster deeper discussions and more actionable feedback.

In the initial phase of planning, pre-arranged meetings were organized, primarily via phone and text / WhatsApp messaging, before the on-site visits. This allowed for structured engagement with key stakeholders such as local business owners, government representatives, and institutional stakeholders. The remote organization was used for those stakeholders with whom contact details were available, allowing for advanced scheduling and ensuring their availability during the visit.

Certain key actors and groups proved difficult to contact beforehand. These stakeholders were engaged through on-the-ground coordination, where meetings were arranged directly during field visits. This flexibility in scheduling was crucial for reaching stakeholders who were more difficult to contact, such as smaller community groups and individuals.

Upon arriving in Barbuda during the week of August 26–30, 2024, the field team conducted a series of consultations based on this combination of pre-arranged meetings and spontaneous discussions.

The decision to organize small group meetings and one-on-one consultations on-site was a deliberate choice that aimed at fostering focused conversations, and to promote richer dialogue and gather a larger variety of opinions. Smaller groups encouraged open dialogue, creating an atmosphere conducive to gathering honest feedback about community concerns, project impacts, and opportunities for improvement. Smaller meetings allowed for a deeper understanding of

personal and group-specific concerns, such as fishing practices, private landownership issues, and economic opportunities in the construction phase. This approach enabled the collection of granular feedback that might otherwise have been missed in larger forums.

This enhanced feedback loop allowed for more detailed, nuanced input, critical for addressing the concerns of the community effectively.

The following table summarizes the planned consultations that took place between August 26 and 30, 2024:

Table 19. Consultation Schedule

Day	Stakeholder	Objective	Location
Monday, 26th	Organization of meetings and contact with stakeholders that will participate of the consultation process (school, hospitals, gas station, etc.) Final contact with key stakeholders identified (Purcell, Bill Ned, Motique Gore, etc.	General organization of the consultation process	Codrington
Tuesday, 27th	Consultation with local business owners Barbuda Chamber of Commerce, local business owners and tourism representatives.	Understand concerns regarding economic impacts and opportunities.	To be defined in field
	Meeting with Local Government Representatives Local Council members, Government agencies, and Codrington representatives.	Discuss project status, impacts, and government involvement in construction phase.	Codrington Town Hall.
Wednesday, 28th	Meeting with key stakeholders identified	Address land-related concerns, clarify project implications for private landowners.	Private meetings in residential locations
	Public Consultation with Fishermen & Fisheries Associations (Barbuda Fisheries, Fishermen Associations, etc.)	Discuss impacts on fishing practices, restoration plans, and docking relocations.	Barbuda Fishers Association Hall.
Thursday, 29th	Private Sector & Construction Representatives (Bill Ned, representatives from construction companies)	Ensure alignment on mitigation strategies and employment opportunities	Construction installations
	Civil Society and NGOs (Environmental groups, gender advocacy organizations, Barbuda GO)	Gather input on social and environmental concerns, address grievances	To be defined in field

Day	Stakeholder	Objective	Location
Friday, 30th	Civil society, General public, community, schools, health sectors.	Feedback on community concerns and program improvements.	Codrington School Auditorium.

The participation strategy successfully facilitated broad stakeholder engagement despite the logistical challenges of organizing meetings with some groups. The strategy of engaging stakeholders through a mix of smaller consultations and focused group meetings proved effective in gathering detailed and actionable feedback. This approach allowed the project team to build stronger connections with community members and stakeholders who might have felt overshadowed or uncomfortable speaking out in larger forums, as well as to obtain more meaningful and candid discussions, and richer, more specific feedback from stakeholders.

Moreover, the adaptive scheduling of meetings ensured that even stakeholders who were not initially reached could still have their voices heard. This flexibility demonstrated a commitment to inclusivity, ensuring that a broad range of perspectives were considered.

9.4. General Description of the Stakeholder Engagement Activities

During the meetings, the first step was to explain the **purpose of the participation and consultation process**.

The consultation process continued with a detailed **description of the Murbee Resort project** and details of the master plan. A map of the project area was presented, alongside the design and infrastructure plans for the resort. Special attention was given to explaining the project's benefits, including job creation, tourism development, and infrastructure improvements. During this description, the project team made emphasis on the new proposed road location, as well as the preservation of the Martello Tower.



Figure.59 Marster plan with references

To aid in the understanding of the project, the team presented the print version of the Project Masterplan to participants.

Following the presentation, participants were encouraged to **share their feedback** on the project. The consultation events were structured in a way that allowed for open dialogue. Finally, in order to maintain continuous communication with the community, the project team made a concerted effort to collect contact information from all participants.

The stakeholder participation over the week-long consultation involved a wide variety of actors from Barbuda's civil society, government, and business sectors.

In total, **41 meetings** were held with a combined total of **136 participants**. These consultations included representatives from local businesses, fishermen, government institutions, educational bodies, and community members. The breakdown of participants according to gender and stakeholder type is summarized in the table below:

Table 20. Meeting descriptions

No	Date	Stakeholder		Participants			Type of stakeholder
		Institution	Detail	Total	M	F	
1	26/08/2024	Grocery Shop	Worker	1		1	Interested party
2	26/08/2024	Digicel	Worker	3		2	Interested party
3	26/08/2024	Barbuda Council	Chairman of Barbuda Council	1		1	Interested party
4	26/08/2024	Health and Wellness Center	Worker	1		1	Interested party
5	26/08/2024	Green Grocery, Rute 1	Community members	9	7	2	Interested party
6	26/08/2024	Highway Supermarket	Community members and workers	3		3	Interested party
7	26/08/2024	The Sage Table Restaurant	Workers	4	2	2	Interested party
8	26/08/2024	ACB Caribbean Bank	Managers and workers.	4	2	2	Interested party
9	27/08/2024	Fisheries	Monitque Gore, President of the Fisheries Association	1	1		Affected party
10	27/08/2024	Lands Department	State workers	6	3	3	Interested party
11	27/08/2024	Holly primary school	Teachers	11	2	9	Interested party
12	27/08/2024	The Stage Table	Owner of the restaurant	1	1		Interested party
13	27/08/2024	Purple Haze Bar and Restaurant	Community members	3	2	1	Interested party
14	27/08/2024	River Dock	Fishermen	2	2		Affected party
15	27/08/2024	River Dock	Fishermen	4	4		Affected party
16	27/08/2024	Dulcina's Apartment	Owners of the hotel	2	2		Interested party
17	28/08/2024	River Dock	Food truck	2	1	1	Affected party
18	28/08/2024	River Dock	Community members	2		2	Interested party
19	28/08/2024	River Dock	Cargo workers	6	6		Affected party
20	28/08/2024	Barbuda Express Ferry	Barbuda Express Ferry Workers and Fishermen	13	12	1	Affected party
21	28/08/2024	Hannah Thomas Hospital	Hospital workers	3		3	Interested party
22	28/08/2024	Hannah Thomas Hospital	Hospital administration workers	2		2	Interested party
23	28/08/2024	Ariel Bar and Restaurant	Workers	4		4	Interested party

24	28/08/2024	Route 1	Fishermen and a citizen	2	1	1	Affected party
25	28/08/2024	Wa'omoni Basturant	Owner of the restaurant	1		1	Interested party
26	28/08/2024	Antigua	Purcell Bird	1	1		Interested party
27	29/08/2024	Cool Kids Daycare	Education	3	1	2	Interested party
28	29/08/2024	Timuk one	Workers	3		3	Interested party
29	29/08/2024	Mechanics place	Community members and workers	3	2	1	Interested party
30	29/08/2024	Route 1	Community members	2		2	Interested party
31	29/08/2024	Airport	Airport workers	5	2	3	Interested party
32	29/08/2024	Abundant Life Ministries Church	Church worker	1	1		Interested party
33	29/08/2024	Gas Station	Workers	3	2	1	Interested party
34	30/08/2024	Fisheries	Community members	3	2	1	Interested party
35	30/08/2024	Fisheries	Department of Tourism workers and school bus driver	4	2	2	Interested party
36	30/08/2024	Hospital	Bus driver	1	1		Interested party
37	30/08/2024	Te Amo Beach Bar	Workers	4	2	2	Affected party
38	30/08/2024	Rute 1	Community members	6	1	5	Interested party
39	30/08/2024	State insurance Company	Workers	3	1	2	Interested party
40	30/08/2024	Block Club Building	Community members	2	2		Interested party
41	30/08/2024	Shack-a-Kai	Owner of the restaurant	1	1		Interested party

Given Barbuda's total population of 1,615 people (2011 Census data, but believed to be smaller now), the engagement of participants during the consultation process represents approximately at least 8.2% of the total population. This is a significant proportion, particularly considering that many stakeholders who participated held leadership roles within their respective families, places of work, communities or industries, meaning that their feedback likely reflects broader sentiments within the population.

A gender analysis of the meetings revealed that the participation rate was balanced. With 136 individuals, 69 being male and 67 females, adequate gender representation was achieved. (50,8% male participation and 49,2% female participation). It is important to note that there is a male dominated participation in several meetings, especially in fishermen meetings or the ones held over the dock area, while there are significant female participants in other sectors, such as education or healthcare.

Most stakeholders were categorized as interested parties, such as workers, community members, teachers, and business owners. These parties are engaged due to their direct or indirect interest in the outcomes and impacts (both positive and negative) of the project. There were also affected parties engaged, including fishermen, cargo workers, and truck operators. These stakeholders are directly impacted by the project's implementation.

Special attention was given to specific sector insights, such as fishermen, education workers, healthcare institutions and private parties. Several meetings involve general public and community members, either exclusively or in conjunction with other stakeholders. Community members tend to have diverse opinions, depending on their roles and proximity to the project's impact areas.

9.5. Analysis of Feedback Received

9.5.1. Questions Raised by the Community

The following section details to the key questions and concerns raised by the community regarding the project, which reflect their concerns, and aspirations.

On the first place, there were many questions about the **timeline of the projects**, specifically when construction will start and how long it will take. Additionally, many participants asked questions regarding the **ownership of the firm**. Some seemed skeptical about the project starting, outlining that there are many projects proposed but not all of them end up effectively being constructed.

Many questions revolve around **whether the development will be accessible to locals**. There is concern about whether the project will operate as a gated community, **limiting access to beaches and other resources**. This focus on worries of being excluded from areas that have historically been open to the community.

On other hand**,** residents have raised numerous questions about the **environmental impact** of the project. They are particularly concerned about **flooding**, and emphasized that Barbuda's low elevation and high-water table. In this line, they asked whether buildings will be constructed at elevated levels to mitigate flood risk and whether proper environmental safeguards will be put in place.

A key concern is how the project will impact existing businesses and whether locals will benefit economically. Questions regarding **job availability**, **restaurant accessibility**, and the **distribution of profits within the local economy** reveal that the community is highly attuned to the potential for outside interests to extract resources without providing lasting benefits to the residents.

Another question that was recurrent during the meetings was related to the **ownership of the land** and if the project owner has the **legal licensing** to start the construction phase.

Finally, many residents are also curious about the specifics of the resort development. They ask about the general layout, the availability of amenities such as restaurants, and the construction of **public-use facilities**. These questions show that the community is interested in how the project will integrate with the island's landscape and how it might serve the local population.

9.5.2. Knowledge of the Project and General Perceptions

Throughout 12 of the 41 meetings conducted (about 30% of the total meetings), at least one participant expressed **prior knowledge of the project**. Analyzing by the number of individuals in each meeting, approximately **15% of participants** spontaneously mentioned having knowledge of the Murbee Resort Project.

A key output of the stakeholder engagement process was to gauge the general public opinion of the project. While many participants did not express purely positive or negative views, a significant portion exhibited a mixed perspective, highlighting both the project's benefits and drawbacks.

In approximately 50% of the meetings a positive feedback was expressed towards the project, while in 31% of the meetings, participants expressed a negative opinion. In the remaining 17% of meetings, participants held mixed opinions, highlighting both positive and negative aspects of the proposed development.

Analysis of the positive evaluations indicates that many stakeholders, particularly those who will directly benefit from economic growth and general population in Barbuda, viewed the project favorably. Negative feedback, on the other hand, originated from a diverse range of stakeholders, including a few private businesses and the Barbuda Council.

The meetings reflect a significant representation from the fishermen sector, with both negative and positive sentiments expressed. While some fishermen express concerns about the potential adverse impacts, others showed a more balanced or positive outlook, indicating a complex dynamic in the sector.

Teachers and education workers generally displayed a positive but cautious attitude, outlining both positive and negative aspects of project and its influence on their activities and the overall community.

Most hospital workers and administrators appeared to view the project positively, likely due to potential improvements or new opportunities it might bring to their sector. Stakeholders from the hospitality sector also leaned towards positive evaluations, though some expressed negative feedback.

9.5.3. Positives and negatives perceptions

Development projects in Barbuda, particularly those related to tourism and infrastructure, appear to provoke a mix of optimism and concern within the local community. As the island faces increased interest from investors and developers, inhabitants recognize the potential economic

benefits while also expressing deep concerns about the environmental, cultural, and social ramifications.

The following analysis delves into the key positive and negative viewpoints based on feedback from the community, highlighting recurring themes, areas of tension, and broader conclusions.

9.5.3.1. Positive Impacts

Many community members believe that Barbuda has the potential to become a highly sought-after tourist destination. The increase in tourism is seen as a driver of economic growth, bringing much-needed revenue to the island and attracting international attention. The influx of visitors could also lead to a stronger local economy, as businesses related to tourism (lodging, restaurants, tour guides, etc.) would flourish.

On the other hand, a significant positive aspect highlighted is the promise of increased **job opportunities**. The development projects, particularly those centered on hotel construction and related industries, provide employment for local residents. Many believe that these projects offer individuals the opportunity to work, potentially improving their financial standing.

Some respondents view the development projects as essential for the island's overall economic revitalization. They see the potential for increased investment, the creation of new infrastructure, and the strengthening of Barbuda's standing in the Caribbean region. This belief is particularly strong among those who rely on tourism or construction industries for their livelihoods.

Finally, despite concerns, some members of the community acknowledge that development could lead to improved infrastructure on the island. This includes potential improvements to roads, public spaces, and utilities, which could raise the quality of life for residents.

9.5.3.2. Negative impacts

The key negative impacts that were expressed by the stakeholders during the consultation events included concerns about **restricted access to beaches and other public areas** due to hotel developments. Residents are apprehensive that they will be barred from **traditionally communal spaces**, leading to exclusion.

This sentiment is exacerbated by ongoing issues with existing developments that, as told during the meetings, already limit access to parts of the island. During the meetings, many people claimed that the access to Pareto Point and to Coco Point are already restricted, as well as the ability of fishermen to do their activities near Coco Point.

Many believe that the influx of workers and tourists from outside the island could **disrupt the traditional way of life** in Barbuda. Some participants believe that the community's close-knit structure and cultural practices might be at risk, particularly as large-scale development brings outsiders with different values and lifestyles. This is seen as a threat to the island's peace, tranquility, and cultural heritage.

A substantial concern is the **exacerbation of social inequality**, with developments seen as catering primarily to the wealthy while leaving local residents vulnerable. This disparity could

manifest in increased poverty, crime, and prostitution. The participants see negatively this point and underline the possibility of segregation between the rich from the rest of the island's population.

Furthermore, a recurring theme in community concerns is the potential for **environmental harm**, particularly related to Barbuda's coastline, mangroves, and natural ecosystems. Many fear that the island's fragile environment could be irreversibly damaged by large-scale projects, particularly the bird sanctuary and other vulnerable habitats – even when reassured that those areas would be outside of the area of influence of this project.

While development is seen as a potential opportunity for infrastructure improvement, there is significant concern about the strain placed on existing infrastructure. The status of the island's **roads** and the cumulative impact of the project on them, in particular, are a major point of contention. Heavy machinery and cargo trucks used in current developments have already caused damage to the roads, leading to costly repairs for local drivers. There is also concern that new roads could disrupt culturally significant routes.

Finally, the arrival of workers from other areas is seen by some as a catalyst for **increased crime and prostitution** on the island. Many fear that the social fabric of Barbuda could deteriorate as new individuals with varying backgrounds and motivations come to the island, creating an environment ripe for criminal activities.

9.5.4. Community proposals

The discussion surrounding the project among the community reveals a highly engaged community, with numerous proposals arising from the local population. This analysis examines the proposals made by the residents, often focus on ensuring that the community directly benefits from the projects.

These proposals could help shape and guide Corporate Responsibility efforts led by the project proponent, which could lead to an increase quality of life in Barbuda, as well as the basis for improved relationships with the community.

The proposals include:

1. **Infrastructure Improvements**: One of the recurring themes in the proposals is the need for improvements to the island's infrastructure. This includes **better roads**, **improved ferry dock**, and construction of sports facilities. The community consistently emphasizes the importance of road quality, not just for transportation but also for the overall development of Barbuda. Specific requests for sports infrastructure, such as gyms, tennis and basketball courts, and public pools, were also made during the meetings.

2. **Education and Training Programs**: Another significant focus is on education and career development. The community needs the construction science laboratories in the local school, as well as air conditioning for better learning environments. They also suggest the creation of training centers to prepare local youth for higher-level positions within the hotel industry. This shows a proactive stance in wanting to ensure that Barbuda's youth are prepared for the future job market that will be created.

3. **Job Opportunities and Local Hiring**: There is a strong emphasis on creating job opportunities for local residents and ensuring that they are prioritized for managerial positions. The community is not only interested in low-skill jobs but is advocating for training and inclusion in decision-making positions. This proposal reflects a concern about outside labor displacing locals and the need for sustained career development opportunities for Barbudans.

4. **Community Benefits**: Proposals to ensure that the community benefits from the development are numerous and varied. Suggestions include the construction of community centers, the provision of scholarships for local youth, and support for existing local businesses. There is a clear expectation that the development should directly benefit the island's residents, not just the investors or tourists.

5. **Environmental Considerations**: Some community members made comments about the environmental challenges facing Barbuda, especially given its flat topography and vulnerability to flooding. Proposals related to the environment include the purification of lagoon water, mosquito control, and the construction of buildings at elevated levels to prevent flood damage. These proposals indicate the population's concerns about the long-term sustainability of the island's natural resources in the face of increased development.

6. **Fishermen's Requests**: The fishing community has made specific proposals to ensure that their livelihoods are protected. They requested a slip road for boats and stressed the importance of maintaining access to docking areas. They specified the need to have a south docking area in order to fish in that part of the island

7. **Tourism Development and Access to the Beach**: While the community generally supports tourism as a source of economic growth, some participants propose maintaining public access to beaches and preventing large-scale gated communities that restrict access to certain areas. Specifically, many participants requested public access to the beach from the Martello Tower.

8. **Social Programs and Community Inclusion**: Many of the proposals suggest that the developers engage more directly with the local population through social programs, such as support for education, infrastructure, and youth development. The community emphasizes the need to be included not just as workers but as stakeholders in the development process, proposing that developers give back to the island in meaningful ways.

9.6. Meeting descriptions and participant comments and queries

The following section presents a detailed account of the stakeholder engagement activities conducted during the field visit from August 26th to 30th, 2024.

A systematic approach was employed to record essential information such as meeting time, location, attendance numbers, and participant genders. Moreover, a comprehensive record of stakeholder opinions, concerns, inquiries, and proposals regarding the project was maintained. While photographic documentation was sought to supplement the written records, it is important to note that not all events were captured visually due to participant preferences.

MEETING N°1		
Date	26/08/2024	
Hour	10.30 AM – 10.55 AM	
Location	Grocery store. Store in front of the church	
No of participants	1	
Gender	Male	
	Female	1
Summary of Participant Feedback	Although she supported development in general, she suggested that developers should engage more directly with the local population instead of only interacting with government officials. She also expressed her discontent, as well as mentioning that there is a general discontent among the community, regarding the management of hotels on the island. The participant commented that the port was not in proper conditions. She expressed that the port lacked basic amenities such as bathrooms and waiting areas, unlike the airport. She emphasized the need for a port that meets appropriate standards. Proposals: • Improvement of the port • Increased communication between the project owners and the local community	
General observations	The interviewee declined to provide her contact information.	

MEETING N°2		
Date	26/08/2024	
Hour	11.00 AM – 11.20 AM	
Location	Digicel Store	
No of participants	3	
Gender	Male	
	Female	3
Summary of Participant Feedback	The participants did not provide any specific comments. One of the participants expressed support for the development, stating that the idea seemed fine.	
General observations	Nea, contact: 7362303 The participants were previously aware of the project, as they had read about it online.	

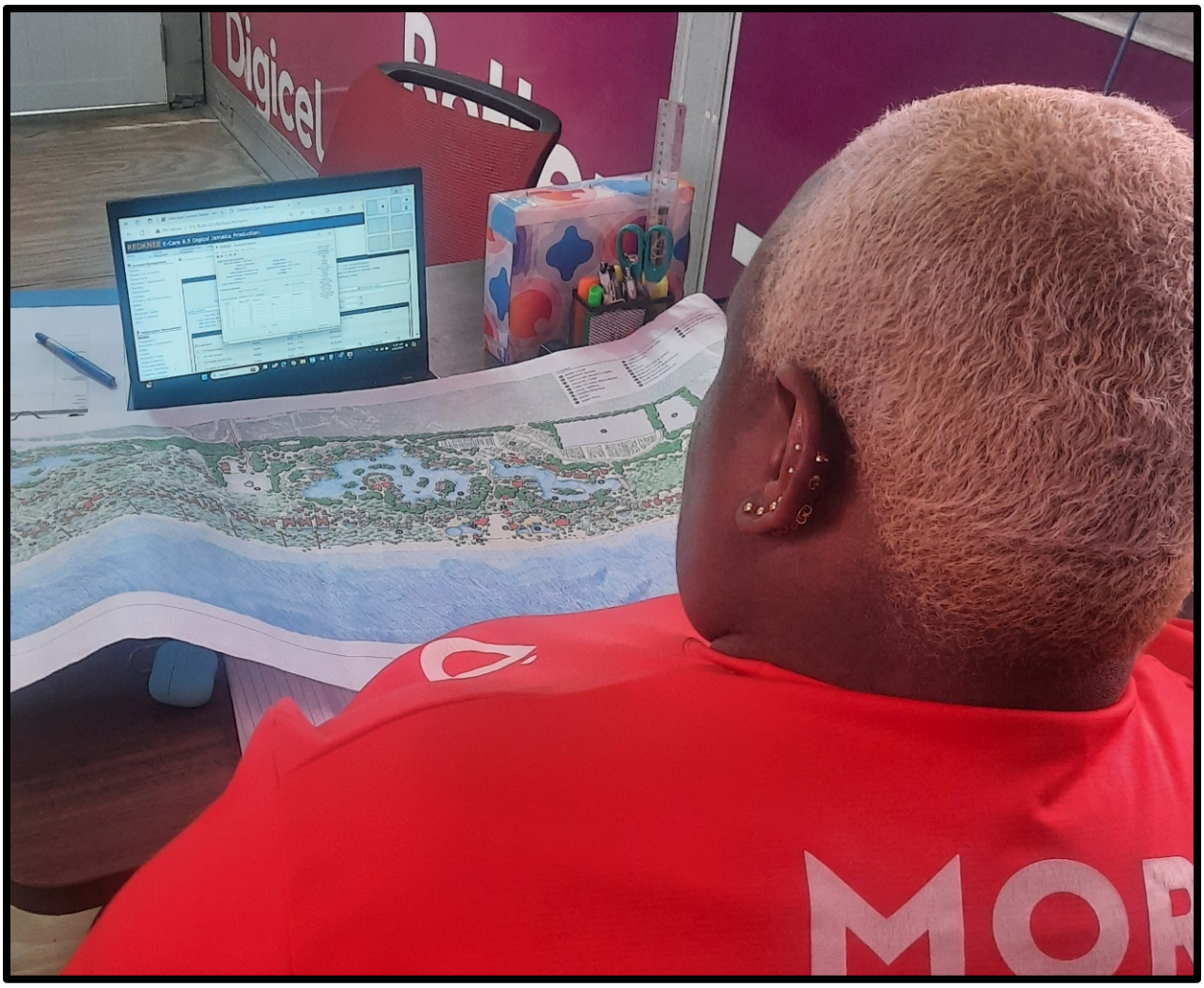

Figure.60:. Digicel Store Participation Event

MEETING N°3		
Date	26/08/2024	
Hour	11.30 AM – 11.45 AM	
Location	Barbuda's Cultural Complex	
No of participants	1	
Gender	Male	1
	Female	
Summary of Participant Feedback	Devon Warner, Chairman of Barbuda's Council, stated that the council is already familiar with the project, its location, and its scope. Moreover, he mentioned being aware of the negative environmental implications. He expressed his opposition to the project, both personally and on behalf of the council.	

	Although a meeting was proposed to discuss the matter with him and other council members and department heads from Barbuda, the chairman declined to organize or hold a meeting. He commented that they had already held meetings with the project owners.
General observations	It is important to note that following this meeting, the team was not permitted to meet with Council Members or enter the government institutions. Moreover, the team agreed to schedule a follow-up meeting on Thursday with Mr. Warner. Despite multiple attempts to contact him on Thursday and Friday, the team was unable to conduct a meeting due to his unavailability.

MEETING N°4	
Date	26/08/2024
Hour	11.45 AM – 11.55 AM
Location	Health and Wellness Center
No of participants	1
Gender	Female
Summary of Participant Feedback	The participant was informed about the project, but upon hearing the company's name, she refused to continue the discussion. She did not support the construction of resorts on the beach.
General observations	

MEETING N°5		
Date	26/08/2024	
Hour	12.00 PM – 12.40 PM	
Location	Green Grocery	
No of participants	9	
Gender	Male	7
	Female	2
Summary of Participant Feedback	During the meeting, participants required that the project create job opportunities for the local residents. One participant inquired about the future of the Martello Tower, specifically whether it would undergo renovation. Additionally, he requested public access to the beach from the Martello Tower. Calvin further mentioned that an archaeological analysis had been conducted for that part of the project's area, which included specific recommendations. He asked for the recommendations to be taken into consideration during the project's construction phase.	

	There was also a query regarding the total number of hectares encompassed by the project.
General observations	One woman expressed opposition to beach-related developments. The participants were previously aware of the project.



Figure.61:. Green Grocery Participation Event



Figure.62 Green Grocery Participation Event

MEETING N°6		
Date	26/08/2024	
Hour	13.00 PM – 13.40 PM	
Location	Highway Supermarket	
No of participants	3	
Gender	Male	
	Female	3
Summary of Participant Feedback	• Participants expressed a strong opposition to the proposed construction of additional hotels, asserting that their land and beach resources were being taken away from them. • One female participant exhibited dismay regarding the development trends in Barbuda, not focusing on this specific project but talking about general development in Barbuda over the last years.	
General observations		

MEETING N°7		
Date	26/08/2024	
Hour	15.00 PM – 15.30 PM	
Location	The Sage Table Restaurant	
No of participants	4	
Gender	Male	2
	Female	2
Summary of Participant Feedback	• Participants indicated their support for the project and expressed interest in potential jobs opportunities it may generate. • Participants emphasized the importance of incorporating environmental considerations into the architectural design of the project, for example, they noted that Barbuda is flat and below sea level island. • Furthermore, they proposed the purification of the lagoon water as a valuable addition to the project's scope	
General observations	Baejah Fryce gave her contact number: 7732461 Tyrell also participated of the meeting but did not share his phone number. They were already familiar with the project, having seen it on a Facebook page.	



Figure.63:. The Sage Table Restaurant Participation Event



Figure.64:. The Sage Table Restaurant Participation Event

MEETING N°8		
Date	26/08/2024	
Hour	15:30 AM - 16:15 AM	
Location	ACB Caribbean Bank	
No of participants	4	
Gender	Male	2
	Female	2

Summary of Participant Feedback	• The participants inquired whether people from Barbuda would have access to the resort complex.
	• They asked about the general layout of the resort accommodations, which was explained.
	• Additionally, they were interested in knowing if public access to the beach would be maintained.
	• They proposed maintaining public access to the beach from Martello Tower.
	• The participants also suggested that the project should provide some form of benefit to the community. They recommended assessing the community's needs and determining how the development could contribute to the community's well-being.
	• When asked about specific needs, they mentioned:
	  ○ Sports infrastructure: gym, a tennis and basketball court and a public pool are needed in the community.
	  ○ Provide the young ones with gym and swimming teachers.
	  ○ Improve the roads
	  ○ Social programs	

General observations	Contacts and names where provided: • Goldine John: 7294686 • Takiyah Mussinston • Demetrii Philip	



Figure.65 ACB Caribbean Bank Participation Event

MEETING N°9		
Date	27/08/2024	
Hour	10:30 AM - 11:15 AM	
Location	Fisheries	
No of participants	1	
Gender	Male	1
	Female	

Summary of Participant Feedback	Meeting with Monitque Gore, the President of the Fisheries Association. He expressed a negative valuation of the project. The general feedback can be summarized as follows: • The large cargo trucks used by current developments are damaging the road, causing frequent damages to the cars. The participant mentioned that they had to replace their tires and the front of their vehicle twice in the past six months due to the poor road conditions. • He inquired about the benefits of the resort for the community. • Concerns were raised about the numerous hotels being built along the coast, potentially isolating the Codrington community and altering the existing social structure and way of life. • Environmental issues related to other real estate developments were also discussed.
General observations	The participant expressed general opposition to this project and any other development.

MEETING N°10		
Date	27/08/2024	
Hour	11:20 AM - 11:40 AM	
Location	Lands Department	
No of participants	6	
Gender	Male	3
	Female	3
Summary of Participant Feedback	• Participants expressed concerns regarding the potential of the coast to be monopolized by developments. • The construction of a new road was met with opposition, with participants citing the cultural significance of the existing road. • The privately owned nature of certain land parcels was emphasized, underscoring the necessity of land acquisition. • Participants discussed Martello Tower and other historic landmarks in the area, underscoring the cultural importance of these sites. • Finally, participants showed not approval of the project, claiming that it will be developed in “one of the last beaches available for recreational activities”	
General observations	Most participants were not aware of the project. One woman participated but chose not to share her opinions.	

MEETING N°11	
Date	27/08/2024
Hour	12:10 PM - 1:00 PM
Location	Holly Primary school
No of participants	11

Gender	Male	2
	Female	9

Summary of Participant Feedback	• Participants asked about the anticipated impact of the project on existing local businesses in the area.
	• They advocated for the hiring of skilled labor from within the community, citing instances where previous projects had imported workers from external regions without considering local candidates for managerial positions.
	• Concerns were raised regarding the state of the island's roads, with particular emphasis on the road to be affected by the project, which is the only solid road on the island,
	• Participants requested that the new road projected should be of equal or superior quality.
	• Participants asked for the access to the beach for locals,
	• They cited the destruction of the riverfront in Antigua due to new resorts and requested a comprehensive analysis to prevent similar impacts and risks within this project.
	• They suggested that the project owner give back some benefits to the community, mentioning the following needs:
	  ○ Math and science laboratories for both schools
	  ○ Sports facilities at the school
	  ○ Air conditioning in the school
	• Questions were raised about the public accessibility of specific restaurants and areas within the project.	

General observations	• Peter Asked for information regarding the existing business in the project's area. 721 2689. • Amelia: Asked information regarding the availability of restaurants and other amenities for the locals. 773 4684 • Karina Balthimore. kerigold2015@gmail.com	



Figure.66 Primary and Secondary teachers – Holy Primary School Participation Event



Figure.67 Primary and Secondary teachers – Holy Primary School Participation Event

MEETING N°12		
Date	27/08/2024	
Hour	2:00 PM - 2:30 PM	
Location	Stage Table	
No of participants	1.	
Gender	Male	1
	Female	
Summary of Participant Feedback	• Concerns were expressed about the environmental impact, particularly regarding the high-water table in Barbuda. • The participant acknowledged that the development could be beneficial but noted that Barbuda is a unique place. While it might improve the landscape, it could also have negative effects. • He requested that Martello Tower be preserved and restored. • Questions were raised about Te Amo Beach Bar and what compensation might be offered. The participant was informed that a response would be provided.	

	• He inquired about a fishermen dock and requested that one be built. • Concerns were raised about the ferry's location and whether it would need to be moved. • The participant emphasized the importance of hiring and properly training local labor. • He highlighted the need for the local community to feel included in the project, suggesting that the community should receive something in return, such as support for the school, infrastructure improvements, a horse carriage for tourism, and that the project should avoid getting involved in local politics. • The participant highlighted the importance of incorporating community feedback to ensure the development includes the people of Barbuda in a harmonious rather than confrontational manner.
General observations	Meeting with Dwayne Hill the owner of the restaurant. He provided contact information: 721 1955 He was in favor of the project and asked for a job. He was already aware of the existence of the resort.

MEETING N°13		
Date	27/08/2024	
Hour	2:40 PM - 2:55 PM	
Location	Purple Haze Bar and Restaurant	
No of participants	3	
Gender	Male	2
	Female	1
Summary of Participant Feedback	• Participants asked when the project would start and who would own the properties. • They commented that the development is much needed on the island.	
General observations	They did not know of the existence of the project. Celeste Thomas gave her contact number 732 6080	



Figure.68 Purple Haze Bar and Restaurant Participation Event

MEETING N°14		
Date	27/08/2024	
Hour	3:30 PM - 4:00 PM	
Location	River Dock	
No of participants	2	
Gender	Male	2
	Female	
Summary of Participant Feedback	• The participants supported the project and requested a slip road for their boats. • They mentioned that in severe weather, they often take their boats ashore to prevent damage.	
General observations		



Figure.69 River Dock Participation Event



Figure.70 River Dock Participation Event

MEETING N°15		
Date	27/08/2024	
Hour	4:15 PM - 4:45 PM	
Location	River Dock	
No of participants	4	
Gender	Male	4
	Female	
Summary of Participant Feedback	• The participants were concerned about the potential impact on marine life and the sustainability of their livelihoods. • They believe that the development would be beneficial for the island and its residents. • They noted that another real estate project had promised a dock specifically for fishermen near Coco Point, (close to where they usually do their fishing activities), but this promise has yet to be fulfilled. • They warned that the project "Is going to be a problem due to its location." Nevertheless, they are in favor of this type of developments, as they bring economic benefits to the island.	
General observations		



Figure.71 River Dock Participation Event

MEETING N°16		
Date	27/08/2024	
Hour	6:20 PM - 6:40 PM	
Location	Dulcina's Apartments	
No of participants	2	
Gender	Male	2
	Female	

Summary of Participant Feedback	• Participants inquired about the project's start date and were informed that the exact timing is not yet known.
	• They expressed appreciation for the planned landscaping shown on the project map.
	• They requested that job opportunities be made available to locals.
	• They asked whether timeshares or rentals would be available for the locals.
	• They inquired about what the community would receive in return for the project and suggested the following:
	  • Improvement of roads
	  • Construction of community centers
	  • Scholarships for young people
	  • A training center to prepare local youth for higher-level positions at the hotel	

General observations	The participants were supportive of the project and were already familiar with it.	

MEETING N°17		
Date	28/08/2024	
Hour	08.00 AM – 8.20 AM	
Location	River Dock	
No of participants	2	
Gender	Male	1
	Female	1
Summary of Participant Feedback	• Asked who the project owner is. • Inquired about the project start date. • Views the project as having both positive and negative aspects. Positively, they highlighted job creation, tourism, and the overall development of the island. • Negatively, the participants expressed concerns about the potential rise in crime and mentioned that outsiders might take advantage of the limited education available on the island.	
General observations	Sand. contact: 723 5012	



Figure.72 River Dock Participation Event

MEETING N°18		
Date	28/08/2024	
Hour	09.00 AM – 9.15 AM	
Location	River Dock	
No of participants	2	
Gender	Male	
	Female	2
Summary of Participant Feedback	• Participants had few comments, they mainly listened to the project description. • They expressed support for the project “as long as local people are taken care of.” • When asked what "taken care of" meant, they emphasized the importance of job creation for locals.	
General observations	Participants were in favor of the project.	



Figure.73 River Dock Participation Event

MEETING N°19		
Date	28/08/2024	
Hour	09.50 AM – 10.20 AM	
Location	River Dock	
No of participants	6	
Gender	Male	6
	Female	
Summary of Participant Feedback	• The meeting was attended by cargo workers and individuals involved in coastal cleanup efforts • Participants expressed support for the proposed development. • Mr. Eldon, a participant, underscored the need for job creation within the community. • Inquiries were made regarding the start date for construction; however, it was clarified that the specific timeline remains uncertain. • Participants expressed their belief in the project's potential to catalyze development and attract investment, leading to increased job opportunities.	

	• The necessity for road improvements and the creation of a sideline was emphasized.
General observations	



Figure.74 River Dock Participation Event

MEETING N°20		
Date	28/08/2024	
Hour	10.30 AM – 11.10 AM	
Location	River Dock. Barbuda Express Ferry	
No of participants	13	
Gender	Male	12
	Female	1
Summary of Participant Feedback	• Participants acknowledged the potential for job creation as a positive outcome of the project. • Questions were raised regarding local access to the beach, the relocation of the port and river dock, and the access to Martello Tower.	

	• One participant expressed concerns about the potential for project profits to leave Barbuda, advocating for measures to retain economic benefits within the community. Participants requested that a portion of the project's profits remain in Barbuda, suggesting specific measures such as local taxes, scholarships, job creation, and career development programs. • Concerns were raised about the potential impact of the project on the livelihood of locals and the relationship between the project and the community. • While some participants expressed support for the project, others voiced opposition, citing potential damage to the ecosystem, particularly the bird sanctuary, and increased vulnerability to hurricanes due to the island's low elevation. • The location of boats for fishermen was discussed, with participants expressing a preference for maintaining their current location and highlighting the unsuitability of the east side of the river dock. • They highlight the need for a southern location for docking the boats, due to the fishing activity on that side of the island.
General observations	The meeting included five ferry workers and seven fishermen.



Figure.75 Barbuda Express Ferry Participation Event



Figure.76 Barbuda Express Ferry Participation Event

MEETING N°21		
Date	28/08/2024	
Hour	02.00 PM - 02.20 PM	
Location	Hospital	
No of participants	3	
Gender	Male	
	Female	3
Summary of Participant Feedback	• Participants emphasized the importance of climate change, noting that the beach is no longer what it used to be and that storms cause regular damage in the area of the proposed project. • They recommended to build houses at elevated levels to prevent damage. • Asked whether local people would have job opportunities at the resort. • One participant, while not opposed to the project, insisted that Barbudans should be "on the top of the list."	

	• Another participant expressed skepticism about the project starting, mentioning that many projects often remain as proposals and are never executed.
General observations	The meeting involved hospital workers, including a disaster management worker and an administrative employee.

MEETING N°22		
Date	28/08/2024	
Hour	02.30 PM - 02.45 PM	
Location	Hospital	
No of participants	2	
Gender	Male	
	Female	2
Summary of Participant Feedback	• One participant express support for the project, while the other displayed limited interest and explicitly stated her lack of enthusiasm. • Questions were raised regarding the hiring of Barbudans and the potential need for specific vaccinations as a prerequisite for employment. • One participant inquired about the need for the lake construction, expressing concerns about the potential for flooding, based on recent experiences with artificial lakes created at Pareto's Point. • The availability of public beach access was confirmed in response to participant inquiries. • Participants asked about the relationship between Rosewood and PLH. • They supported the project if it would bring revenue to the community. • Finally, they expressed concerns about the mangroves.	
General observations	• The participants were hospital administrative staff. • Contact provided: Abi – 719 246	

MEETING N°23		
Date	28/08/2024	
Hour	03.00 PM - 03.20 PM	
Location	Ariel Bar and Restaurant	
No of participants	4	
Gender	Male	
	Female	4
Summary of Participant Feedback	• Participants viewed the project positively, believing that Barbuda has the potential to become a highly sought-after tourist destination. • They mentioned that the project provides opportunities for individuals to come and work.	

	• It was observed that the new projects are leading to increased employment opportunities for locals, although there are some who may not be interested in pursuing these opportunities. • They highlighted the importance of providing quality accommodation for workers to come to the island to work in projects.
General observations	

MEETING N°24		
Date	28/08/2024	
Hour	03.50 PM - 04.15 PM	
Location	Street	
No of participants	2	
Gender	Male	1
	Female	1
Summary of Participant Feedback	• Participants expressed the belief that Barbuda does not require additional development, citing the presence of established projects such as Nobu and PLH. They consider that there is a development saturation. • Concerns were raised about the excessive accumulation of beach area, with participants noting that the entire southern part is already occupied by developments. • A temporary pause before the initiation of any further projects was suggested. While not opposed to development, participants expressed a preference for delaying new projects for a few years	
General observations		

MEETING N°25		
Date	28/08/2024	
Hour	05.00 PM – 05.30 PM	
Location	“Wa’omoni Bestaurant”	
No of participants	1	
Gender	Male	
	Female	1
Summary of Participant Feedback	• The project was described as being "crazy" and excessively large. • The absence of an access road to the beach from Martello Tower was disapproved of. • A preference for smaller-scale boutique establishments over large-scale developments was expressed. • Concerns were raised about the potential difficulty in finding a sufficient number of workers to meet the demands of such a large project. Additionally, there was apprehension that an	

	influx of workers could contribute to an increase in crime on the island.
General observations	



Figure.77 “Wa’omoni Bestaurant” Participation Event

MEETING N°26		
Date	28/08/2024	
Hour	05.15 PM – 06.00 PM	
Location	Antigua	
No of participants	1	
Gender	Male	1
	Female	

Gender	Male
Summary of Participant Feedback	• A meeting with Purcell Bird took place in Antigua. • He is the land owner • Mr. Bird provided background information on the project conception and licensing and approval efforts.
General observations	Contact number: 773 8551

MEETING N°27		
Date	29/08/2024	
Hour	10.30 AM – 11.00 AM	
Location	Cool Kids Daycare	
No of participants	3	
Gender	Male	1
	Female	2
Summary of Participant Feedback	• Participants asked if the sand mine, bar, and ferry dock would need to be relocated • Considered the project to be good overall. • Stressed the importance of training Barbudans to work in the project. • They also questioned whether another project was necessary, given the number of ongoing developments. • Finally, they asked about land acquisition, noting that the land has multiple owners and that arrangements need to be made with each.	
General observations	The meeting included the daycare owner, an employee, and a parent who stayed to participate.	

MEETING N°28		
Date	29/08/2024	
Hour	11.15 AM – 11.50 AM	
Location	Timbuk One	
No of participants	3	
Gender	Male	
	Female	3
Summary of Participant Feedback	• Participants inquired about the origin of the firm. They expressed support for the project, noting that it will contribute to the growth of their business. • Questions were raised regarding the future of Martello Tower and the location of the project, to which responses were provided. • They asked about the start date of the project, and it was communicated that the exact date is currently uncertain.	

	• They expressed their approval of the project, highlighting positive aspects such as the increase in tourism, the creation of more jobs for locals, and the renewal of the country. • Concerns were raised about whether the houses will be built on elevated structures to prevent flooding. They mentioned that the area remains submerged for weeks when it floods. • Participants emphasized that Barbuda and the community require support, particularly in infrastructure such as roads. They noted that the town needs various facilities, including commercial spaces, a gym, public pools, businesses, shopping malls, parks, a children's playground, and venues for events like concerts. They commented that Barbuda is very flat and lacks many amenities. • As a negative aspect, they mentioned that bringing in people from various places could make Barbuda a dangerous area. They stressed the importance of establishing a certain standard of living for the workers. • They also recommended ensuring good hygiene in the lagoons due to concerns about mosquitoes.
General observations	The participants were Kenya and Lorraine, who are employees, and Michelle, the owner.



Figure.78 “Timbuk One Participation Event

MEETING N°29		
Date	29/08/2024	
Hour	12.00 PM – 12.30 PM	
Location	Mechanics place	
No of participants	3	
Gender	Male	2
	Female	1
Summary of Participant Feedback	• Miranda Thomas claimed ownership of the land that Purcell asserts is his. She mentioned having documentation from 1993, while Purcell holds documentation from 2016 for the same land. Additionally, she commented that she is currently involved in a legal dispute with Roosevelt over the land. • She stated that she is not in favor of the project, as it infringes on her land. • Environmental concerns were also highlighted. The participants noted that the project would destroy the coastline and the mangroves.	

	• Another participant commented, "I don't like the project because I'm Barbudan. Once people start taking land away, there is no turning back."
General observations	

MEETING N°30		
Date	29/08/2024	
Hour	12.35 PM – 12.50 PM	
Location	Rute 1 – Private House next to mechanic	
No of participants	2	
Gender	Male	
	Female	2
Summary of Participant Feedback	• A participant asked if the project would benefit the local people. General positive social impacts of the project were discussed and exposed. • They mentioned that developments are good for the island. • Inquired whether the access would be public or private. • They also asked if local people would be hired for the project. • Concerns were raised about potential issues with the road and the businesses that were projected to be placed along it. While they mentioned that this was not a personal concern, they noted that the community might not be in favor. • As an idea, they proposed establishing a differential pricing for locals who might want to use the constructed facilities.	
General observations		

MEETING N°31		
Date	29/08/2024	
Hour	02.20 PM – 02.35 PM	
Location	Airport	
No of participants	5	
Gender	Male	2
	Female	3
Summary of Participant Feedback	• The airport workers expressed concerns and none of them appear to support the project. • They pointed out that the roads in the area are in poor condition. • When shown the new access road, one participant voiced disapproval. • They inquired if the project would be a gated community. • They promptly ended the meeting and invited the team to leave after five minutes.	

General observations	

MEETING N°32		
Date	29/08/2024	
Hour	03.00 PM – 03.35 PM	
Location	Abundant Life Ministries Church	
No of participants	1	
Gender	Male	1
	Female	
Summary of Participant Feedback	• The participant supports the project and the progress of the island. • He highlighted that current access to the beach is poor, with residents being prevented from accessing the beach by security at other nearby resorts. He noted that fishermen are also restricted from operating near these areas. He suggested that this issue could be resolved by enforcing the legislation that mandates a 50-foot public right of way. • Expressed concern about the lagoons, rainfall, and natural water drainage, recommending that construction be elevated to prevent flooding. • While supportive of progress, he emphasized the importance of listening to and engaging with the local community. • Opposed the idea of farming within the hotel, as it could lead to reduced purchases from local producers. • In favor of job creation. • As community needs, he emphasized the need to make improvements to roads and to enhanced safety measures on the ferry.	
General observations		



Figure.79 “Abundant Life Ministries Church Participation Event

MEETING N°33		
Date	29/08/2024	
Hour	16.00 AM – 16.30 AM	
Location	Gas Station	
No of participants	3	
Gender	Male	2
	Female	1
Summary of Participant Feedback	• Participants asked whether the project would be open to locals and if it would operate as a timeshare. • They mentioned that access to Pareto Point is already restricted, and they have difficulties accessing some areas and beaches. They expressed concerns about access to the beach within the project area. • Participants noted that certain beaches hold cultural significance, particularly for picnics during holidays, and requested direct access to the beach from Martello Tower. • They supported the development, as long as it does not restrict beach access. • Additionally, they highlighted the vulnerability of that part of the island to natural disasters and hurricanes, expressing concern that the number of ongoing developments might negatively impact the environment.	

General observations	



Figure.80 Gas Station Participation Event

MEETING N°34		
Date	30/08/2024	
Hour	10.00 AM – 10.25 AM	
Location	Fisheries.	
No of participants	3	
Gender	Male	2
	Female	1
Summary of Participant Feedback	• Participants expressed support for the project, believing it would bring more tourism and employment. • They acknowledged potential community issues related to beach access due to the project. • They inquired about the timeline for completing the hotel. • Participants emphasized the need for road improvements and better equipment for the hospital, such as an X-ray machine.	

General observations	The participants were employees of the Barbuda Bell hotel and provided their contact information:



Figure.81 Fisheries Participation Event

MEETING N°35		
Date	30/08/2024	
Time	11:00 AM – 11:25 AM	
Location	Fisheries	
No of participants	4	
Gender	Male	2
	Female	2
Summary of Participant Feedback	• Participants asked if the dock would be improved and inquired about job opportunities and the project start date. • One participant expressed interest in working in security for the project. • They questioned the ownership of the land. • They stated that as long as the project benefits Barbudans, they would support it.	

	• They remarked that the project looks “good on paper.”
General observations	Two participants were workers from the Barbuda Department of Tourism, and one was a school bus driver.



Figure.82 Fisheries Participation Event

MEETING N°36		
Date	30/08/2024	
Time	12:00 PM – 12:15 PM	
Location	Hospital	
No of participants	1	
Gender	Male	1
	Female	
Summary of Participant Feedback	• The participant expressed strong opposition to the project and to the developments in Barbuda in general. • He identified himself as a secessionist. • A detailed explanation of the project boundaries was not provided because the participant interrupted the presentation, as he was against the project.	
General observations	The participant was the driver of a vehicle belonging to the hospital unit. He expressed significant anger towards the project.	

MEETING N°37		
Date	30/08/2024	
Time	14:10 PM – 14.40 PM	
Location	Te Amo Beach Bar	
No of participants	4	
Gender	Male	2
	Female	2
Summary of Participant Feedback	• Participants inquired about job opportunities, particularly one individual who owns a trucking company, Darby C. Enterprise Construction. He mentioned that they had previously worked for PLH but ceased due to "issues with payment." • They asked about the ownership of the development. • Another participant asked when the project would start. • The group expressed support for the project, provided that locals are involved. • They raised concerns about access to the beach areas	
General observations	Te Amo Beach Bar is managed by Nigel Archibald. Contact: 726 2353. The area includes two establishments: a recently opened food venue and Te Amo Beach Bar.	

MEETING N°38		
Date	30/08/2024	
Time	15:30 PM – 16:00 PM	
Location	Rute 1	
No of participants	6	
Gender	Male	1
	Female	5
Summary of Participant Feedback	• Participants requested that beach access be maintained for locals. • They inquired if this project was related to the "Dulcina Project," a previous housing development that did not succeed. • They asked how the project would benefit the community. • They emphasized the importance of monitoring the mangroves and protecting the environment. • Participants expressed support for the project, especially for job creation for locals. • They questioned why all developments are concentrated on the coast rather than in the town, where quality of life could be improved. • They highlighted the importance of contributing to society, particularly to children, suggesting the creation of a learning center, tennis courts, and hiring a tennis coach. They stressed the importance of looking after future generations.	
General observations		

MEETING N°39		
Date	30/08/2024	
Time	16:00 PM – 16:25 AM PM	
Location	State Insurance Company	
No of participants	3	
Gender	Male	1
	Female	2

Summary of Participant Feedback	• Participants expressed interest in applying for jobs and emphasized the need for well-paid positions, including higher-level roles.
	• They inquired about environmental impacts and the risk of flooding in the area.
	• They viewed the project positively, believing it would bring good opportunities, and expressed eagerness for its commencement.
	• Participants suggested initiatives to enhance the local workforce and maintain good working relationships, stating that land is sacred to the people of Barbuda and that the company should commit to the community.
	• When asked how the project could help the community, they mentioned
	  ○ Improving roads,
	  ○ Implementing school programs,
	  ○ Offering scholarships for young people
	  ○ Supporting community development,
	  ○ Providing uniforms,
	  ○ Collaborating with churches,
	  ○ Assisting underprivileged people	

General observations	Two participants were employees of the State Insurance Company, and one was an employee of Barbuda Landscaping Co.,	



Figure.83 State Insurance Company Participation Event

MEETING N°40		
Date	30/08/2024	
Hour	16.35 PM – 17.00 PM	
Location	Block Club Building	
No of participants	2	
Gender	Male	2
	Female	
Summary of Participant Feedback	• Participants believe that the project is utilizing an excessive amount of land. • They asked if the project owners have permission to acquire the land, saying that they have to meet with the council to address these matters.	
General observations		



Figure.84 Block Club Building Participation Event

MEETING N°41		
Date	30/08/2024	
Hour	17.30 PM – 17.55 PM	
Location	Shack-a-Kai.	
No of participants	1	
Gender	Male	1
	Female	
Summary of Participant Feedback	• He inquired whether the lease has already been secured and who the owner of the property is. • He believes there are already too many developments on the island, which has led to an increase in crime. • He highlighted prostitution as a significant issue in the town, attributing it to the influx of workers from other counties. • He expressed concern that the peace and tranquility of the community will be disrupted, stating that he is not in favor of the project. • He argued that these developments exacerbate social inequality, with the wealthy living in gated communities with	

	security while poverty—and consequently crime and prostitution—continues to rise.
General observations	

9.7. Final considerations

The stakeholder engagement process that took place between August 26 and August 30, 2024, represents a critical component in aligning the Murbee Resort project with the interests and concerns of the Barbuda community. The series of consultations, focus groups, and impromptu field discussions reflected a dynamic, multi-layered dialogue between the project's proponents and various community stakeholders.

The objective of these consultations was to gather diverse perspectives, ensuring that all stakeholders—ranging from government representatives, business owners, workers, and community members—had the opportunity to express their views and concerns regarding the proposed development. The process also aimed to provide transparency and foster an inclusive environment where community members are heard and valued in the decision-making process.

The feedback gathered during the consultations presents a complex picture of how the Barbuda population perceives the Murbee Resort project. Many stakeholders, especially those involved in businesses such as restaurants, shops, and other service-oriented sectors, expressed optimism about the economic opportunities the project could generate. Participants noted that the resort could potentially increase tourism, create jobs, and stimulate economic growth for local businesses, particularly in hospitality and retail sectors.

However, despite these positive expectations, there were also strong reservations and negative sentiments expressed by various groups. Many community members, particularly those engaged in environmental activities or traditional sectors like fishing, raised significant concerns about the potential ecological impact of the project. The loss of access to key fishing areas and the potential damage to marine ecosystems were recurring themes during these discussions. Fishermen and other stakeholders voiced the fear that development could permanently disrupt the natural landscape and lead to the degradation of the island’s unique biodiversity.

In total, 41 different consultations were held over five days, with 136 participants, spanning community members, business owners, government officials, and institutional representatives. These meetings were held across various venues, including shops, schools, restaurants, and key community gathering points, ensuring that a wide cross-section of Barbuda’s population was engaged in the process.

A key element of the consultation process was the inclusion of both pre-scheduled meetings and spontaneous discussions with harder-to-reach groups. This combination of approaches ensured that a broad spectrum of stakeholders was involved, including those who might have otherwise been excluded due to limited communication access or mobility issues.

The meetings were held in diverse locations, from public institutions such as the Barbuda Council, the Hannah Thomas Hospital, and local schools, to informal settings like grocery stores, restaurants, and public gathering areas. This wide range of venues facilitated participation from various sectors of the community, allowing for richer, more inclusive dialogue. In addition to formal

stakeholders such as business owners, council members, and institutional representatives, ordinary citizens and workers were actively engaged, particularly through impromptu discussions in places like shops and the River Dock.

One of the most notable aspects of the consultation process was the involvement of gender-balanced groups. Out of the 136 participants, 67 were women, and 69 were men, allowing for a more comprehensive understanding of gender-specific concerns and priorities.

As previously noted, the feedback from stakeholders reflected a mix of optimism and caution. On the positive side, many stakeholders, especially business owners and some government representatives, were enthusiastic about the potential economic benefits of the Murbee Resort project. For many, the prospect of job creation and increased tourism was seen as a much-needed boost for Barbuda's economy, which has struggled with limited opportunities for growth in recent years. Small business owners, particularly in the hospitality and retail sectors, were hopeful that the influx of tourists would result in more customers and increased demand for local goods and services.

The positive feedback was particularly strong among workers in service industries such as restaurants, bars, and shops. For instance, during consultations held at local restaurants like The Sage Table and Ariel Bar and Restaurant, participants expressed optimism about the potential rise in tourism-related business activity. Similarly, workers at the ACB Caribbean Bank and the State Insurance Company viewed the project as an opportunity to expand their services and play a more prominent role in the local economy.

Nevertheless, this optimism was tempered by deep-seated concerns among other segments of the population. Fishermen, and local residents voiced strong opposition to the project due to fears of environmental degradation. The consultations at the River Dock and the Fisheries Association, in particular, highlighted the risks of losing access to vital fishing grounds and the potential destruction of marine habitats. Fishermen were particularly concerned about how the construction of the resort might disrupt their livelihoods, emphasizing that the fishing sector plays a critical role in Barbuda's economy and identity.

Moreover, several participants voiced concerns about the long-term social and cultural impacts of the resort. Community members raised questions about the potential loss of traditional lands, changes to public access areas like beaches, and the potential for increased social inequality and crime associated with rapid tourism development. These concerns were especially evident during consultations held with community members at the Green Grocery and the Block Club Building, where many voiced the fear that the project could exacerbate social divides and disproportionately benefit foreign investors at the expense of local residents.

Throughout the consultation process, stakeholders offered a variety of proposals and raised critical questions regarding the future of the project. Among the most frequently discussed topics were infrastructure improvements, environmental protection, and the equitable distribution of economic benefits.

Many participants called for investments in local infrastructure, including roads, waste management systems, and community facilities, as part of the project's development plan. Local residents stressed the importance of ensuring that the benefits of the Murbee Resort extend beyond the resort itself to improve the overall living conditions on the island. The consultations at

Cool Kids Daycare and Holly Primary School, for example, highlighted the need for educational infrastructure to keep pace with future development.

Lastly, stakeholders raised important questions about the timeline of the project, who would benefit from it, and how it would affect public access to key areas. The duality of the community's perspectives highlights the importance of continued dialogue and transparency as the project moves forward. While many stakeholders are open to the potential benefits, they want assurances that the project will be conducted with careful consideration of the island's unique ecological and cultural heritage.

9.8. Stakeholder Engagement Limitations

This section details the main limitations encountered during the participation process:

- There was no consultation with council members or state representatives. The team held a first meeting with Mr. Devon Warner, the Chairman of Barbuda's Council. He stated that the council was already familiar with the project, expressed opposition to it (both personally and on behalf of the council) and declined to organize or hold a meeting with the council members. It is important to note that following this meeting, the team was not permitted to meet with Council Members or enter the government institutions. Moreover, a follow-up meeting was agreed for Thursday with Mr. Warner. Despite multiple attempts to contact him on Thursday and Friday, the team was unable to conduct a meeting due to his unavailability.
- Vulnerable populations (children, the elderly, and those reliant on care facilities), were underrepresented in the stakeholder engagement process. While consultations were held with representatives from schools and the hospital, the broader participation of vulnerable groups and their advocates was limited.

10. CONCLUSIONS AND FINAL RECOMMENDATIONS

The Socioeconomic Assessment for the Murbee Resort Inc. provides a comprehensive evaluation of the potential social and economic impacts that the project development may have on the local community in Barbuda.

Through a combination of primary fieldwork and secondary data collection, including stakeholder consultations and public engagement, the assessment has identified both positive and negative impacts and risks associated with the project.

The project is anticipated to significantly impact the local economy, socio-cultural dynamics, and environment, offering both opportunities and challenges to the community.

From an economic perspective, the resort's development is expected to inject substantial investment flows into the island, creating jobs in the construction sector and related industries and services. This influx of employment could enhance livelihoods, boost local businesses, and contribute to Barbuda's overall economic growth. Furthermore, the development of infrastructure, including new residences and enhanced facilities, presents opportunities for long-term economic stability and growth.

The Socioeconomic Assessment also identifies several potential risks, particularly concerning local livelihoods and cultural heritage. Fishing and sand mining are critical economic activities in Barbuda, and the resort's construction may disrupt these industries. The relocation of fishermen and the potential reduction in access to key resources necessitates careful planning and mitigation efforts.

The proximity of the project to the historic Martello Tower also presents risks on the preservation of cultural heritage. As an important archaeological and historical site, ensuring the Martello Tower remains intact and protected is crucial. The Socioeconomic Assessment emphasizes the need for a robust cultural preservation plan that balances development with the conservation of Barbuda's cultural identity.

Moreover, increased traffic and pressure on essential infrastructure and utilities during construction pose risks to the community's daily life and mobility. Coordinated efforts with local service providers are needed to minimize disruptions to water, electricity, and road networks.

Another key aspect is the social integration of the project within Barbuda's community. As a small island with a strong cultural identity rooted in its natural environment, Barbuda faces the risk of social fragmentation if the project is not managed inclusively. Ensuring that local voices are integrated into ongoing project plans and that community benefits are equitably distributed is fundamental to the project's success.

The Social Management Plan (SMP) outlines mitigation strategies for these risks. Key programs include traffic and pedestrian management, community health and safety protocols, livelihood restoration plans for fishermen, and the preservation of cultural heritage. Additionally, the project commits to maintaining transparent communication with the community, establishing grievance mechanisms, and adhering to international standards such as the IFC Performance Standards.

The following recommendations outline key areas for consideration to guarantee the effective implementation of social measures at all stages of the project.

No.	Specific area	Consideration and recommendation
1	**Strengthening Stakeholder Engagement and Communication Channels** **Ongoing Public Socialization and Participation:**	Create continuous opportunities for public participation throughout the project's lifecycle: • **Socialization of the Final ESIA** (Environmental and Social Impact Assessment): Once the ESIA is finalized, socialize its findings and the mitigation measures planned. This ensures transparency and community understanding of the project's environmental and social impacts. • **Regular Project Updates**: As the project moves forward, maintain a steady flow of communication with the community through newsletters, meetings, and digital platforms. These updates should cover project progress, important environmental and social measures taken, and anticipated milestones, such as construction completion timelines. • **Pre-construction and Operational Communication**: Before construction starts, organize public engagement sessions to update the community on final timelines, mitigation strategies, and construction phases. During the operational phase, continue to inform the public of any changes, impacts, or relevant developments. Establish a formal communication channel to create reliable and private communications between the project developers and the community, including an institutional email address and regular follow up meetings with key community groups, including fishers, business owners and local institutions.
2	**Fishermen and Dock Relocation**	Engage with the local fishermen to negotiate and agree on a suitable relocation site for the dock, ensuring minimal disruption to their livelihoods. • **Collaborative Decision-making:** The project team should work closely with the fishing community to identify an alternative docking location in the south of the island that is both accessible and safe. Meetings should be held to address the concerns of fishers and agree on a mutually beneficial solution. • **Dock Improvement Plan:** Once the relocation site is chosen, create a plan that includes upgrades and infrastructure that will benefit the fishermen, ensuring that they have the facilities needed for their work post-relocation.

No.	Specific area	Consideration and recommendation
3	**Cultural Heritage Preservation and Community Engagement**	As the Martello Tower is within the project area and holds cultural significance, it is imperative to: • **Define Responsibilities for Restoration**, including the development of the restoration plan • **Community Consultation and Transparency**: Share detailed plans with the local community regarding how the Martello Tower will be preserved. This includes a public presentation of the timeline for restoration, renders, materials to be used, and any other heritage preservation actions.
4	**Economic Compensation and Support for Affected Businesses**	Provide clear documentation to the community regarding the compensation agreements made with business owners affected by the project. These documents should include: • **Compensation Details**: Specify the types of compensation offered, such as financial payments, relocation assistance, or alternative business opportunities. This ensures transparency and addresses any concerns about fairness or exclusion. • **Public Presentation of Agreements**: Hold community meetings or release documents outlining the specific conversations held with business owners in the area, making it clear how each will be compensated for any loss or disruption of business.

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APENDIX DOCUMENTATION

APENDIX 1. GENERAL SOCIAL INTERVIEWS

GENERAL INFORMATION		
1	No. Of Interview	
2	Location	

SOCIODEMOGRAFIC INFORMATION	
Name	
Birth of Birth	
How long have you been living in Barbuda?	
What facilities do you have access to? (water, electricity, etc.)	

EDUCATION	
What is your highest level of education?	
How many schools are there in Barbuda?	
If you have children, where do they go to school?	
How far is the school from your home?	

HEALTH	
Are there hospitals or other health institutions in your area?	
Do you have health insurance?	
Do you use traditional medicine? If so, which types?	
What is your general opinion of the health services in Barbuda?	

ECONOMY	
What are the typical economic activities?	
What is your job or main economic activity?	

COMMUNICATION	
What media do you usually use to get information?	

What is the level of connectivity? (internet, cellphone, etc.)	

TRANSPORT	
What means of transport do you generally use?	
Do you have your own means of transport? (e.g., car, motorcycle, etc.)	
Is there public transportation available?	
Do you use airplane or ferry services?	
What is your general opinion about the transport services offered on the island?	

CULTURAL ACTIVITIES	
Are there social organizations in Codrington?	
Do you attend any social organizations?	
What are the typical festivities and activities in Codrington?	

TOURISM	
What is the level of tourism in Barbuda?	
What are the relevant touristic attractions?	
What is your perception of tourism?	

COMMUNITY	
What do you value positively about Codrington?	
What are the negative aspects?	
Are there any social conflicts in your community?	

APENDIX 2. FISHERMEN INTERVIEWS

GENERAL INFORMATION	
1 **No. Of Interview**	
2 **Location**	
Name	
Place of Birth	
How long have you been living in Barbuda?	
What facilities do you have access to? (water, electricity, etc.)	

EDUCATION	
What is your highest level of education?	
How many schools are there in Barbuda?	
If you have children, where do they go to school?	
How far is the school from your home?	

HEALTH	
Are there hospitals or other health institutions in your area?	
Do you have health insurance?	
Do you use traditional medicine? If so, which types?	
What is your general opinion of the health services in Barbuda?	

ECONOMY	
What are the typical economic activities?	
What is your job or main economic activity?	
What percentage of your total income comes from fishing?	
Where do you usually go for fishing?	

What facilities or infrastructure do you need for your fishing activities?	
What types of fish do you catch?	
Your fishing activities are primarily for commercial purposes or for your own consumption?	

COMMUNICATION	
What media do you usually use to get information?	
What is the level of connectivity? (internet, cellphone, etc.)	

TRANSPORT	
What means of transport do you generally use?	
Do you have your own means of transport? (e.g., car, motorcycle, etc.)	
Is there public transportation available?	
Do you use airplane or ferry services?	
What is your general opinion about the transport services offered on the island?	

CULTURAL ACTIVITIES	
Are there social organizations in Codrington?	
Do you attend any social organizations?	
What are the typical festivities and activities in Codrington?	

TOURISM	
What is the level of tourism in Barbuda?	
What are the relevant touristic attractions?	
What is your perception of tourism?	

COMMUNITY	
What do you value positively about Codrington?	

What are the negative aspects?	
Are there any social conflicts in your community?	

APENDIX 3. STAKEHOLDER ENGAGEMENT PLAN SUMMARY

STAKEHOLDER ENGAGEMENT PLAN

MURBEE RESORT PROJECT

DEBORAH BROSNAN & ASSOCIATES



OBJECTIVES OF THE STAKEHOLDER ENGAGEMENT PROCESS

1. **Ensure participation** from local population, social organizations' representatives and public institutions in the Project's development.
2. **Enhance Transparency.** Provide clear and accessible information about the project, its impacts, and the design decision-making processes.
3. **Gather Input and Feedback.** Collect opinions, concerns, and suggestions from the community and stakeholders. This ensures that diverse perspectives are considered, and that the community feels involved and valued
4. **Identify and Address Potential Issues**: Identify potential conflicts, concerns, or issues early in the process. Addressing these issues proactively can help mitigate risks and enhance the overall success and acceptance of the project.

DEBORAH BROSNAN & ASSOCIATES

STAKEHOLDER ENGAGEMENT PROCESS: FOUR STEPS

1. IDENTIFICATION OF STAKEHOLDERS

2. DESIGN OF PARTICIPATION STRATEGY

3. CONSULTATION EVENTS

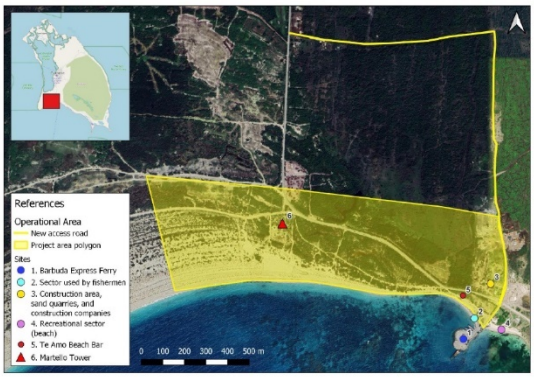
4. STAKEHOLDER ENGAGEMENT REPORT



DEBORAH BROSNAN & ASSOCIATES

1. IDENTIFICATION OF STAKEHOLDERS

EXAMPLE OF STAKEHOLDER MAPPING AND ANALYSIS

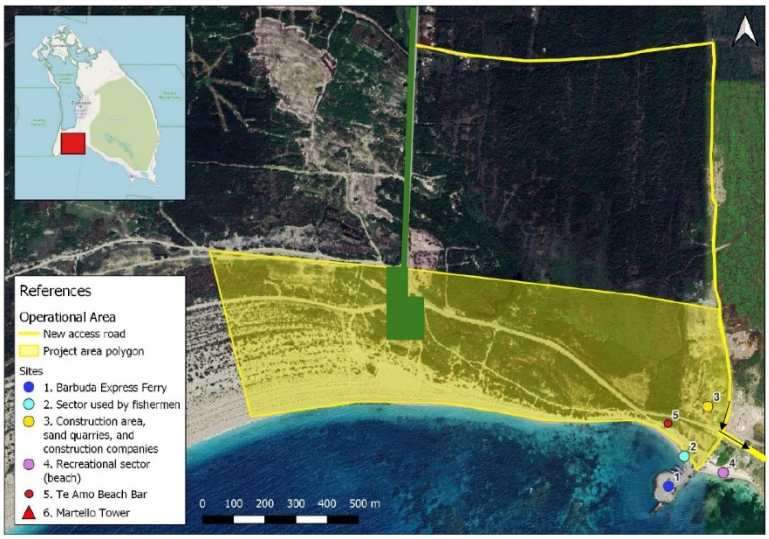


IDENTIFIED GROUS

- Government agencies, council members, and representatives from the health and education sectors.
- Private sector agencies (construction companies, local businesses, tourism sectors, etc.)
- Social groups, NGOs, gender organizations, environmental organizations.
- Fishermen groups and fishermen social organizations.

DEBORAH BROSNAN & ASSOCIATES

Updated Map Based on Client Input and Request to Present



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2. DESIGN OF PARTICIPATION STRATEGY

Due to the nature of the proposed project and the fact that the population is concentrated in a single populated center, the strategy centers on:

- ✓ **Small meetings organized in workshops or focus groups**
- ✓ Gather input from different stakeholders and diverse perspectives
- ✓ Address concerns
- ✓ Invitations made directly through phone contact / messaging / face to face interaction



DEBORAH BROSNAN & ASSOCIATES

3. CONSULTATION EVENTS - PLANNING



PURPOSE AND SCOPE

PROJECT DESCRIPTION

OPEN TO FEEDBACK



DEBORAH BROSNAN & ASSOCIATES

3. CONSULTATION EVENTS - PRELIMINARY SCHEDULE

Agenda October 26 to July 30.

DAY	STAKEHOLDER	OBJECTIVE	LOCATION
Monday, 26th	Organization of events and contact with stakeholders that will participate of the consultation process (school, hospitals, gas station, etc.) Final contact with key stakeholders identified (Bill Nedd, Montique Gore, etc.)	General organization of the consultation process	Codrington
Tuesday, 27th	Consultation with local business owners Local business owners and tourism representatives.	Understand concerns regarding economic impacts and opportunities.	To be defined in field
	Meeting with Local Government Local Council members, Government agencies	Discuss project status, impacts, and government involvement in construction phase.	Codrington Town Hall.

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3. CONSULTATION EVENTS - PRELIMINARY SCHEDULE (cont'd)

Agenda October 26 to July 30.

DAY	STAKEHOLDER	OBJECTIVE	LOCATION
Wednesday, 28th	Meeting with key stakeholders identified	Address land-related concerns, clarify project implications for private landowners.	Private meetings in residential locations
	Public Consultation with Fishermen & Fisheries Associations (Barbuda Fisheries, Fishermen Associations, etc.)	Discuss impacts on fishing practices, restoration plans, and docking relocations.	Barbuda Fishers Association Hall.
Thursday, 29th	Private Sector & Construction Representatives (Bill Nedd, representatives from construction companies)	Ensure alignment on mitigation strategies and employment opportunities	Construction installations
	Civil Society and NGOs (Environmental groups, gender advocacy organizations, BarbudanGO)	Gather input on social and environmental concerns, address grievances	To be defined in field
Friday, 30th	Civil society, General public, community, schools, health sectors.	Feedback on community concerns and program improvements.	Codrington School Auditorium.

DEBORAH BROSNAN & ASSOCIATES

4. STAKEHOLDER ENGAGEMENT REPORT

OBJECTIVES

- ✓ **Summarize Consultation Outcomes:** Provide an overview of the results and findings from the event
- ✓ **Describe key themes and issues identified:** Highlight the main topics and concerns that emerged
- ✓ **Gather, analyze and document feedback:** Collect and evaluate feedback from stakeholders
- ✓ **Communicate updates and address further concerns:** updates based on the feedback received

REPORT CONTENT

- Participation strategy
- Stakeholder mapping
- Dates, times, and venue of the events.
- Summary of presentations made
- Attendee analysis
- Questions and responses, suggestions, grievances
- Photographic record of the events

DEBORAH BROSNAN & ASSOCIATES

Thank you



DEBORAH BROSNAN
& ASSOCIATES

APENDIX 4. STAKEHOLDER EVENT DOCUMENTATION

ATTENDANCE SHEET TEMPLATE

Date:
Place:

NAME	ORGANIZATION AFFILIATION	CONTACT NUMBER	MAIL	GENDER	AGE	ROLE AT THE ORGANIZATION

DEBORAH BROSNAN & ASSOCIATES

COMMENTS AND QUESTIONS SHEET	
Date	
Location	
Name	
Comments, questions or quarries	
Proposal	
Observations	

STAKEHOLDER EVENT	
Date	
Hour	
Location	
No of participants	
Gender	
Summary of participants feedback	
General observations	

Appendix 9: Civil Engineering Drainage Report (Harris Civil Engineers)

ROSEWOOD BARBUDA DEVELOPMENT
PINK SANDS BEACH, BARBUDA

CIVIL ENGINEERING DRAINAGE REPORT

Prepared For:
Murbee Resorts Inc.
Villa Noval Court, CNR. Dr. Rosa Lee Drive & 4th Avenue
Gambles, Terrace, St. John's, Antigua

Prepared By:

HARRIS CIVIL ENGINEERS, LLC
1200 Hillcrest Street, Suite 200
Orlando, Florida 32803
(407) 629-4777

HCE Job #: 8300001

MARCH 2024

REVISION 1: JUNE 2024

I. Background 1
II. Water Quality Requirements 1
III. Water Attenuation Requirements 2
IV. On-Site and Off-Site Contributing Basins 2
V. Pond and Conveyance Evaluation 2
VI. Opinion of the Environmental and Aesthetic Appropriateness 3

I. Background

Harris Civil Engineers, LLC (HCE) has been tasked with evaluating the primary stormwater management system of the Rosewood Barbuda development project (herein referred to as the "site"). In order to do so HCE has evaluated the following:

1. Determine the water quality requirements.
2. Determine water attenuation requirements.
3. Evaluate the off-site and on-site drainage basins both in the pre-construction and post-construction conditions.
4. Evaluate the sizes of the proposed primary ponds and convergence systems in relation to their ability to provide water quality, attenuation, and conveyance for the on-site and off-site contributing basins.
5. Render an opinion as to the appropriateness of the pond areas for environmental and aesthetic purposes.

Note that this report focuses on the contributing areas that discharge to the three main ponds on the western 2/3 of the site, and not the water that discharges to the marina.

II. Water Quality Requirements

Due to a general lack of governmental guidance, HCE has developed criteria to evaluate the water quality requirements for the site. A widely used standard in the US is that the water quality requirements are the greater of 1" of runoff over the entire contributing area, or 2.5" of runoff from the impervious area within the contributing area. It is important to note that HCE determined that these rules should be applied to the on-site contributing areas for only two reasons:

1. The off-site contributing area is so large and so flat that the water coming from that area will already likely have been filtered.
2. Even though we are accepting off-site runoff into the on-site systems, it is not typical to include off-site contributing areas in an evaluation such as this.

The required water quality volume is 12.609 ac-ft. Table 1 below shows the results of the analysis and the water quality requirements for the ponds.

Table 1: Post Development Water Quality

POND - Wet Retention							
Elevation	Area	Area	Avg. Area	Δ	Volume	Σ Volume	Σ Volume
(ft)	(sf)	(acre)	(sf)	(ft)	(cf)	(cf)	(ac-ft)
0.00	628,015	14.417	0	0	0	0	0.000
3.00	728,366	16.721	678,191	3.0	2,034,572	2,034,572	46.707
6.50	797,727	18.313	763,047	3.5	2,670,663	4,705,235	108.017
10.00	1,109,641	25.474	953,684	3.5	3,337,893	8,043,128	184.645

III. Water Attenuation Requirements

Due to a general lack of governmental guidance, HCE has developed criteria to evaluate the water attenuation requirements for the site. It is important to note that water attenuation requirements are meant to stop the runoff from a site from flooding its downstream neighbor. This Site's downstream neighbor is the Ocean. Therefore, HCE is treating attenuation requirements in less of a pre-post requirement and more of a controlled conveyance requirement. In this case, HCE has determined that we want to control the water outflow to the marina at a rate of 2 ft/s for pond-to-pond conveyance and 5 ft/s over a weir that separates the east most pond and the marina.

IV. On-Site and Off-Site Contributing Basins

HCE has delineated and evaluated the on-site and off-site drainage basins. Exhibits 3 and 4 (EXH-3 and EXH-4) in Appendix A show the delineated basins. Table 2 and Table 3 below show the evaluation of the basins.

Table 2: Pre-Development Delineated Basins

Pre-Development			
	Basin	Area (ac)	Flowrate, Q (ft3/s)
2yr-24hr	1	59.2	0.63
	2	220.3	
	3	234.8	
	4	91.4	
50yr-24hr	1	59.2	8.24
	2	220.3	
	3	234.8	
	4	91.4	

Table 3: Post-Development Delineated Basins

Post-Development			
	Basin	Area (ac)	Flowrate, Q (ft3/s)
2yr-24hr	1	67.4	78.58
	2	46.6	54.33
	3	21.2	24.72
	4	39.7	46.29
50yr-24hr	1	67.4	415.17
	2	46.6	287.05
	3	21.2	130.59
	4	39.7	244.54

V. Pond and Conveyance Evaluation

The ultimate outfall for the primary ponds and conveyance system is over a weir that will be under the bridge that separates the western 2/3 of the Site from the marina on the eastern 1/3 of the Site. The marina water outfalls to the south through the channel entrance. Recall that an evaluation of the water that discharges directly to the marina and out to the ocean is not a part of this evaluation.

HCE started with the ponds as shown on the provided master plans, then made some assumptions about the normal water elevation and the sloping characteristics of the ponds. Next, we made some assumptions about the conveyance between each of the three ponds, and from the eastern (third) pond to the marina.

From there, HCE put together a preliminary computer model of the primary ponds and conveyance systems. The goal was to meet the requirements of conveyance system as shown in the sections above while still not allowing the ponds water elevation to stage up to an elevation that would endanger the surrounding structures.

Two rainfall events were modeled. The 2-year/24-hour event and the 50-year/24-hour event. The 2-year event was chosen to represent a "typical" heavy rainfall event so that HCE could evaluate the fluctuations in the ponds. The 50-year event was chosen to ensure that water could escape the system before flooding the surrounding buildings during a hurricane style rainfall event.

2-year/24-hour Event Results
In the 2-year/24-hour rainfall event, the modeling indicates that the ponds will stage to a level of 1.95 ft. This elevation was also used to set the height of the overflow weir between the eastern pond and the marina.

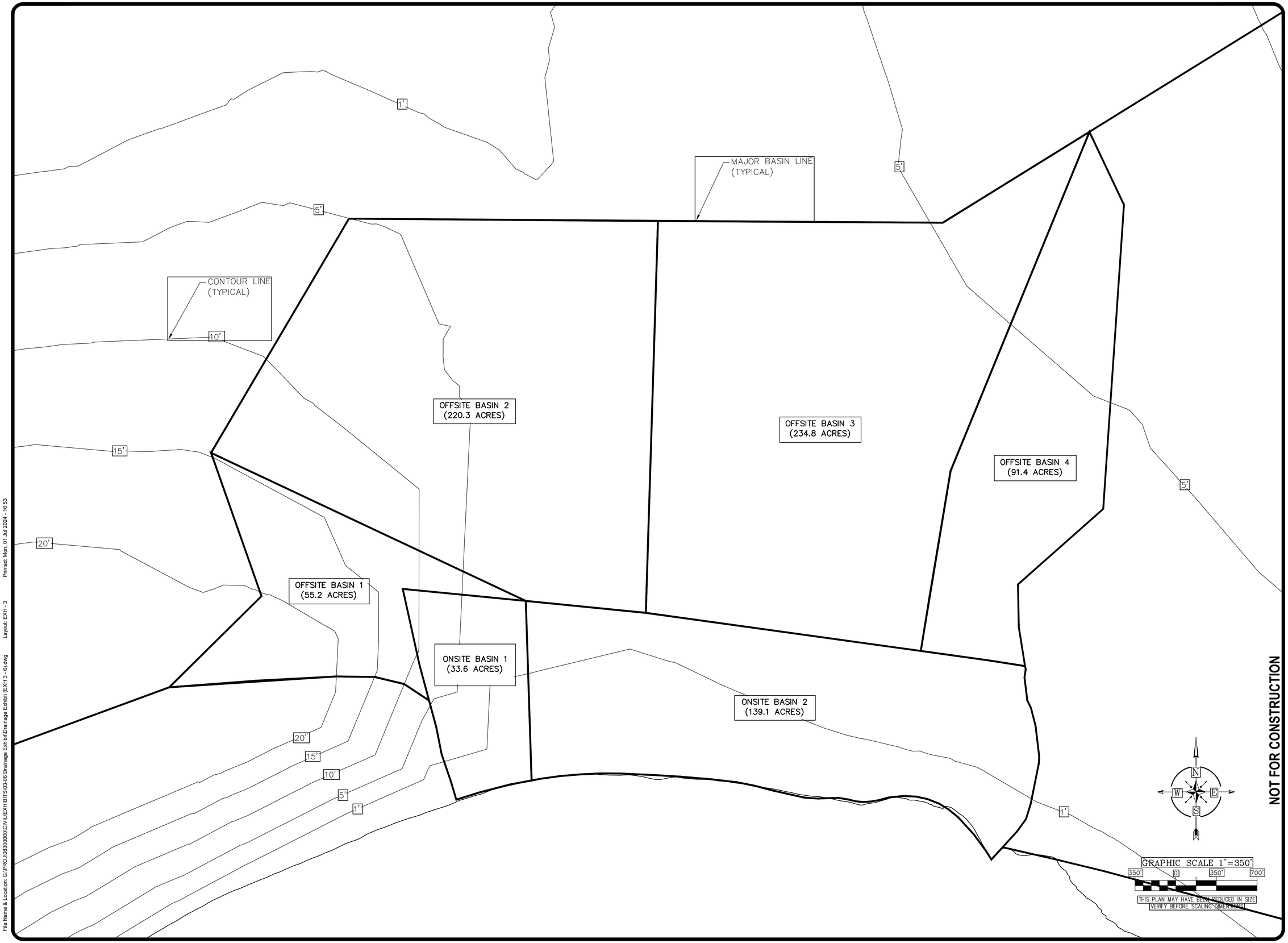
50-year/24-hour Event Results
In the 50-year/24-hour rainfall event, the modeling indicates that the size of the of the rectangular culvert between the ponds should be 6.5 ft x 10 ft, and the length of the weir should be 40 ft. The model also indicates that the water will stage to an elevation of 5.38 ft which is below the assumed elevation of the surrounding buildings of 10 ft.

Exhibits 5 and 6 (EXH-5 and EXH-6) in Appendix B show the pond and conveyance systems as they were evaluated.

VI. Opinion of the Environmental and Aesthetic Appropriateness

When looking at the appropriateness of the ponds from an environmental and an architectural standpoint, HCE used the model results of the 2-year rainfall event. HCE does not object to the ponds being used in an environmental capacity. HCE recommends any aesthetic functions be above the elevation of 5.38 ft (the stage of the water during the 50-year rainfall event).

APPENDIX A



File Name & Location: G:\PRO\08300000\CIVIL\EXHIBITS\03-06 Drainage Exhibit\Drainage Exhibit (EXH 3 - 6).dwg Layout: EXH - 3 Printed: Mon, 01 Jul 2024 - 16:53

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ENGINEER SEAL

NEIL D. WOLFE, P.E. #93551

Project Title:

ROSEWOOD EXHIBIT

Project Address:

PINK SANDS BEACH, BARBUDA

Design By:	KS
Drawn By:	KS
Checked By:	NW
Date:	03/13/2024

HCE Project: 8300001

Sheet Title:

PRE-DEVELOPMENT BASIN MAP EXHIBIT

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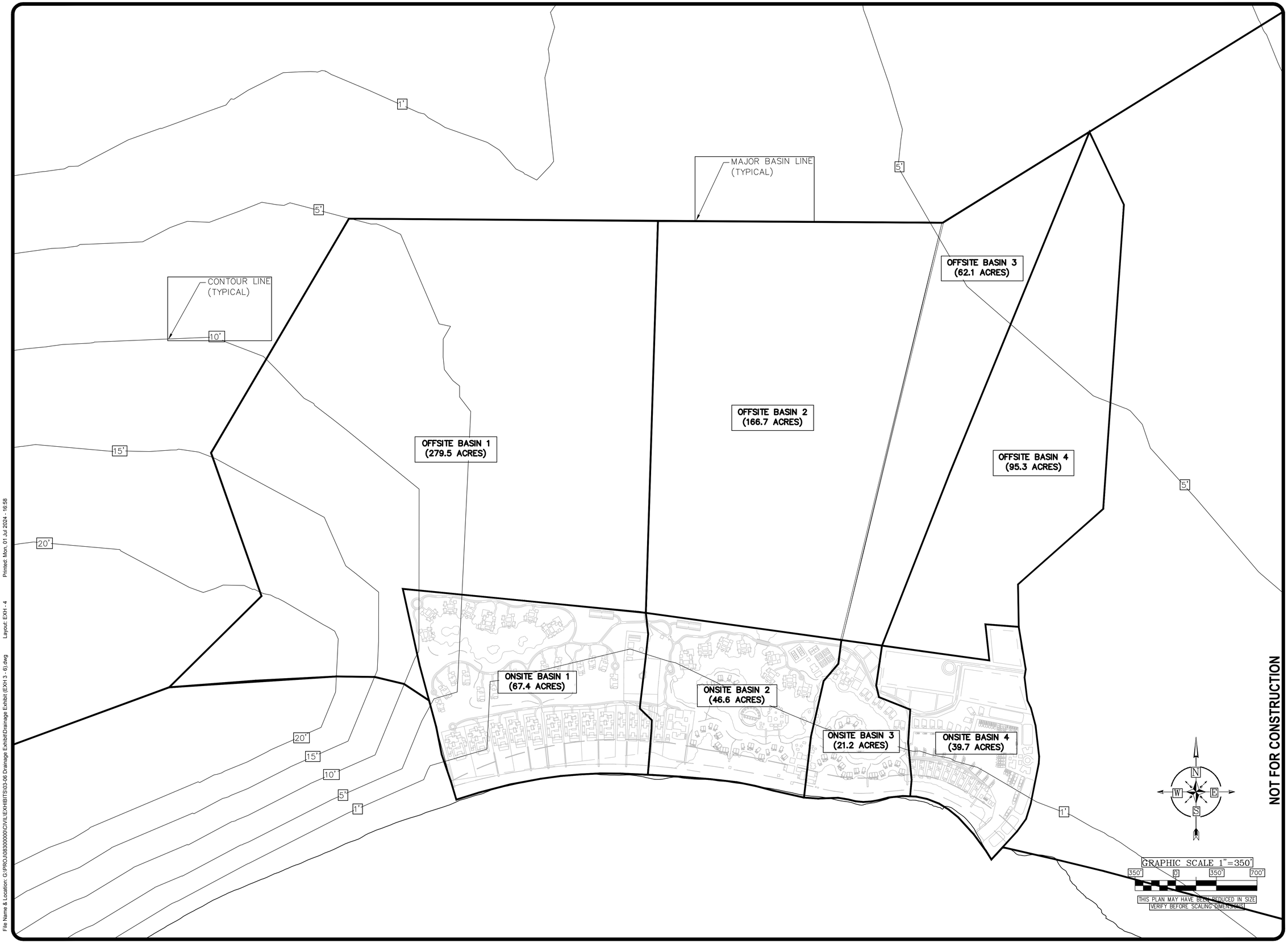
Sheet Number:

EXH-3



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Project Address:

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Design By: KS
Drawn By: KS
Checked By: NW
Date: 03/13/2024

HCE Project: 8300001

Sheet Title:

POST-DEVELOPMENT BASIN MAP EXHIBIT

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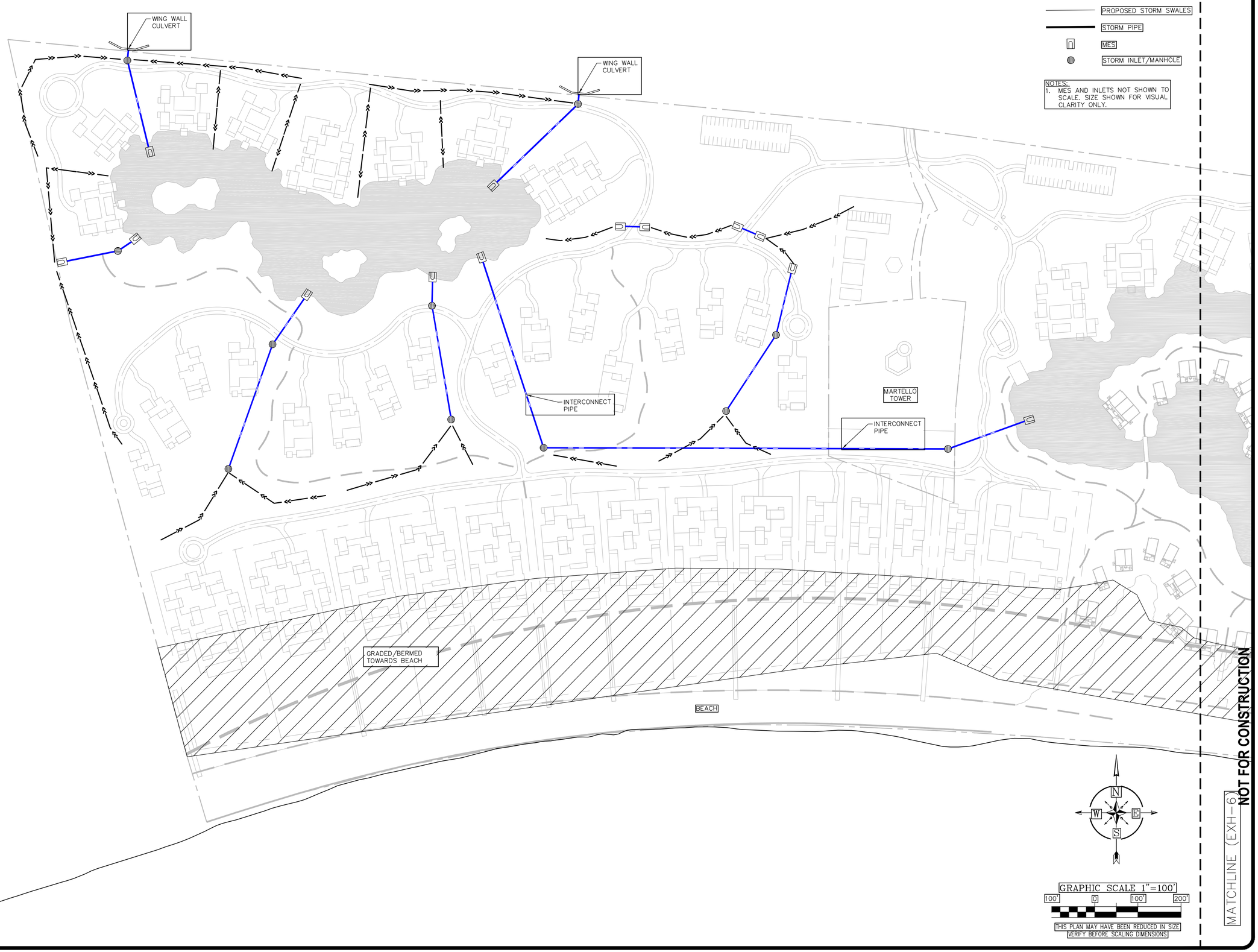
EXH-4

APPENDIX B



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Drawn By:	KS
Checked By:	NW
Date:	03/13/2024

HCE Project: 8300001

Sheet Title:

DRAINAGE EXHIBIT

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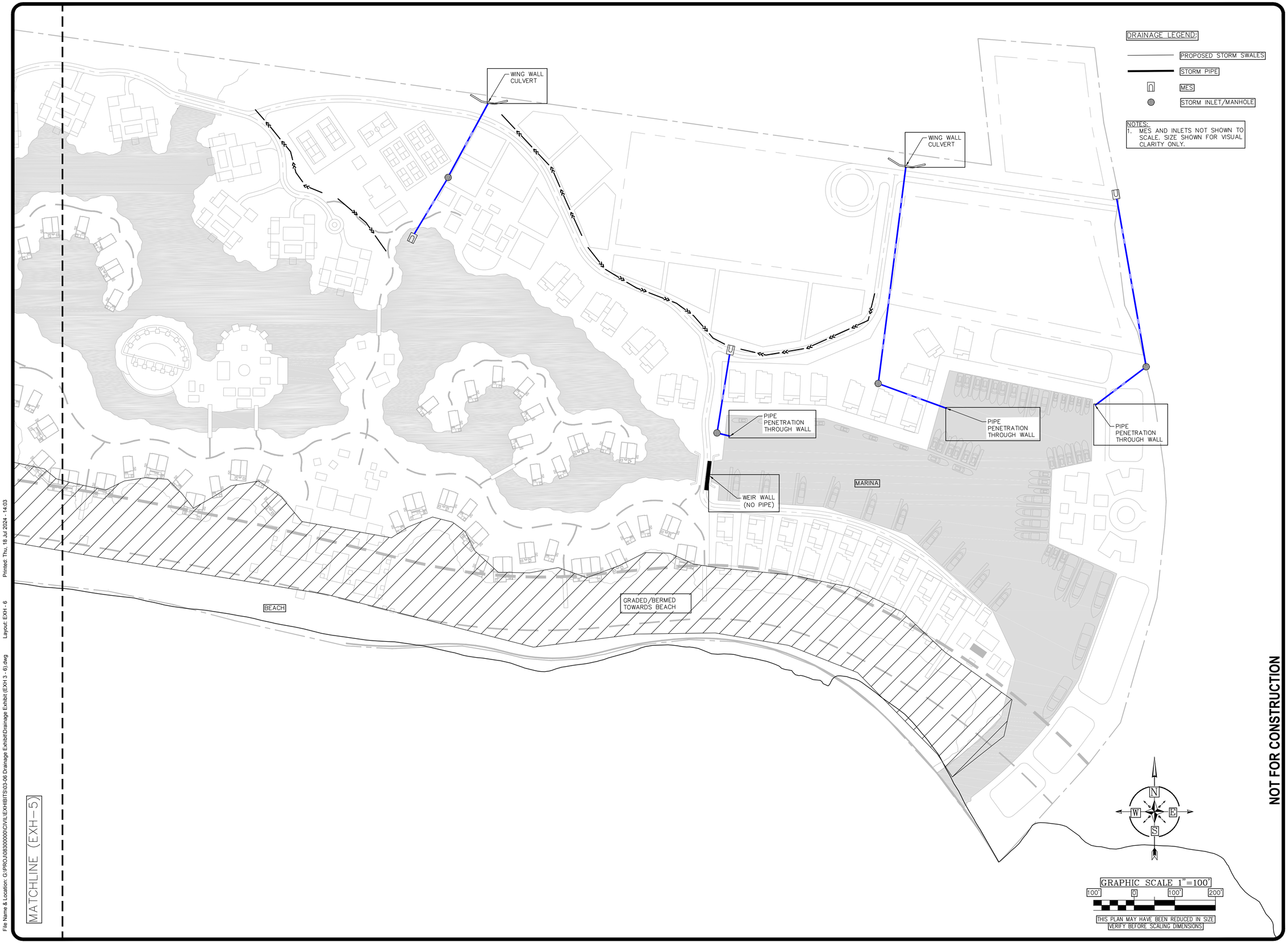
Sheet Number:

EXH-5



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DRAINAGE EXHIBIT

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EXH-6

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Appendix 10: Update to the Civil Engineering Drainage Report (Harris Civil Engineers)

The drainage report presented in Appendix 9 was completed based on the original master plan, which included Ponds 1 and 2, where the eastern end of Pond 2 was connected unidirectionally with the marina via a weir. These calculations are supplemental to the drainage report and are based on the updated master plan, where the marina has become Pond 3, and is connected to the ocean by an open 24" pipe.

These update documents include:

1. The drainage inputs for models of 100 year-24 hour, 50 year-24 hour, 10 year-24 hour, and 2 year-24 hour storm conditions;
2. The node max report for these four models, showing the maximum stage (rise in water height under flood conditions); and
3. The simple basin max report, which summarises the runoff from each of the defined basins.

Simple Basin: Offsite Basin 1

Scenario:	Scenario1
Node:	Lagoon 1
Hydrograph Method:	NRCS Unit Hydrograph
Infiltration Method:	Curve Number
Time of Concentration:	4182.0000 min
Max Allowable Q:	0.00 cfs
Time Shift:	0.0000 hr
Unit Hydrograph:	UH484
Peaking Factor:	484.0
Area:	279.5000 ac
Curve Number:	45.0
% Impervious:	0.00
% DCIA:	0.00
% Direct:	0.00
Rainfall Name:	

Comment:

Simple Basin: Offsite Basin 2

Scenario:	Scenario1
Node:	Lagoon 2
Hydrograph Method:	NRCS Unit Hydrograph
Infiltration Method:	Curve Number
Time of Concentration:	3934.0000 min
Max Allowable Q:	0.00 cfs
Time Shift:	0.0000 hr
Unit Hydrograph:	UH484
Peaking Factor:	484.0
Area:	166.7000 ac
Curve Number:	45.0
% Impervious:	0.00
% DCIA:	0.00
% Direct:	0.00
Rainfall Name:	

Comment:

Simple Basin: Offsite Basin 3

Scenario:	Scenario1
Node:	Lagoon 2
Hydrograph Method:	NRCS Unit Hydrograph
Infiltration Method:	Curve Number
Time of Concentration:	3961.0000 min
Max Allowable Q:	0.00 cfs

Time Shift:	0.0000 hr
Unit Hydrograph:	UH484
Peaking Factor:	484.0
Area:	62.1000 ac
Curve Number:	45.0
% Impervious:	0.00
% DCIA:	0.00
% Direct:	0.00
Rainfall Name:	

Comment:

Simple Basin: Offsite Basin 4

Scenario:	Scenario1
Node:	Lagoon 3
Hydrograph Method:	NRCS Unit Hydrograph
Infiltration Method:	Curve Number
Time of Concentration:	3960.0000 min
Max Allowable Q:	0.00 cfs
Time Shift:	0.0000 hr
Unit Hydrograph:	UH484
Peaking Factor:	484.0
Area:	95.3000 ac
Curve Number:	45.0
% Impervious:	0.00
% DCIA:	0.00
% Direct:	0.00
Rainfall Name:	

Comment:

Simple Basin: Onsite Basin 1

Scenario:	Scenario1
Node:	Lagoon 1
Hydrograph Method:	NRCS Unit Hydrograph
Infiltration Method:	Curve Number
Time of Concentration:	10.0000 min
Max Allowable Q:	0.00 cfs
Time Shift:	0.0000 hr
Unit Hydrograph:	UH484
Peaking Factor:	484.0
Area:	67.4000 ac
Curve Number:	60.0
% Impervious:	0.00
% DCIA:	0.00

% Direct:	0.00
Rainfall Name:	

Comment:

Simple Basin: Onsite Basin 2

Scenario:	Scenario1
Node:	Lagoon 2
Hydrograph Method:	NRCS Unit Hydrograph
Infiltration Method:	Curve Number
Time of Concentration:	10.0000 min
Max Allowable Q:	0.00 cfs
Time Shift:	0.0000 hr
Unit Hydrograph:	UH484
Peaking Factor:	484.0
Area:	46.6000 ac
Curve Number:	60.0
% Impervious:	0.00
% DCIA:	0.00
% Direct:	0.00
Rainfall Name:	

Comment:

Simple Basin: Onsite Basin 3

Scenario:	Scenario1
Node:	Lagoon 2
Hydrograph Method:	NRCS Unit Hydrograph
Infiltration Method:	Curve Number
Time of Concentration:	10.0000 min
Max Allowable Q:	0.00 cfs
Time Shift:	0.0000 hr
Unit Hydrograph:	UH484
Peaking Factor:	484.0
Area:	21.2000 ac
Curve Number:	60.0
% Impervious:	0.00
% DCIA:	0.00
% Direct:	0.00
Rainfall Name:	

Comment:

Simple Basin: Onsite Basin 4

Scenario:	Scenario1
Node:	Lagoon 3
Hydrograph Method:	NRCS Unit Hydrograph
Infiltration Method:	Curve Number
Time of Concentration:	10.0000 min
Max Allowable Q:	0.00 cfs
Time Shift:	0.0000 hr
Unit Hydrograph:	UH484
Peaking Factor:	484.0
Area:	39.7000 ac
Curve Number:	60.0
% Impervious:	0.00
% DCIA:	0.00
% Direct:	0.00
Rainfall Name:	

Comment:

Node: Lagoon 1

Scenario:	Scenario1
Type:	Stage/Area
Base Flow:	0.00 cfs
Initial Stage:	1.00 ft
Warning Stage:	6.50 ft

Stage [ft]	Area [ac]	Area [ft2]
1.00	1.8400	80150
2.00	2.3200	101059
3.00	2.8800	125453
4.00	3.4300	149411
5.00	3.9800	173369
6.00	4.5100	196456
7.00	5.5500	241758

Comment:

Node: Lagoon 2

Scenario:	Scenario1
Type:	Stage/Area
Base Flow:	0.00 cfs
Initial Stage:	1.00 ft
Warning Stage:	6.50 ft

Stage [ft]	Area [ac]	Area [ft2]
1.00	6.4800	282269
2.00	7.8500	341946
3.00	9.3500	407286
4.00	10.8600	473062
5.00	11.9500	520542
6.00	13.6300	593723
7.00	16.8400	733550

Comment:

Node: Lagoon 3

Scenario: Scenario1
Type: Stage/Area
Base Flow: 0.00 cfs
Initial Stage: 1.00 ft
Warning Stage: 6.50 ft

Stage [ft]	Area [ac]	Area [ft2]
1.00	5.5200	240451
2.00	5.9800	260489
3.00	6.4300	280091
4.00	6.8800	299693
5.00	7.3400	319730
6.00	7.7900	339332
7.00	8.7000	378972

Comment:

Node: Ocean

Scenario: Scenario1
Type: Time/Stage
Base Flow: 0.00 cfs
Initial Stage: 0.00 ft
Warning Stage: 5.50 ft
Boundary Stage:

Year	Month	Day	Hour	Stage [ft]
0	0	0	0.0000	0.00
0	0	0	12.0000	6.00
0	0	0	24.0000	0.00

Comment:

Pipe Link: L1 to L2		Upstream		Downstream	
Scenario:	Scenario1	Invert:	4.00 ft	Invert:	3.19 ft
From Node:	Lagoon 1	Manning's N:	0.0130	Manning's N:	0.0130
To Node:	Lagoon 2	Geometry: Rectangular		Geometry: Rectangular	
Link Count:	1	Max Depth:	6.00 ft	Max Depth:	6.00 ft
Flow Direction:	Both	Max Width:	8.00 ft	Max Width:	8.00 ft
Damping:	0.0000 ft	Fillet:	0.00 ft	Fillet:	0.00 ft
Length:	1624.18 ft	Bottom Clip			
FHWA Code:	0	Default:	0.00 ft	Default:	0.00 ft
Entr Loss Coef:	0.00	Op Table:		Op Table:	
Exit Loss Coef:	0.50	Ref Node:		Ref Node:	
Bend Loss Coef:	0.00	Manning's N:	0.0000	Manning's N:	0.0000
Bend Location:	0.00 dec	Top Clip			
Energy Switch:	Energy	Default:	0.00 ft	Default:	0.00 ft
		Op Table:		Op Table:	
		Ref Node:		Ref Node:	
		Manning's N:	0.0000	Manning's N:	0.0000

Comment:

Pipe Link: L2 to L3		Upstream		Downstream	
Scenario:	Scenario1	Invert:	3.19 ft	Invert:	3.09 ft
From Node:	Lagoon 2	Manning's N:	0.0130	Manning's N:	0.0130
To Node:	Lagoon 3	Geometry: Rectangular		Geometry: Rectangular	
Link Count:	1	Max Depth:	6.00 ft	Max Depth:	6.00 ft
Flow Direction:	Both	Max Width:	8.00 ft	Max Width:	8.00 ft
Damping:	0.0000 ft	Fillet:	0.00 ft	Fillet:	0.00 ft
Length:	200.00 ft	Bottom Clip			
FHWA Code:	0	Default:	0.00 ft	Default:	0.00 ft
Entr Loss Coef:	0.00	Op Table:		Op Table:	
Exit Loss Coef:	0.00	Ref Node:		Ref Node:	
Bend Loss Coef:	0.00	Manning's N:	0.0000	Manning's N:	0.0000
Bend Location:	0.00 dec	Top Clip			
Energy Switch:	Energy	Default:	0.00 ft	Default:	0.00 ft
		Op Table:		Op Table:	
		Ref Node:		Ref Node:	
		Manning's N:	0.0000	Manning's N:	0.0000

Comment:

Pipe Link: L3 to Ocean		Upstream		Downstream	
Scenario:	Scenario1	Invert:	3.09 ft	Invert:	1.89 ft
From Node:	Lagoon 3	Manning's N:	0.0130	Manning's N:	0.0130
To Node:	Ocean	Geometry: Circular		Geometry: Circular	
Link Count:	1	Max Depth:	2.00 ft	Max Depth:	2.00 ft
Flow Direction:	Both	Bottom Clip			
Damping:	0.0000 ft	Default:	0.00 ft	Default:	0.00 ft

Length:	1000.00 ft	Op Table:		Op Table:	
FHWA Code:	0	Ref Node:		Ref Node:	
Entr Loss Coef:	0.00	Manning's N:	0.0000	Manning's N:	0.0000
Exit Loss Coef:	0.00	Top Clip			
Bend Loss Coef:	0.00	Default:	0.00 ft	Default:	0.00 ft
Bend Location:	0.00 dec	Op Table:		Op Table:	
Energy Switch:	Energy	Ref Node:		Ref Node:	
		Manning's N:	0.0000	Manning's N:	0.0000

Comment:

Simulation: 100yr/24hr

Scenario: Scenario1
Run Date/Time: 12/17/2024 12:53:02 PM
Program Version: ICPR4 4.07.08

General

Run Mode: Normal

	Year	Month	Day	Hour [hr]
Start Time:	0	0	0	0.0000
End Time:	0	0	0	24.0000

	Hydrology [sec]	Surface Hydraulics [sec]	Groundwater [sec]
Min Calculation Time:	60.0000	0.1000	900.0000
Max Calculation Time:		30.0000	

Output Time Increments

Hydrology

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	15.0000

Surface Hydraulics

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	15.0000

Groundwater

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	60.0000

Restart File

Save Restart: False

Resources & Lookup Tables

Resources

Rainfall Folder:	
Reference ET Folder:	
Unit Hydrograph Folder:	

Lookup Tables

Boundary Stage Set:	
Extern Hydrograph Set:	
Curve Number Set:	
Green-Ampt Set:	
Vertical Layers Set:	
Impervious Set:	
Roughness Set:	
Crop Coef Set:	
Fillable Porosity Set:	
Conductivity Set:	
Leakage Set:	

Tolerances & Options

Time Marching:	SAOR	IA Recovery Time:	24.0000 hr
Max Iterations:	6	ET for Manual Basins:	False
Over-Relax Weight Fact:	0.5 dec		
dZ Tolerance:	0.0010 ft	Smp/Man Basin Rain Opt:	Global
Max dZ:	1.0000 ft	OF Region Rain Opt:	Global
Link Optimizer Tol:	0.0001 ft	Rainfall Name:	~SCSIII-24
		Rainfall Amount:	14.90 in
Edge Length Option:	Automatic	Storm Duration:	24.0000 hr
Dflt Damping (2D):	0.0050 ft	Dflt Damping (1D):	0.0050 ft
Min Node Srf Area (2D):	100 ft2	Min Node Srf Area (1D):	100 ft2
Energy Switch (2D):	Energy	Energy Switch (1D):	Energy

Comment:

Simulation: 10yr/24hr

Scenario:	Scenario1
Run Date/Time:	12/17/2024 12:53:20 PM
Program Version:	ICPR4 4.07.08

General

Run Mode: Normal

	Year	Month	Day	Hour [hr]
Start Time:	0	0	0	0.0000
End Time:	0	0	0	24.0000

	Hydrology [sec]	Surface Hydraulics [sec]	Groundwater [sec]
Min Calculation Time:	60.0000	0.1000	900.0000
Max Calculation Time:		30.0000	

Output Time Increments

Hydrology

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	15.0000

Surface Hydraulics

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	15.0000

Groundwater

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	60.0000

Restart File

Save Restart: False

Resources & Lookup Tables

Resources

Rainfall Folder:
Reference ET Folder:
Unit Hydrograph Folder:

Lookup Tables

Boundary Stage Set:
Extern Hydrograph Set:
Curve Number Set:
Green-Ampt Set:
Vertical Layers Set:
Impervious Set:
Roughness Set:
Crop Coef Set:
Fillable Porosity Set:
Conductivity Set:
Leakage Set:

Tolerances & Options

Time Marching: SAOR
Max Iterations: 6
Over-Relax Weight Fact: 0.5 dec
dZ Tolerance: 0.0010 ft

IA Recovery Time: 24.0000 hr
ET for Manual Basins: False
Smp/Man Basin Rain Opt: Global

Max dZ:	1.0000 ft	OF Region Rain Opt:	Global
Link Optimizer Tol:	0.0001 ft	Rainfall Name:	~SCSIII-24
		Rainfall Amount:	8.62 in
Edge Length Option:	Automatic	Storm Duration:	24.0000 hr
Dflt Damping (2D):	0.0050 ft	Dflt Damping (1D):	0.0050 ft
Min Node Srf Area (2D):	100 ft2	Min Node Srf Area (1D):	100 ft2
Energy Switch (2D):	Energy	Energy Switch (1D):	Energy

Comment:

Simulation: 2yr/24hr

Scenario: Scenario1
Run Date/Time: 12/17/2024 12:53:36 PM
Program Version: ICPR4 4.07.08

General

Run Mode: Normal

	Year	Month	Day	Hour [hr]
Start Time:	0	0	0	0.0000
End Time:	0	0	0	24.0000

	Hydrology [sec]	Surface Hydraulics [sec]	Groundwater [sec]
Min Calculation Time:	60.0000	0.1000	900.0000
Max Calculation Time:		30.0000	

Output Time Increments

Hydrology

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	15.0000

Surface Hydraulics

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	15.0000

Groundwater

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	60.0000

Restart File

Save Restart: False

Resources & Lookup Tables

Resources

Rainfall Folder:
Reference ET Folder:
Unit Hydrograph Folder:

Lookup Tables

Boundary Stage Set:
Extern Hydrograph Set:
Curve Number Set:
Green-Ampt Set:
Vertical Layers Set:
Impervious Set:
Roughness Set:
Crop Coef Set:
Fillable Porosity Set:
Conductivity Set:
Leakage Set:

Tolerances & Options

Time Marching:	SAOR	IA Recovery Time:	24.0000 hr
Max Iterations:	6	ET for Manual Basins:	False
Over-Relax Weight Fact:	0.5 dec		
dZ Tolerance:	0.0010 ft	Smp/Man Basin Rain Opt:	Global
Max dZ:	1.0000 ft	OF Region Rain Opt:	Global
Link Optimizer Tol:	0.0001 ft	Rainfall Name:	~SCSIII-24
		Rainfall Amount:	5.05 in
Edge Length Option:	Automatic	Storm Duration:	24.0000 hr
Dflt Damping (2D):	0.0050 ft	Dflt Damping (1D):	0.0050 ft
Min Node Srf Area (2D):	100 ft2	Min Node Srf Area (1D):	100 ft2
Energy Switch (2D):	Energy	Energy Switch (1D):	Energy

Comment:

Simulation: 50yr/24hr

Scenario: Scenario1
Run Date/Time: 12/17/2024 12:53:53 PM
Program Version: ICPR4 4.07.08

General

Run Mode: Normal

Year	Month	Day	Hour [hr]

Start Time:	0	0	0	0.0000
End Time:	0	0	0	24.0000

	Hydrology [sec]	Surface Hydraulics [sec]	Groundwater [sec]
Min Calculation Time:	60.0000	0.1000	900.0000
Max Calculation Time:		30.0000	

Output Time Increments

Hydrology

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	15.0000

Surface Hydraulics

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	15.0000

Groundwater

Year	Month	Day	Hour [hr]	Time Increment [min]
0	0	0	0.0000	60.0000

Restart File

Save Restart: False

Resources & Lookup Tables

Resources

Rainfall Folder:
Reference ET Folder:
Unit Hydrograph Folder:

Lookup Tables

Boundary Stage Set:
Extern Hydrograph Set:
Curve Number Set:
Green-Ampt Set:
Vertical Layers Set:
Impervious Set:
Roughness Set:
Crop Coef Set:
Fillable Porosity Set:
Conductivity Set:
Leakage Set:

Tolerances & Options

Time Marching: SAOR
Max Iterations: 6
Over-Relax Weight Fact: 0.5 dec
IA Recovery Time: 24.0000 hr
ET for Manual Basins: False

dZ Tolerance:	0.0010 ft	Smp/Man Basin Rain Opt:	Global
Max dZ:	1.0000 ft	OF Region Rain Opt:	Global
Link Optimizer Tol:	0.0001 ft	Rainfall Name:	~SCSIII-24
		Rainfall Amount:	12.80 in
Edge Length Option:	Automatic	Storm Duration:	24.0000 hr
Dflt Damping (2D):	0.0050 ft	Dflt Damping (1D):	0.0050 ft
Min Node Srf Area (2D):	100 ft2	Min Node Srf Area (1D):	100 ft2
Energy Switch (2D):	Energy	Energy Switch (1D):	Energy

Comment:

Node Max Conditions [Scenario1]

Node Name	Sim Name	Warning Stage [ft]	Max Stage [ft]	Min/Max Delta Stage [ft]	Max Total Inflow [cfs]	Max Total Outflow [cfs]	Max Surface Area [ft2]
Lagoon 1	100yr/24hr	6.50	7.65	0.0010	514.70	116.03	248255
Lagoon 2	100yr/24hr	6.50	6.99	0.0010	593.76	61.98	739620
Lagoon 3	100yr/24hr	6.50	6.99	0.0010	315.86	12.34	379714
Ocean	100yr/24hr	5.50	6.00	0.0042	12.34	7.19	0
Lagoon 1	10yr/24hr	6.50	5.16	0.0010	223.89	18.80	190073
Lagoon 2	10yr/24hr	6.50	4.21	0.0010	225.22	11.94	490155
Lagoon 3	10yr/24hr	6.50	4.20	0.0010	138.80	3.93	306486
Ocean	10yr/24hr	5.50	6.00	0.0042	3.93	7.19	0
Lagoon 1	2yr/24hr	6.50	3.91	0.0010	78.58	0.00	147308
Lagoon 2	2yr/24hr	6.50	2.05	0.0004	79.05	0.00	345359
Lagoon 3	2yr/24hr	6.50	2.36	0.0010	53.19	0.00	267527
Ocean	2yr/24hr	5.50	6.00	0.0042	0.00	7.19	0
Lagoon 1	50yr/24hr	6.50	6.81	0.0010	415.19	77.07	239637
Lagoon 2	50yr/24hr	6.50	6.12	0.0010	459.74	42.95	617284
Lagoon 3	50yr/24hr	6.50	6.11	0.0010	251.50	10.38	345241
Ocean	50yr/24hr	5.50	6.00	0.0042	10.38	7.19	0

Simple Basin Runoff Summary [Scenario1]

Basin Name	Sim Name	Max Flow [cfs]	Time to Max Flow [hrs]	Total Rainfall [in]	Total Runoff [in]	Area [ac]	Equivalent Curve Number	% Imperv	% DCIA
Offsite Basin 1	100yr/24hr	3.44	24.0167	14.90	0.05	279.5000	45.0	0.00	0.00
Offsite Basin 2	100yr/24hr	2.39	24.0167	14.90	0.06	166.7000	45.0	0.00	0.00
Offsite Basin 3	100yr/24hr	0.88	24.0167	14.90	0.06	62.1000	45.0	0.00	0.00
Offsite Basin 4	100yr/24hr	1.35	24.0167	14.90	0.06	95.3000	45.0	0.00	0.00
Onsite Basin 1	100yr/24hr	514.68	12.2333	14.90	9.11	67.4000	60.0	0.00	0.00
Onsite Basin 2	100yr/24hr	355.84	12.2333	14.90	9.11	46.6000	60.0	0.00	0.00
Onsite Basin 3	100yr/24hr	161.89	12.2333	14.90	9.11	21.2000	60.0	0.00	0.00
Onsite Basin 4	100yr/24hr	303.15	12.2333	14.90	9.11	39.7000	60.0	0.00	0.00
Offsite Basin 1	10yr/24hr	1.04	24.0167	8.62	0.02	279.5000	45.0	0.00	0.00
Offsite Basin 2	10yr/24hr	0.73	24.0167	8.62	0.02	166.7000	45.0	0.00	0.00
Offsite Basin 3	10yr/24hr	0.27	24.0167	8.62	0.02	62.1000	45.0	0.00	0.00
Offsite Basin 4	10yr/24hr	0.41	24.0167	8.62	0.02	95.3000	45.0	0.00	0.00
Onsite Basin 1	10yr/24hr	223.89	12.2500	8.62	3.81	67.4000	60.0	0.00	0.00
Onsite Basin 2	10yr/24hr	154.79	12.2500	8.62	3.81	46.6000	60.0	0.00	0.00
Onsite Basin 3	10yr/24hr	70.42	12.2500	8.62	3.81	21.2000	60.0	0.00	0.00
Onsite Basin 4	10yr/24hr	131.87	12.2500	8.62	3.81	39.7000	60.0	0.00	0.00
Offsite Basin 1	2yr/24hr	0.19	24.0167	5.05	0.00	279.5000	45.0	0.00	0.00
Offsite Basin 2	2yr/24hr	0.14	24.0167	5.05	0.00	166.7000	45.0	0.00	0.00
Offsite Basin 3	2yr/24hr	0.05	24.0167	5.05	0.00	62.1000	45.0	0.00	0.00
Offsite Basin 4	2yr/24hr	0.08	24.0167	5.05	0.00	95.3000	45.0	0.00	0.00
Onsite Basin 1	2yr/24hr	78.58	12.2667	5.05	1.33	67.4000	60.0	0.00	0.00
Onsite Basin 2	2yr/24hr	54.33	12.2667	5.05	1.33	46.6000	60.0	0.00	0.00
Onsite Basin 3	2yr/24hr	24.72	12.2667	5.05	1.33	21.2000	60.0	0.00	0.00

Basin Name	Sim Name	Max Flow [cfs]	Time to Max Flow [hrs]	Total Rainfall [in]	Total Runoff [in]	Area [ac]	Equivalent Curve Number	% Imperv	% DCIA
Onsite Basin 4	2yr/24hr	46.29	12.2667	5.05	1.33	39.7000	60.0	0.00	0.00
Offsite Basin 1	50yr/24hr	2.55	24.0167	12.80	0.04	279.5000	45.0	0.00	0.00
Offsite Basin 2	50yr/24hr	1.77	24.0167	12.80	0.05	166.7000	45.0	0.00	0.00
Offsite Basin 3	50yr/24hr	0.65	24.0167	12.80	0.05	62.1000	45.0	0.00	0.00
Offsite Basin 4	50yr/24hr	1.00	24.0167	12.80	0.05	95.3000	45.0	0.00	0.00
Onsite Basin 1	50yr/24hr	415.17	12.2333	12.80	7.26	67.4000	60.0	0.00	0.00
Onsite Basin 2	50yr/24hr	287.05	12.2333	12.80	7.26	46.6000	60.0	0.00	0.00
Onsite Basin 3	50yr/24hr	130.59	12.2333	12.80	7.26	21.2000	60.0	0.00	0.00
Onsite Basin 4	50yr/24hr	244.54	12.2333	12.80	7.26	39.7000	60.0	0.00	0.00

Appendix 11: Environmental Management for Hotels: Hazardous Materials (International Tourism Partnership)

ENVIRONMENTAL MANAGEMENT FOR HOTELS

THE **INDUSTRY GUIDE** TO **SUSTAINABLE** OPERATION

International Tourism Partnership

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This manual was published in 2014 when Sustainable Hospitality Alliance was known as International Tourism Partnership (ITP), part of Business in the Community (BITC).



Any substance that can cause injury, impairment to health or death to living organisms or which can damage the environment is **hazardous** and must be used, stored and disposed of in a responsible manner

8 HAZARDOUS MATERIALS

A number of substances found within the fabric of hotel buildings or that are used as part of the hotel operation pose potential hazards to human health, biodiversity and the environment. They must be handled, stored and disposed of carefully and replaced with less hazardous alternatives where possible. This approach should include phasing out the use of man-made chemicals that do not naturally degrade in nature and thus systematically increase in concentration over time.

This section examines the issues associated with various materials and substances and the practices you should put in place to manage the risks they present.

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8.1 DEFINING HAZARDOUS MATERIALS

A hazardous material is any substance that can cause injury, impairment to health or death to living organisms, or which can damage the environment through, for example being toxic, flammable, explosive, corrosive or infectious.

In most countries there are legal requirements governing the responsible use, storage and disposal of hazardous materials. There are also international agreements covering the use of substances that pose a hazard to health and the environment. These include the **Stockholm Convention**, a global treaty to protect human health and the environment from persistent organic pollutants (POPs). POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife. The European Union has passed numerous directives and regulations to avoid the dissemination and restrict the use of hazardous substances, the best known being the **Restriction of Hazardous Substances Directive** and the **Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)** directive which came into force in June 2007. To complement REACH, the United Nations has proposed a new regulation, the **Globally Harmonised System of Classification and Labelling of Chemicals (GHS)**, which will require enterprises to use standardised symbols and phrases on packaging and on Safety Data Sheets (SDS) to inform users about hazardous chemicals.

In the UK, several pieces of legislation apply such as the **Control of Substances Hazardous to Health Regulations 2002 (COSHH)**, **The Health and Safety at Work Act 1974**, **The Food and Environment Protection Act** and **The Control of Pesticides Regulations 1986**.

See FIGURE 8.1 for a list of definitions used for hazardous materials most commonly encountered in hotels, together with their identification symbols.

8.2 FUEL OIL AND OTHER OIL PRODUCTS

Fuel oil is the term used for any liquid petroleum product that is burned (in a furnace or boiler) in order to generate heat or used (in an engine) to generate power. Other oils derived from hydrocarbons are used for lubrication, to prevent corrosion, as a hydraulic medium or as solvents. These include lubricating oils and automatic transmission fluid.

8.2.1 The issues

There are a number of safety and environmental hazards associated with the storage, handling and use of oil, gas and oil products. In liquid form they pose a fire risk and if they escape as vapour or in gaseous form they can cause an explosion.

You should never allow any fuel to be emptied into drains leading to the public sewerage system or to your waste water treatment plant. Many drains lead directly to rivers, streams or lakes and fuel oil emptied into drains will have a similar effect to pouring it directly into the watercourse. If fuel oil is released into the ground, it coats the soil with which it comes into contact and seeps down to the water table. Because it is lighter than water it sits on top of the groundwater and

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FIGURE 8.1 Hazard symbols

BELOW ARE THE DEFINITIONS USED FOR HAZARDOUS MATERIALS MOST COMMONLY ENCOUNTERED IN HOTELS, TOGETHER WITH THEIR IDENTIFICATION SYMBOLS.

These symbols are derived from the United Nations (UN) system of identifying dangerous goods. Not all countries use exactly the same graphics in their national regulations. Some use graphic symbols, but without English wording or with similar wording in their national language. You should refer to the Dangerous Goods Transportation Regulations that apply to your country as this is the most widely applied regulatory scheme.



CORROSIVE

A corrosive material may be defined as something that destroys other materials by chemical reaction. When in contact with human tissue, these substances may burn and destroy. At greatest risk are skin, eyes, the lungs and stomach. Oven and toilet cleaners are usually corrosive.



ENVIRONMENTAL HAZARD

A substance that can pollute nature, according to directive 67/548/EWG by the European Chemicals Bureau.



EXPLOSIVE

An explosive substance is capable of producing gas at such a temperature, pressure and speed as to cause damage to the surroundings.



FLAMMABLE

A substance that can be easily ignited by sparks or flames to cause fire, or which can spontaneously combust or which can react violently with water. Of particular concern are those liquids with low flashpoints, such as solvents and certain fuels.



HARMFUL

A substance which if inhaled, ingested or penetrates the skin may incur limited health risks.



INFECTIOUS

Substances that are 'biohazardous' such as virus cultures, pathology specimens and used intravenous needles.



IRRITANT

A non-corrosive substance which can cause inflammation through immediate, prolonged or repeated contact with the skin or mucous membranes. Certain acid cleaners can be irritants.



OXIDISING

An oxidising substance destroys organic matter by breaking down the cell walls. An example is hydrogen peroxide.



POISONOUS

A substance that is toxic to humans. Can cause damage to health, physical or mental impairment or even death when inhaled, ingested or absorbed. Examples include some pesticides and herbicides.



RADIOACTIVE

A substance or a combination of substances which emit ionizing radiation.



TOXIC

A substance that is liable to cause death or serious injury to human health if inhaled, swallowed or absorbed through the skin. Examples include potassium cyanide, mercuric chloride and certain pesticides.

tends to move with it, often over great distances. This can have serious implications especially where groundwater is the source of domestic water supply or is used for animals. One litre of oil can contaminate a million litres of water. Equally plants cannot survive in ground affected by fuel oil, as nutrients cannot move freely through the soil.

Because of these hazards, there are many regulations associated with the handling, transport, storage and use of fuels, for example in England if you store oil in containers with a capacity of more than 200 litres, the **Oil Storage Regulations** may apply. Generally In Europe, the USA and Canada the controls are very tight, but in some developing countries they may be negligible.

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8.2.2 Fuel oil and your hotel

Hotels rely on fuel and other oils for a variety of applications such as:

- **oil** to fire boilers to provide heating, cooling, steam and hot water
- **diesel oil** to power emergency generators
- **fuel** to power lawn-mowers and other garden maintenance equipment such as saws and trimmers
- **diesel** or **petrol** for vehicles
- **lubricating oils**
- **transmission fluids**
- **oils** used as solvents such as paraffin (kerosene).

Many establishments store fuel on site in tanks either above or below ground. The tanks range in size from small day tanks with a capacity of 200 litres to large and multiple tanks of up to 50,000 litres each. The risk of fuel spillage and escape can occur at a number of points as outlined below. As a rule, primary containers (whether tanks, intermediate bulk containers, mobile bowsers or drums) should not be situated outside a building within 50 metres of any borehole or 10 metres of any inland freshwaters and coastal waters that any leaking oil could enter.

a RISKS IN HANDLING:

- spillage due to **overfilling**
- **lack of precautionary measures** when carrying out maintenance or repairs on equipment carrying fuel
- **misuse of fuel** for other purposes
- **mistakes** when cleaning out tanks
- **improper disposal** into the sewerage system.

b RISKS IN STORAGE:

- **internal or external corrosion** or rust perforation of the tank – the older the tank, the greater the likelihood
- **mechanical faults**
- **installation faults** in tanks, piping or pumps
- **disused tanks** that have not been properly decommissioned.

8.2.3 Good management practices

Good practice in fuel handling and storage should aim to:

- **Minimise the risk of fire and explosions.**
- Ensure that there is **no environmental contamination** resulting from current practice.
- Ensure that **future operations** do not cause contamination.
- Ensure that all storage facilities are **appropriately licensed** and **conform** to local regulations.
- Prevent financial losses from **product leakage** and the cost of **cleaning up** contaminated land and water.

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8.2.4 The action plan

It may be necessary to engage external professional help in order to sort out any fuel storage problems you may have. Make sure any outside operators you contract are qualified and licensed to do the work through being registered with any applicable agencies. These criteria apply to consultants, contractors, vendors and suppliers of any fuel. Similarly, any equipment you purchase should be from reputable suppliers, and installed by qualified personnel to the manufacturer's exact specifications and in accordance with the appropriate codes and regulations.

a FIND OUT THE REGULATIONS THAT APPLY TO YOU:

Identify all the national, regional and local fire and environmental regulatory requirements as well as any company standards that are applicable for fuel storage, handling and use. Regulations vary greatly around the world. In the UK for example, businesses are subject to the **Control of Pollution (Oil Storage) (England) Regulations 2001** which apply to oil stored in tanks, intermediate bulk containers, oil drums and mobile bowsers.

b CARRY OUT A FUEL-STORAGE INVENTORY:

TANKS AND DISTRIBUTION SYSTEM

Collect and keep in one place information on the infrastructure as follows:

- ✓ **age** of the tank, **date of installation**, **supplier** and **installer**, any **warranties** or **guarantees**
- ✓ **material** from which the tank is made (this is usually steel, plastic or fibreglass)
- ✓ **corrosion protection** (cathode protection for example), coating, interior lining
- ✓ any **cleaning, repairs** or **modifications** that have been conducted in the past with the dates
- ✓ **condition** of the **tank, piping** and **pumps**
- ✓ **condition** of the **tank interior** (amount of water, deposits)
- ✓ any **history** of **leaks** or **spills**
- ✓ **geologic, hydrologic** and **soil characteristics** of the area surrounding the tank
- ✓ any **settlement** of the soil that has occurred that could have caused the tank to change position
- ✓ any **pressure exerted** on the tank from the top, sides or from below (by plant roots for example)
- ✓ the **height** of the **water table** in relation to the tank
- ✓ whether the tank is **positioned** in such a way that leakage could pose a threat to the water supply.

MAINTENANCE AND OPERATIONS

Gather operational information including:

- ✓ daily/monthly/yearly **throughput**
- ✓ **inventory records** (both via metering and manually logged records)
- ✓ **spill and leakage monitoring** both within and outside any secondary containment
- ✓ **operating procedures**
- ✓ procedures for **preventive maintenance**
- ✓ **records of inspections** and tests by relevant authorities
- ✓ **any additives** which may have been used to disperse sludge or prevent corrosion (what and when).

LEAK DETECTION / SPILL PREVENTION

Collate information on what is in place to prevent leaks and spills such as:

- ✓ **leak detectors**
- ✓ **secondary containment**
- ✓ **automatic tank gauging**
- ✓ **overspill protection** (and equipment for recovery and disposal of fuel spilled during filling)
- ✓ **interstitial monitoring** (monitors the space between the inner and the outer walls of tanks or piping systems, at least once every month, including sumps and any vertical pipes)
- ✓ **visual and electronic monitoring** of wells for underground storage (visual and electronic checks)
- ✓ **bunding** for above ground storage (and recovery and disposal of fuel collected in bunding)
- ✓ if you are only storing a small quantity of oil in a drum, then the drip tray should have a capacity of not less than 25 per cent of the drum.

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c ASSESS WHETHER YOU ARE MEETING THE STANDARDS YOU HAVE IDENTIFIED:

If you are not meeting the standards outlined in **8.2.4.a** you will need to take swift corrective action. You need to assess how far you are from meeting the standards and to plan how you are going to achieve compliance.

IDENTIFY LEAKS AND SPILLS

If there is no immediate visual or other evidence (such as an odour), you should check to make sure there are no leaks through unexplained losses in inventory (such as discrepancies in deliveries which are due to changes in temperature, a sales error, or pilfering on a frequent or cumulative basis). If they are not already fitted, you should install meters to measure filling and consumption quantities). Leaks can occur if the tank is more than 10 years old or if there is visible structural damage on the surface or settlement. In addition to looking on the ground or in the drains (for above ground tanks), in monitor wells or extraction wells (for underground tanks), look in the soil downstream of the tank. Dying vegetation is often symptomatic of fuel spill, as are fuel odours in the basement or ground floor of buildings. **SEE FIGURE 8.2**

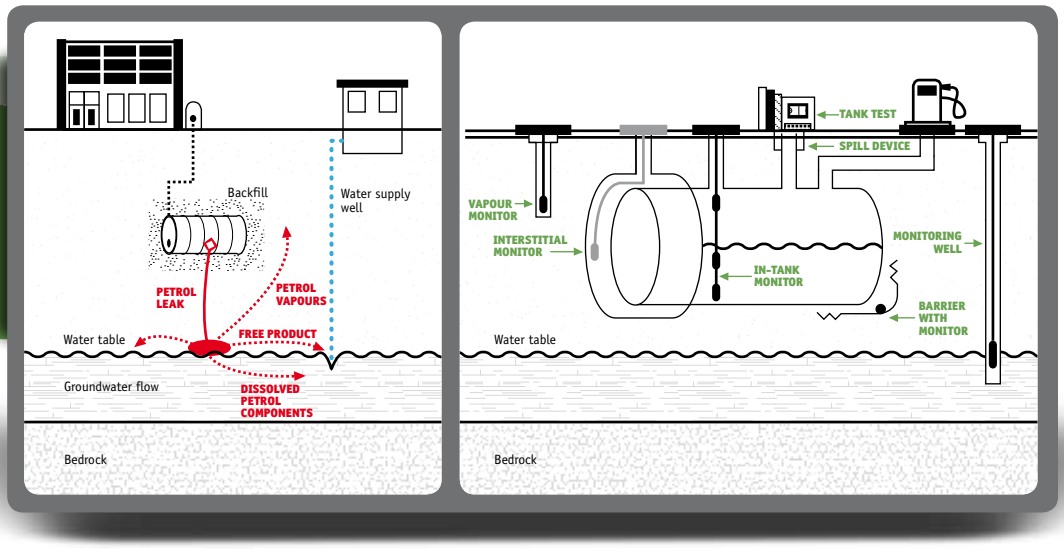

FIGURE 8.2

left: Leaking fuel and petrol underground flow

right: Leak detection alternatives

If your site investigation or fuel inventory suggests there may be a leak, the tank and supply lines need to be tested. Common techniques include pressure testing (with air or other gas) or hydrostatic pressure testing (using fluid). Hydrostatic testing requires the system to be emptied, filled with test fluid and then refilled with fuel, all of which is expensive and time-consuming, and reveals only major leaks. Neither pressure or hydrostatic testing is recommended as it may cause fuel oil to leak into the ground.

A precision test using the fuel that is being stored will account for all variables, such as volume change, pressure, temperature, tank deflection, etc. affecting the product and tank system. Such a test should include the complete underground storage and handling system. All devices and techniques used during the test should be able to detect leaks as small as 0.2 litres per hour. Since generally at least two tanks are installed, the standby tank should be filled up and also subjected to this test. Test results are valid for the time of the test only and offer no continuing surveillance and protection and monitoring systems should be installed for continuous control.

If a leak or spill is confirmed, you should notify the local fire department, the local regulatory authority and the company that owns the equipment (if applicable). Take all possible steps to contain the leak, and if vapours are present, ventilate the area. The tank will have to be emptied and cleaned internally. If any personnel have to enter the tank, you must ensure they have an adequate air supply and take full safety precautions, including having someone nearby at all times.

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Assess the extent of the leak and take remedial action. Any spilt fuel will have to be removed and the contamination may require that the soil or groundwater be biologically reclaimed. This may involve excavation. Underground leaks can require extensive and long-term corrective action, especially where they have existed for some time before detection and the spill has spread. Surface spills or leaks from piping are usually detected quickly and their spread can generally be limited through prompt response.

- **REPLACE INSTALLATIONS**

  If you need to replace a tank or piping, the new installation should meet the latest regulations. Tanks should have double walls of either steel or reinforced fibreglass. Metal installations should have corrosion protection, with plastic cladding or cathodic protection with the installation of sacrificial anodes. Unless piping is made of material that will not corrode (such as plastic), it must meet the requirements for cathodic protection. Existing piping should be coated with a corrosion-resistant coating.

- **PROVIDE LEAK DETECTION DEVICES**

  Automatic tank gauging, monitoring for vapours in the soil, interstitial monitoring and monitoring for liquids on groundwater can all be done continuously by detection devices. **SEE FIGURE 8.2**

- **DECOMMISSION OBSOLETE TANKS**

  Disused tanks should be emptied, cleaned and filled with a non-corrosive substance (such as clean sand) until they are dismantled by a licensed contractor. Similarly, all obsolete piping should be removed, capped or filled.

8.3 LIQUEFIED PETROLEUM GAS (LPG)

Liquefied petroleum gas (LPG), in the form of propane and butane, is used by hotels principally for heating and cooking. It is also found in camping-style lamps and in pressurised lines transferring beverages such as beer from the cellar to the bar. LPG is either stored in large tanks or in more portable cylinders.

8.3.1 The issues

THE MAIN HAZARDS WITH LPG[1]

- impact from a **gas cylinder explosion** or the **rapid release of compressed gas**
- **impact from parts of gas cylinders** or **valves that fail**, or from any flying debris
- **contact with the released gas**
- **fire** resulting from the escape of LPG
- impact from **falling cylinders**
- **manual handling injuries**.

THE MAIN CAUSES OF ACCIDENTS

- **inadequate training and supervision**
- **poor installation** of the equipment
- **inadequate examination and maintenance**
- **faulty equipment** and/or **design** (e.g. badly fitted valves and regulators)
- **poor handling**
- **poor storage**
- **inadequate ventilation**
- **incorrect filling procedures**
- **unseen damage** to the cylinder.

8.3.2 How to reduce the risks

See **FIGURE 8.3** overleaf for information on how to reduce the risks associated with LPG usage.

[1] Much of the material in this section draws on the UK Health and Safety Executive (HSE) publication: Safe use of gas cylinders, June 2004.

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FIGURE 8.3

LIQUEFIED PETROLEUM GAS (LPG)

REDUCING THE RISKS OF LPG USAGE

General guidelines

- Be aware of the **national** and **local regulations** covering the filling, use and storage of LPG on your premises.
- Make sure you are purchasing from a **reputable supplier** who is using gas cylinders that are designed and manufactured to an approved standard.
- **Cylinders** need to stand up to everyday use to prevent danger. They must be **inspected** before they are put into service and **examined** at appropriate intervals to ensure that they remain safe while in service.

Training

- Anyone who examines, refurbishes, fills or uses a gas cylinder should be **suitably trained** and have the necessary skills to carry out their job safely. They should understand the risks associated with the gas cylinder and its contents.
- **New employees** should **receive training** and be supervised closely.
- Users should be able to carry out an **external visual inspection** of the gas cylinder and any attachments (such as valves, flashback arresters, and regulators) to determine whether they are damaged. Visible indicators may include dents, bulges, evidence of fire damage (scorch marks) and severe grinding marks etc.
- **Valves** should only be removed by **trained personnel** using procedures that ensure that either the cylinder does not contain any pressure or that the valve is captured during the removal process.
- Cylinders should be **permanently marked** by the appropriate inspection body to show the date of the last periodic examination.

Handling and use

- Use gas cylinders in a **vertical position**, unless they are specifically designed to be used otherwise.
- **Restrain cylinders securely** to prevent them falling over.
- Always double check that the cylinder/gas is the **right one for the intended use**.
- Before connecting a gas cylinder to equipment or pipe-work make sure that the **regulator and pipe-work are suitable** for the type of gas and pressure being used.
- **Wear suitable safety shoes** and other personal **protective equipment** when handling gas cylinders.
- Do not use gas cylinders for any other purpose than **transporting and storing gas**.
- **Do not drop, roll or drag** gas cylinders.
- **Close the cylinder valve** and **replace dust caps**, where provided, when a gas cylinder is not in use.
- Where appropriate, fit cylinders with **residual pressure valves** (non-return valves) to reduce the risk of back flow of water or other materials into the cylinder during use that might corrode it (such as beer forced into an empty gas cylinder during cylinder change-over).
- Ensure that the valve is protected by a **valve cap or collar** or that the valve is designed to withstand impact if the cylinder is dropped.

Filling

- Make sure that your supplier adheres to the **correct filling procedures** as outlined in the relevant legislation. For example anyone filling gas cylinders should wear appropriate protective equipment. This may include safety shoes, protective overalls, gloves, and ear and eye protection.

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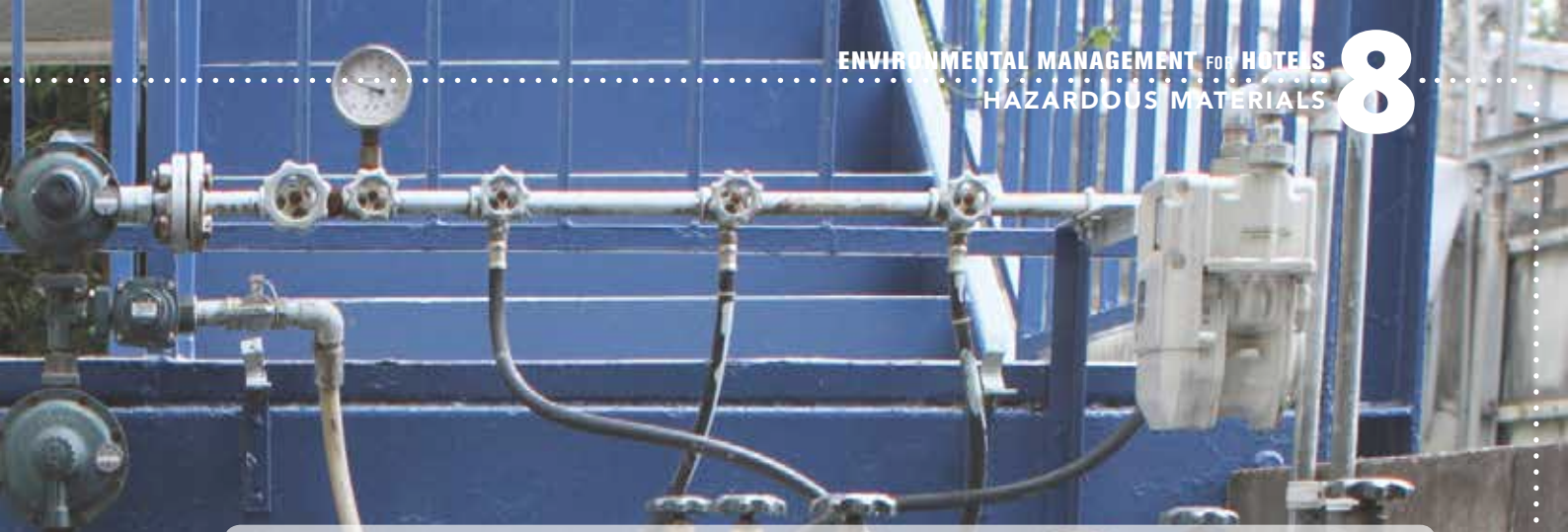

Lifting

- Gas cylinders can be very **heavy**: use suitable cradles, slings, clamps or other effective means when lifting cylinders with a hoist or crane.
- **Do not use valves, shrouds and caps** for lifting cylinders unless they have been designed and manufactured for this purpose.
- Gas cylinders **should not be raised or lowered on fork lift trucks** unless adequate precautions are taken to prevent them from falling.

Transport

- Fit **suitable protective valve caps and covers** to cylinders, when necessary, before transporting. Caps and covers help prevent moisture and dirt from gathering in the valve of the cylinder, in addition to providing protection during transport.
- **Securely stow** gas cylinders to prevent them from moving or falling. This is normally in the vertical position, unless instructions for transport state otherwise.
- **Disconnect regulators and hoses** from cylinders whenever practicable.
- Ensure gas cylinders are **clearly marked** to show their contents (including their UN Number) and the danger signs associated with their contents.
- The transport of gas cylinders is subject to **carriage requirements**. For example, that the vehicle is:
  - ✓ **suitable for the purpose**
  - ✓ **suitably marked** to show that it is carrying dangerous goods
  - ✓ the **driver is suitably trained**
  - ✓ the driver carries the **appropriate documentation** about the nature of the gases being carried.

Storage

- Gas cylinders should **not be stored for excessive periods of time**. Only purchase sufficient quantities of gas to cover short-term needs.
- **Rotate stocks** of gas cylinders to ensure they are used in the order they have been purchased.
- Store gas cylinders in a **dry, safe place** or on a **flat surface in the open air** or in **well-ventilated housing**. If this is not practicable, store in an adequately ventilated building or part of a building specifically reserved for this purpose.
- **Protect** gas cylinders **from external heat sources** that may adversely affect their mechanical integrity.
- Store them **away from sources of ignition** and other flammable materials.
- **Avoid** storing gas cylinders so that they stand or lie in water.
- Ensure the **valve is kept shut on empty cylinders** to prevent contaminants getting in.
- Make sure gas cylinders are **securely restrained** (for example with a chain), unless they are designed to be freestanding.
- Gas cylinders must be **clearly marked** to show what they contain and the hazards associated with their contents.
- **Store** cylinders where they are **not vulnerable to impact** (such as vehicles in the hotel car park).

Repair

- **Never try to repair a cylinder** on your premises. Any modifications or major repairs should only ever be carried out by qualified personnel from the supply company.

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8.4 CLEANING CHEMICALS

8.4.1 The issues

Around 1,500 new chemicals are marketed every year, adding to the 70,000 or more already in existence.[2] Many people believe that all chemicals are harmful to humans, animals and the environment. Some are known to cause health problems such as dermatitis, cancers, occupational asthma and reproductive problems and there may be much we still have to learn about the long-term effects of others. However, we have also come to rely on chemical products to maintain and improve our quality of life, particularly when it comes to delivering high standards of hygiene.

- Chemical products have **environmental implications throughout their life cycle** – i.e. from their design and development, through the raw materials used in their manufacture and for packaging, in transportation, in use (when the chemical product performs its job), and finally in disposal and recycling. In high concentrations, or if used in combination, some chemical cleaning products are potentially hazardous to human health and/or the environment.
- Many chemicals used for cleaning and other uses eventually **find their way into the environment** either in waste water effluent through drains or with solid waste to landfill or incineration. Some of these chemicals are known to 'bio-accumulate' in plants and animals and pose adverse long term effects. High concentrations of phosphate and nitrate have been the focus of debate about the increase of algal growth in some watercourses.
- Even cleaning products that are based on **natural ingredients** can have direct or indirect environmental implications which need to be considered. For instance, palm oil is a natural and key ingredient of soap, beauty products and foodstuffs. However, growing this lucrative crop in tropical areas such as Malaysia and Indonesia involves clearing natural rain forest to make way for palm oil plantations. This reduces the habitat for many animal and plant species, threatening their survival. Other issues include use of pesticides on the crop, which can poison animals such as the elephants that eat the leaves. Some producers and consumers of palm oil are now working to develop sustainable palm oil production methods.
- The **disposal of containers and packaging** can be problematic especially in resorts or environmentally-sensitive areas.

8.4.2 Benefits of minimising chemical use

a. **Significant cost savings** can be achieved by eliminating non-essential products, using products at the correct frequency and concentrations, buying in bulk or in concentrated form and using refillable containers to reduce waste disposal costs. Many hotels use more chemicals than are necessary to meet hygiene requirements. Excessive use of chemicals usually results from:
   - non-existent or poor dosing equipment (which can be due to lack of maintenance)
   - poor staff training
   - technical factors (such as low temperatures or an improper wash pressure).

b. Using less hazardous products or those which prevent or minimise skin contact will **minimise the health and safety** risks (and the associated potential liability) of your operation.

c. Reducing chemical use and selecting cleaning products with a lower environmental impact[3] will help protect the **quality of the aquatic environment** such as lakes and streams. Choose products that are not hazardous to the environment and optimise chemical use by using chemicals only when needed and in the correct doses.

[2] United Nations Environment Programme, May 2004: Stockholm Convention on Persistent Organic Pollutants Coming into Force. See **www.unep.org/Documents.Multilingual/Default.asp?DocumentID=398&ArticleID=4487&l=en**

[3] Note that in practice, it takes considerable competence to fully interpret the environmental impact of individual substances, and in many cases not even the scientists are categorically sure. For example, it is not easy to decide whether a highly acute aquatic toxic substance is more hazardous than one that is not, but is bio-accumulative, or non-biodegradable. If unsure, consult the MSDS (materials safety data sheets) and your supplier.

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d Using products with minimal packaging can help to **reduce pressure on landfill sites** and reduce any chemical run-off that can occur from such sites. Where possible, select products with minimal packaging that has been (or can be) recycled and is not hazardous to the environment.

e Some chemical cleaning products will also kill the bacteria that are essential for breaking down and treating waste water effectively, which is an important consideration for **hotels that operate their own waste water treatment plant**. Used correctly, the small amounts released are insignificant, however large spillages can compromise local treatment plants.

8.4.3 Cleaning products commonly used in hotels and their impacts

Chemical cleaning products are most likely to be used by the housekeeping, kitchen, laundry and engineering departments. They are essential in hotel kitchens and outlets where food is being prepared, where hygiene is crucial and systematic operation and control methods are required in order to prevent food poisoning.

Chemicals are available in solid, liquid, powder, granules, tabs and gel forms. They include:

a **laundry and dishwashing detergents** (which may contain some/any of the following: alkalis, bleaching agents, sequestering agents, surfactants, solubilisers and acids)

b **toilet and bath cleaners** (acids, alkalis)

c **bleaches** (may include hydrogen peroxide, sodium hypochlorite, sodium chlorite and sodium perborate)

d **surface and floor cleaners** (alkalis, surfactants, solvents)

e **disinfectants** (quaternary ammonium compound, chlorine, acids, alchohols, peroxygen)

f **degreasers and oven cleaners** (alkalis, surfactants, solvents)

g **descalers or delimers** (acids, such as hydrochloric acid)

h **glass cleaners** (solvents, surfactants)

i **metal cleaners** (solvents)

j **dry-cleaning chemicals** (organic solvents such as perchloroethylene, a chlorinated hydrocarbon)

k **swimming pool chemicals** such as chlorine and bromine **SEE SECTION 3.3.4**.

More information on the raw materials used to make cleaning products together with their impacts can be found in **APPENDIX 4**.

8.4.4 Effective management of chemicals

a **OBJECTIVES:**

The key to using any chemical product is **careful and informed selection, efficient use** and **safe disposal**. Basically, if you use 20 per cent more product than you need, you are adding 20 per cent to every other impact in the life cycle and 20 per cent to your costs. In order to use chemical cleaning products in the most environmentally responsible way you should ensure that:

- the product is **necessary and the right one for the job**
- it causes **minimal adverse environmental impacts**
- the **optimum doses** are used
- the products are **stored, labelled, used, handled and disposed** of in accordance with local and **international standards and regulations**.

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b THE ACTION PLAN:

Identify and record where hazardous materials are being used, what they are being used for and the reasons for their use.

- **Assess the hazards associated with the product's use.** You may need to examine the product information sheet for each product and ensure that staff are using the appropriate concentration (this will vary according to local conditions such as the hardness of the water and soil conditions). **Materials Safety Data Sheets (MSDS)**, referred to in some countries as **Safety Data Sheets (SDS)**, are standardised documents that describe the known hazards associated with a material, indicating the safe handling procedures and recommended responses to accidents. The information is set out under 16 sections **SEE APPENDIX 1**. The sheets are prepared by the chemical supplier and in many countries they are required by law to send you an MSDS if you buy a chemical. They should also send one on request even if you are only considering purchase. If you already have the chemical but the MSDS is lost or the material is so old that none came with it, most manufacturers are happy to email or fax a relevant MSDS on request and should even make compilations of their data sheets available free of charge. When assessing an MSDS it is important not to confuse the risk statements associated with the raw materials and those of the final formulation, which may be a minute amount. (Sections 3 and 15 in the MSDS give the final classification of the product but people often give more attention to the raw material details in sections 2 and 16).
- Make sure you **understand the full package of requirements and support from your supplier** – e.g. technical advice, training, equipment and support materials. Some suppliers will conduct a complete review of your chemical usage and identify options for improvement.
- Identify opportunities for **reducing the number of different chemical cleaning products** and **replacing them** with simpler, cheaper and environmentally-preferable alternatives where possible.
- Review **handling, storage, labelling and disposal procedures**.
- Compile a **hazardous materials manual**.

c THE HAZARDOUS MATERIALS MANUAL

In some cases it may not be possible to use a less hazardous substance so it is important to ensure that the effects of its continued usage and disposal are minimised. One way to achieve this is to compile a hazardous materials manual, covering the use, handling, storage and disposal of hazardous chemicals and other hazardous substances used in your hotel. The manual needs to be in a format that can be readily and regularly updated.

- **Ask manufacturers and suppliers to provide details** for every substance that they supply to you. This information can be compiled into a manual for use by staff. Make sure that it is continually updated with new pages if new chemicals/hazardous materials are purchased. **APPENDIX 2** shows how you might set out your own hazardous materials sheets.
- It is particularly important that you **follow the correct disposal method**. Too often, chemicals are given the respect they deserve when they are being handled and used, but are then thoughtlessly disposed of into the normal waste-water system. It is imperative that the end-user is aware of correct disposal methods, and the implications of failing to follow them.
- Make sure that the necessary **information reaches the end-user** in his or her department.
- You should also ensure that any **hazardous chemicals are stored separately** or 'flagged' with a special method of identification in order to bring their hazardous nature to the attention of the person taking them from the stores.

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d STORAGE

Storage of chemicals should be:

- **In a cool place**, to avoid chemical reaction through excessive heat or direct sunlight.
- **'Secure'**, i.e. on strong shelving, stacked in such a way so the containers will not fall over, and only accessible to those authorised to use them.
- In such a way as to facilitate **stock rotation**.
- So that they **do not block corridors, access or exit points**.
- With all appropriate **emergency equipment readily to hand**, i.e. correct fire-extinguishers, fire blankets, fire hose and a comprehensive first-aid box.
- Aimed at keeping all chemicals **securely isolated** from each other, as mixing products may cause a chemical reaction or even an explosion.
- With particularly **volatile chemicals** (such as chlorine) stored and **secured correctly outside the building**.
- Managed in a way that **avoids over-stocking** and hence waste and disposal problems.
- In **properly-labelled containers**.

e USE

- Always ensure that any new chemical products you purchase meet the basic **health and safety requirements** for your property.
- If possible **avoid products marked 'Danger', 'Poison', or 'Warning'**. When you must use a strong product to get the job done, protect yourself by wearing gloves and goggles, and be sure that your work area is well-ventilated.
- **Wear protective gloves** when using any cleaning products.
- **Never mix** different chemical products, and ensure that staff are trained not to do so under any circumstances. This could pose a serious health and safety risk.
- **Always add chemical products to water** and never water to the product.
- **Natural alternatives** may be appropriate for some cleaning applications (such as using vinegar and water to clean glass), but not where their use may compromise hygiene standards, such as in areas where food is prepared or displayed.



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f LABELLING, ENVIRONMENTAL AND ETHICAL CLAIMS

- Many cleaning products carry some form of **environmental branding**. However some of the claims made on these labels may be unclear and cannot be verified so read them carefully and, if in doubt, consult the manufacturer.
- Be wary of the term **'natural'** when used to describe cleaning products. Although the chemical ingredients may be extracted from plants or the earth, they are likely to have been chemically converted or 'synthesised' in order to become useful in cleaning products.
- Beware of products that claim to be **biodegradable**. Only substances, not products, can be classified as biodegradable. In fact, over time all substances are biodegradable – it just depends how long it will take. Look for information on the substance's ultimate biodegradability, which involves its complete breakdown into simple salts, water and oxygen, which is the internationally recognised indicator.
- Some cleaning products or their chemical components are still **tested** by their manufacturers (or in some countries the authorities) **on animals**. If you want to source ethical as well as environmentally responsible products, you may wish to select a manufacturer that either does not currently test on animals or has established a date by which all animal testing will cease. Ask your supplier for their policy on this.

g QUANTITIES AND TIMING

- It is generally necessary to use more cleaning chemicals in hard water areas than in soft water areas. This is because chemicals are needed to soften the water for maximum cleaning efficiency. Investment in **water softening plant** will help to reduce the total volume of cleaning chemicals used. Such equipment may be particularly justified if your establishment has a restaurant or busy laundry.
- **Avoid manual dosing** if possible as it is not possible to be as exact on quantities. Many of the larger manufacturers of cleaning products provide **staff training** and **automated dispensers** (which measure out the precise quantity of concentrated products) to ensure that appropriate quantities and concentrations of a product are used. Take care, however, because concentrated chemical products can be more hazardous to handle than their diluted alternatives. In most cases your supplier will fit the equipment and advise you on appropriate handling and storage arrangements.
- It is important to leave the product in contact with what is being cleaned for **the necessary amount of time**. If the recommended contact time is not respected the cleaning result will be poor and a second cleaning will be required, doubling your chemical consumption.

h PACKAGING

- If possible, choose products that are packaged in recyclable containers or can be supplied through **refill systems**.
- The **'recyclability'** of containers will depend on the facilities available in your area. PVC containers (polyvinylchloride) are more difficult to recycle than high and low density polyethylene (HDPE and LDPE), polypropylene (PP), polyethylene (PE) and polyethylene tetraphthalate (PET).
- **Reuse** chemical containers only where they are to be filled with the same product, as cross-contamination can be dangerous. Thorough cleaning will require higher chemical and water consumption.

i DISPOSAL

- Some chemical products should be treated and disposed of as hazardous waste. When changing to alternative cleaning products consult the MSDS to ensure that **appropriate disposal routes** are chosen.
- If your hotel operates its own waste-water treatment plant or has to comply with discharge consents, **check the likely implications** of changing chemical cleaning products with your chief engineer or local authority prior to making a decision.

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j TRAINING

- All relevant hotel **staff should be trained** in the handling, use, storage and disposal of chemicals. Many chemical companies incorporate a full training programme as part of their supply/maintenance package, and such facilities should be assessed and, where relevant, used as fully as possible.
- Contractors, vendors and suppliers using, handling and disposing of chemicals and other hazardous materials should be subjected to **pre-qualification assessments** to determine whether they can comply with the hotel's requirements. It should be noted that in many countries the hotel is liable for damages if the contractor improperly disposes of the hazardous wastes.

8.5 MERCURY IN CFLs

Mercury (Hg) is a naturally occurring heavy metal and is one of six elements that are liquid at or near room temperature and pressure. It occurs in deposits throughout the world and it is harmless in an insoluble form such as mercuric sulfide, but it is poisonous in soluble forms such as mercuric chloride or methylmercury.

8.5.1 The issues

The largest man-made source of mercury is coal-fired power stations as the mercury that naturally exists in coal is released into the atmosphere when it is burned. Mercury is used in a variety of industrial and scientific applications and in dentistry, although its use is being reduced and phased out where possible due to the negative health effects of mercury exposure. These include tremors, impaired cognitive skills, and sleep disturbance in workers with chronic exposure to mercury vapour even at low concentrations. The **World Health Organization**, the US **Occupational Safety & Health Administration (OSHA)**, and US **National Institute for Occupational Safety and Health (NIOSH)** all treat mercury as an occupational hazard, and have established specific occupational exposure limits.

Environmental releases and disposal of mercury are regulated in the US primarily by the **Environmental Protection Agency**. In the EU, the **Directive on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment** bans mercury from certain electrical and electronic products, and limits the amount in other products to less than 1000 ppm. Its use in new non-electrical measuring devices, such as thermometers and barometers has also been banned since 2007, with certain exemptions for the healthcare sector and a two-year period of grace for manufacturers of barometers.

8.5.2 Mercury in CFLs

Mercury is essential to enabling a compact fluorescent lamp (CFL) to be an energy-efficient light source. CFLs contain a very small amount of mercury (around five milligrams) sealed inside the glass tubing. This is roughly equal to the amount that would cover the tip of a ballpoint pen. Older style thermometers, in comparison, contain about 500 milligrams of mercury, or 100 times more.

Many lighting manufacturers have taken significant steps to reduce mercury used in their fluorescent lighting products and there is no danger when the bulbs are in use. However, being made of glass, the lamps can break if dropped or roughly handled.

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8.5.3 Safe handling of CFLs

PRECAUTIONS

- **Take care** when removing the bulb from its packaging, when installing it, or replacing it.
- Always screw and unscrew the lamp **by its base** (not using the glass).
- **Never use force** to twist the CFL into a light socket.

IF A CFL BREAKS

Open a window and **vacate the room** for 15 minutes or more

↓

Using **disposable gloves**, rather than bare hands, **carefully scoop up the fragments and powder** with stiff paper or cardboard and place them in a **plastic bag**

↓

ON HARD SURFACES:
Do not use a vacuum or broom to clean up the broken bulb. Wipe the area clean with damp paper towels or disposable wet wipes and place them in the plastic bag

ON CARPETS:
Remove all the materials you can without using a vacuum cleaner. Sticky tape (such as duct tape) can be used to pick up small pieces and powder. If vacuuming is needed after all visible materials are removed, vacuum the area where the bulb was broken, remove the vacuum bag (or empty and wipe the canister) and put the bag or vacuum debris into a plastic bag

↓

Place all the materials you have used to clear up the debris in **a second sealed plastic bag**

↓

Either take it to your **local recycling centre** or tell your waste contractor what is in the bag so that it does not go into the waste for general landfill

↓

Wash your hands after disposing of the bag.

DISPOSAL

- If the lamp has failed within its warranty period, the best thing to do is **return it to your supplier** and ask them to confirm it will be disposed of responsibly.
- Most landfill sites now have **separate recycling facilities** for CFL and other fluorescent lamps. Your waste contractor should advise you on how it will collect and dispose of spent CFLs. If there is no segregation in place at your local landfill site, you should **'double seal'** the bulb within two plastic bags in your area for waste collection. CFLs should not be disposed of in an incinerator.



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8.6 PESTICIDES, HERBICIDES AND ALTERNATIVE CONTROL MEASURES

8.6.1 The issues

Hotels experience a variety of problems with unwanted pests, bugs and weeds. The specific methods used to combat them will depend on the location of the hotel and the problems being experienced. For example, hotels in the tropics are more likely to have a problem with cockroaches, ants and mosquitoes whereas hotels in urban locations may have trouble with rodents. The parts of the hotel which are most vulnerable are in kitchens, waste storage areas, guest rooms and hotel grounds.

Pesticides, insecticides, herbicides, bactericides and fungicides are terms used to describe the many chemical agents developed to kill unwanted life forms. They are widely used in hotel kitchens, waste storage areas, guest rooms and in hotel grounds.

- **Pesticides, rodenticides** and **insecticides** are used to control insect and other animal infestations.
- **Herbicides** are used to control 'weeds' and other unwanted plants.
- **Bactericides, sterilants, biocides** and **fungicides** are used to combat bacteria and moulds.

These substances range from simple to complex compounds, and have a correspondingly large range of environmental hazards associated with them. Some kill only the target organisms, others will kill a range of different life forms if used indiscriminately. Once employed, the chemicals may take considerable time to break down and become inactive. Additionally, they may become more concentrated as they pass up the food chain. Short term exposure to pesticides and herbicides can cause a range of health problems in humans and other animals, including eye, lung, throat and skin irritation, dermatitis and poisoning. They can also have long-term effects, including cancers and birth defects. Because they 'persist', meaning that residues may build up in our food and water supplies for considerable periods, environmental problems and damage to other life forms may occur long after the initial application.

There are many laws governing the use of substances used to control pests. In the UK for example they are subject to the **Control of Substances Hazardous to Health Regulations 2002 (COSHH), The Food and Environment Protection Act** and **The Control of Pesticides Regulations 1986**. Internationally, the **Stockholm Convention on Persitent Organic Pollutants** bans the use of certain pesticides and insecticides. SEE APPENDIX 3 AND ALSO SECTION 3.4.4

8.6.2 Your action plan

a OBJECTIVES

Good environmental practice in pest, weed, bacteria and fungal control involves maximising non-chemical methods to minimise the use of pesticides and herbicides. Insects and rodents have to be controlled, but the use of chemicals should be considered as a supplement to basic sanitation and other physical and biological measures aimed at the elimination or control of breeding areas.

In order to safeguard the health of employees and guests, and to protect the general environment, your objective in managing pest control chemicals should be to:

- **control and minimise the use** of pest and bacteriological control substances.
- **replace** hazardous substances with less hazardous (preferably naturally-occurring) alternatives.
- ensure that any substances you do use are **stored securely**.
- **supervise and control the preparation and use** of chemical applications.
- ensure that any residues and/or containers are **disposed of in an environmentally safe manner**.

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b ACTIONS

This will involve:

- identifying **which pesticides and herbicides are being used** and the exact problems they are intended to resolve. The more that is known about the problem, the less chance there is of making a mistake. The words organic, natural and biodegradable in this context do not guarantee that they are safe
- determining whether their use **complies with local, international and company regulations**
- **assessing other methods of control** and substituting them for hazardous substances
- ensuring that pesticides and herbicides are **stored, used and disposed** of in a manner that protects human health and safeguards the environment
- ensuring that pesticide use **does not annihilate other life forms** that you wish to encourage
- **carrying out specific checks and actions** relating to the storage, preparation, application and disposal of chemicals.

8.6.3 Pesticide and herbicide management

Where the application of chemical pesticides and herbicides is unavoidable, proper management is absolutely essential.

Manufacturers and suppliers should provide full details of the hazards associated with the pesticides and herbicides they supply. They should also supply the appropriate information relating to storage, preparation and application. A review of the chemicals can then be undertaken to assess whether there are safer alternatives. For example, some insect sprays are based on **pyrethrum**, a natural insecticide obtained by extraction from chrysanthemum flowers. Pyrethrum-based insecticides are more readily broken down than some other types of pesticide.



Chrysanthemum cinerariifolium, from which potent natural **pyrethrum** insecticide is made

You can obtain information on available pesticides and on the proper application equipment direct from the manufacturers or general handbooks on current pesticides and herbicides and their use. Details of all pesticides and herbicides that you use should be recorded in a hazardous material sheet as shown in **APPENDIX 2**.

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a HEALTH AND SAFETY OF PERSONNEL AND GUESTS:

- **STAFF**

  Where staff are employed in pest-management, they need to be properly trained in health and safety measures, in the causes and effects of misapplication of the pesticides and in the protection measures required for safe application. See the checklist in **APPENDIX 2**.

- **CONSULTANTS**

  In many instances it will be necessary to call on outside expertise to advise on pest-management problems, particularly in the creation of integrated pest-management programmes, which may require detailed knowledge of the biology and ecology of a particular species.

- **CONTRACTORS**

  In some instances a pest problem may only be solved by the application of special toxic pesticides. If this is the case, you should use specialised contractors. Ensure that all chemicals used by the contractor are approved by the local and national authorities and that their use is properly documented.

- **VENDORS AND SUPPLIERS**

  Vendors and suppliers should provide current data sheets for all chemicals and materials supplied. They should also either be able to take back unused or surplus pesticides or recommend a suitable agent through which they can be disposed.

- **GUESTS**

  Guests should be informed of any pest-control management systems. When application or spraying is in progress, they should be warned of this activity and kept away from the area in which it is taking place.



b SPECIFIC CHECKS AND ACTIONS:

SEE FIGURE 8.4 OVERLEAF

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FIGURE 8.4

PESTICIDE AND HERBICIDE MANAGEMENT

SPECIFIC CHECKS AND ACTIONS

Storage

1. **Storage areas** must be dry, frost-free, well-ventilated and secure against theft and vandalism.
2. They should be situated **away from other buildings**, especially residential buildings or areas where food or flammable materials are stored.
3. Stores should be built to **resist foreseeable accidents**, including leakage and spillage, fires and the weather. Ensure there is no risk of any spillage entering the ground and polluting water sources. Floors should be impervious to liquids, anti-slip, chemical-resistant, washable and with a means of diverting spillages. Ideally they should be below surrounding ground level without the risk of flooding. Drainage should be into sumps or tanks large enough to contain any foreseeable leakage. Do not site them near watercourses, ponds, ditches or areas liable to flooding.
4. **Display warning signs** without attracting unwanted attention and in large areas, provide **emergency exits**.
5. **Shelving and stacking** facilities should be appropriate for the size of the containers stored in them. Flammable pesticides should be separated from other pesticides. Consideration should be given to possible reactions between chemicals coming in contact with each other. Proper emergency plans should be drawn up and made available.
6. Make sure all pest control chemicals are **clearly labelled** and that the manufacturer's instructions for use are kept with them.
7. **Effective first-aid provisions** should be available, together with data sheets on all the products in the store and the chemical safety precautions. Details of any statutory requirements and emergency telephone numbers should be available.
8. **Emergency telephone numbers** and other emergency facilities should be checked and if necessary updated at regular intervals. Make sure there is a first aid leaflet to hand and, ideally, display first aid information on the wall.

Preparation and handling

1. **Accurate measurements** should be made during both mixing and application phases. Use the most suitable chemical, in the minimum necessary amount, to achieve the desired results.
2. A **safe area** should be available for mixing pesticides. This should be done on a concrete pad, with a separate sump or tank to contain any leakage.
3. Operators should be provided with, and adequately trained in the use of the **necessary equipment** and **protective clothing**. Sufficient spares should be available.
4. **Proper health surveillance** should be available to all those working with pesticides and herbicides.
5. The **area of application** should be clearly marked, and **unnecessary access prevented** while spraying is in progress.
6. **Neighbours** and others in the area should be warned of the spraying programme.
7. Only the **appropriate quantity** of pesticide and herbicide should be removed from the pesticide store for immediate use.
8. Chemicals (especially pesticides and herbicides) must **never be put into unmarked containers**.
9. **Do not transport** chemicals in vehicles used for carrying people or food.

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Application

1. **Time the treatment** to coincide with the presence of the pest.
2. Use a **selective chemical** that has the least effect on non-target species and treat only the area affected.
3. **Equipment** should be **frequently checked** and **properly maintained**, both for health and safety reasons and to minimise spray drift.
4. Spraying **should not be carried out in unsuitable weather**. Anyone operating sprayers should have access to a wind-speed meter and only spray when the wind speed is nil or negligible.
5. **Avoid inhalation of dusts** and **fumes** and **contact with the skin**. Users should wear protective clothing and headgear, and change clothing and wash thoroughly with soap and water after applying pest control chemicals.
6. **Hours of work** should be controlled so that people are exposed for the minimum time.
7. Ensure that anyone handling toxic chemicals **never works alone** and that the work area is **well-ventilated**. In confined areas, they should wear a safety-approved respirator.
8. **Wear a respirator** for outdoor spraying or dusting of organic phosphorus compounds.
9. Take care to **avoid the contamination of food and drinking water**.
10. **Eating, drinking and smoking** should be **prohibited** when using or handling chemicals.
11. Users should be **familiar with the effects** on the body of the chemicals they are likely to be using, and how the chemicals may enter the body.
12. Users should be **aware of the signs and symptoms** of acute poisoning related to chemicals they are using:
    - They should **stop work** if they are feeling ill.
    - They should **seek medical advice** and report the matter if they experience nausea, excessive sweating, are unusually thirsty or have unusual difficulties with their eyesight.
13. **Sprays should be turned off** before inspecting nozzles. Correct protective clothing should be worn for these inspections, and nozzles of pipes should not be blown through (using air from the lungs) or sucked on in order to clear blockages.
14. When using a **'rucksack'** type sprayer, be aware of the following hazards:
    - Liquid should **not be allowed to spill** on to the user's back or clothing.
    - **Shoulder straps** should be suitable and easily adjustable.
    - Sprays should **not be too heavy** to be lifted when full.
    - **Pump seals** should be regularly checked, and replaced as soon as there is any sign of deterioration.
    - **Hand lance triggers** and joints should be checked for seepage.
    - It should be possible to check from the outside how full the sprayer is **to avoid spillage** from overfilling.
15. **Control the re-entry** of people into the treated area.

Disposal of leftover chemicals

As most pesticides and herbicides are extremely toxic, due regard must be paid to **disposal** of unused chemicals. Disposal methods will depend on the:

- **quantity of waste** for disposal
- chemical and biological **degradability** of the active ingredients
- **toxic properties**
- **concentration**
- **physical form** of the waste
- **disposal options** available.

Always follow the **manufacturer's and/or supplier's instructions** even when disposing of empty containers. These details should he kept in the hazardous materials manual **SEE 8.4.4.c**. Landfilling pesticides and herbicides is not generally an environmentally sound option and in most cases incineration is advised, at temperatures in excess of 1000°C and at a residence time of at least two seconds.

The following general guidelines should also be adopted:

- **Never transfer pesticides** to **unlabelled** or **mislabelled** containers. Keep in clearly labelled containers even when disposing of them.
- **Do not reuse** pesticide/herbicide containers.
- **Rinse out containers** before disposal, and use the rinse water for pest and weed control.
- **Puncture containers** after they have been used, to prevent re-use.
- **Segregate pesticide/herbicide wastes** from general hotel wastes.
- Use an **authorised waste-disposal contractor**.
- Use an **authorised disposal site**.

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8.6.4 Specific pests and how to deal with them

As a general rule, control methods must attack both adults and larvae or young, with the emphasis normally being on controlling the larvae and young in order to break the life cycle.

FIGURE 8.5

Common pests associated with hotels:

a: ants
b: aphids
c: bed bugs
d: caterpillars
e: cockroaches
f: dust mites
g: flies
h: mosquitoes
i: moths
j: rodents
k: snails
l: wasps

See text for full details



NOTE: IMAGES ARE NOT TO SCALE

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a ANTS



Ants can become a problem during the summer, particularly when food is left on counters or crumbs and debris remain on the floor. **Pavement ants, larger yellow ants, thief ants** and **carpenter ants** are commonly found in hotels.

Ant control requires knowing their habits and where they enter from the outside. The ants establish colonies and send out scouts to find food and water. These scouts leave a scent trail which enables them to find their way back to the colony with news of found resources. Other colony members then follow the scent trails to retrieve the resources. Some ant varieties establish sub-colonies near resources or send out queens to establish new independent colonies.

The first thing to do is to kill any ants you see and to wipe down the area with soapy water in order to prevent major scent trails from being formed and to stop the scouts returning to the colony. If there is already an established trail, wipe backwards from the food source to the entrance of the trail. Then block the entry point to the building – the ants will give up trying to find a way through after a day or two. Temporary blockades can be made using sticky substances such as petroleum jelly or chili powder, cinnamon and boric acid. If you can find the entrance to the nest, pour boiling water into it.

To cut off the supply of food, keep opened foodstuffs in sealed containers or store them in the refrigerator or freezer. Wipe down worktops and sweep floors regularly. Clean out kitchen cabinets, drawers and shelves to remove crumbs and stains. Keep sinks and worktops dry and dry pans and dishes immediately after use.

Baits are best put in the path of an ant trail and then removed after the ant activity stops, before they lure ants from another colony to the area. You may need to try different baits if the first one doesn't work as they use different attractants. Use sticky barriers to stop ants traveling up trees and plants. Prune branches close to the building and remove fences or anything that might create a bridge for the ants to cross.

Low toxicity compounds to control ants include boric acid and diatomaceous earth (DE), a chalk-like powder consisting of the fossilised remains of diatoms, a type of hard-shelled algae. Make certain that any other compounds used in ant control products are safe and ensure that you follow the instructions carefully.

Pharaoh ants are tiny white insects that can come in with the delivery of clean laundry and are therefore not easily spotted. Once established they can spread throughout a building in a very short time. The treatment for infestations can only be administered by a licensed pest control contractor and involves feeding the ants liver dosed with a hormone that acts on the pests' reproductive cycle. This stops them breeding and eventually they die off. Treatment is expensive as it can take up to six months to eradicate an infestation.

b APHIDS



Before toxic insecticides were introduced in the 1940s it was standard practice to use beneficial insects for pest control in agriculture, but the availability of convenient, branded products combined with effective marketing rendered these techniques almost obsolete. Today, many garden pests have developed a tolerance of chemicals whilst the same chemicals are also killing off the beneficial insects that nature intended to control the pests. Cutting out the use of chemicals enables natural predators such as ladybirds (ladybugs) and green lacewings to return. As a result, butterflies and birds also become more plentiful.

Releasing predatory mites, ladybirds and lacewings into the grounds several times over a period of weeks will help to manage sap-sucking pest mites and whitefly. Parasitic wasps can also be used to control scales on trees, shrubs and flowers.

If it is difficult to obtain supplies of beneficial insects for release into the garden, then it is possible to purchase a branded 'lure' that simulates the scent of aphids and lures ladybirds and lacewings to the area.

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c BED BUGS



Although bed bugs have been traditionally associated with backpackers' hostels and budget accommodation, the rise in international travel means they are on the increase and are particularly prevalent in some areas of Eastern Europe and the Far East. Sadly for some hotel guests, paying for a luxury room in a top hotel does not automatically guarantee immunity from bed bugs. Often they come in with hotel deliveries or in guests' luggage. Kitchens are a favourite location where they shelter behind wall tiles, equipment or in the crevices in walls and floors – any warm and damp locality near food. They also hide near beds in lampshades, behind fixed headboards and in upholstery. They are attracted to human hosts when they detect an increase in the level of carbon dioxide, exhaled during sleep.

Adult bed bugs are around four to six millimetres long and clearly visible to the naked eye, but colonies can build up without being spotted due to their nocturnal behaviour. However, if a guest has been bitten by a bedbug, they are likely to complain. Sores or bites on the body, often in a line, are fairly conclusive evidence, as are blood spots on sheets, skins that have been cast by bugs as they hatch, excrement that looks like mould on wallpaper, bedheads, fabrics and carpet close to the bed. If there is a serious infestation the room may also have a sweet, sickly smell.

Bedbugs only feed once a week, so they hide in wall cavities, ceilings and central heating ducts and reappear throughout the hotel at different times. Once established it is very difficult to eradicate an infestation as they are prolific breeders with a very short life cycle. Studies have shown that the average time taken for bed bugs to spread to adjacent rooms is seven weeks. For this reason, it is not sufficient merely to treat the room in which they are found as the problem is likely to have spread to other areas of the hotel. The most effective course of action is to enlist professional help so that other rooms can be checked for signs of secondary infestation and treated if necessary.

d CATERPILLARS



Proprietary-branded bacterial insecticides derived from natural ingredients are available to control caterpillars. Check that the insecticide does not remain in the environment for long – some are suitable for use even up to the day of harvest. The insecticide works by paralysing the digestive system of the caterpillars, making them unable to eat.

e COCKROACHES



Cockroaches have been around for more than 400 million years and are believed to share a common ancestor with termites. They contaminate food with their excrement and secrete an unpleasant odour that can permeate the indoor environment. Many individuals also develop allergies to them.

Cockroaches are broad, flattened insects with long antennae and are often confused with beetles. However adult cockroaches have membranous wings and lack the thick, hardened fore-wings of beetles. They are nocturnal and run rapidly when disturbed. Immature cockroaches (nymphs) look like adults, but are smaller and do not have wings. Females can carry an egg case with them for quite some time, dropping it wherever it may fall. Each egg case may contain hundreds of eggs which hatch into nymphs.

Cockroaches require high humidity, warmth, and a food source. They live and breed in moist dark places behind skirting boards, around plumbing, under refrigerators and in cupboards, pantries and kitchens. The holds of aircraft are notorious sources of cockroach infestation and the insects enter the hotel on customers' luggage or other items such as crates of food or drink. Outdoors they are found in piles of debris, rubbish and waste. They will readily feed on carbohydrates, paint, wallpaper paste, and book bindings.

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Adult cockroaches can hide in a crack as narrow as 1.6 mm wide, while immature cockroaches tend to stay in even smaller cracks where they are well-protected. They tend to congregate in corners and generally travel along the edges of walls or other surfaces. Use a flashlight at night to inspect cracks, underneath counters, around water heaters, and in other dark locations and look for live and dead cockroaches, cast skins, egg capsules and droppings.

There are five main species and effective control depends on identifying them correctly. Measures to take include effective hygiene and exclusion practices, sticky traps lined with pheromones, boric acid, insect growth regulators and sprays.

Cleanliness should be your prime objective in the elimination of cockroaches. All food-handling areas should be cleaned frequently. In general, cockroach control is best done by a professional on a contract basis, through the application of pesticides to reduce the population to a reasonable level. Control is necessary on a regular basis because of the mobility, reproductivity, longevity and behaviour of these pests. Ensure that you know what pesticides are being used by the professional contractor and do not assume that they are using an environmentally appropriate chemical.

f DUST MITES



Fabrics, bedding (especially mattresses and pillows) and carpets all attract and generate dust – the perfect home for a dust mite. The problem is greater in Northern European countries and in North America where fabrics and carpets form such a major part of the room décor.

Dust mites are only 0.4mm long and so cannot be seen with the naked eye. Unfortunately, they are such a common problem that almost any bed examined under a microscope will be found to have dust mites.

There are several ways to keep dust mites at bay, including regular vacuuming of mattresses and pillows and the use of special mattress and pillow case covers. These need not be made of synthetic or rubber material as specially woven and treated cotton covers are also available that stop the mites getting through from the mattress. Improved ventilation and a low relative humidity will help in reducing numbers.

Thermal treatment of beds and furnishings on a periodic basis is also effective. The bed and furnishings are put into a very large plastic bag which is then sealed and heated up to 100°C, killing off any mites and bed bugs. It also denatures any other irritants that might affect allergy-sensitive guests. Although the process is energy-intensive, it avoids the use of chemicals or pesticides.

g FLIES



Flies of various descriptions, including bluebottles, house flies and fruit flies, are highly efficient carriers of a wide variety of diseases including dysentry, gastroenteritis, typhoid, cholera, meningitis and tuberculosis. For this reason they are highly undesirable visitors to your hotel – particularly the kitchen and restaurant. Once attracted in by food, they can very quickly cross-contaminate food if not dealt with immediately.

Flies reproduce most readily in waste and manure, which is where control should begin. Under warm weather conditions the reproduction cycle – from egg, to larva, to pupa, to adult winged fly – requires approximately one week. For this reason, collection of waste and residues should be carried out at least twice a week. It is also important to keep refuse areas in a clean condition to avoid providing flies with a breeding site. Ensure dustbin lids fit tightly and the interiors of bins are cleaned regularly to keep surfaces free of encrusted food material.

The use of fine mesh window and door screens is a good barrier against entry by any flying insect. Windows and doors can still be opened and, although both light and ventilation will be slightly impaired, it will not dramatically alter the general operating conditions in

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the work-place. Ultra-violet (UV) fly killing machines are very effective so long as they are sited correctly and should not just be reserved for kitchens. UV machines disguised as uplighters in dining and lobby areas are discreet and highly effective because they attract and eliminate flies quickly and silently. In food preparation areas they should only be used once all possible precautions have been taken to keep flying insects out. In many catering establishments, poorly-sited fly machines pose a greater food hygiene hazard than having no insect killers at all. This is because when placed next to the food preparation area they draw flies to the food which they are likely to contaminate before being killed. The best position is close to an entry point, at right angles to the nearest competing light source such as a window. If the UV bulb in the machine is working effectively, the insects should fly straight to it, keeping them well away from the food.

Avoid siting UV machines:

- near open doors and windows facing outwards as they will attract flying insects into the building
- where they may be obstructed by a fridge or other large piece of equipment
- near ceiling fans or air conditioning units where they will be prevented from getting to the machine by the air current
- too high up – flies normally fly below 2.5 metres so any higher means the machine will be above the flight path. It will also make it more difficult to service. The UV bulbs should be changed every 12 months to guarantee their effectiveness.

Chemical control of flies calls for treatment of the breeding sites using larvicides or residual sprays which are applied to surfaces where the adult flies land. The use of mist sprays quickly kills flying adults, as do baits containing substances to attract them, mixed with a poison. Some machines automatically spray a metered dose of natural pyrethrum extracted from the *Chrysanthemum cinerariaefolium* plant and can be used in kitchens and restaurants. A potential downside of such machines is that dying flying insects often fall into or on food so staff vigilance is paramount. 'Safe sprays' are available for food preparation areas, but you should check with your supplier to ensure you know exactly what chemical they contain and how they work.

h MOSQUITOES



Mosquitoes pose a real problem in some tourist areas, carrying with them the threat of malaria, yellow fever, dengue fever and encephalitis. Secondary infections can occur when mosquito bites are scratched, even when no disease agent was transmitted. Some mosquito strains have evolved immunity to several of the known safe preventative medicines.

Most types of mosquito lay their eggs in stagnant water, forming 'rafts' of eggs that are around a quarter of an inch long and an eighth of an inch wide. The best control method is to eradicate their habitat and make their environment an unfavourable one.

- Because they like moisture and lay their eggs in standing water, it is important not to leave flower pot saucers, buckets, plastic sheeting or other open containers outside collecting water. Ensure that any water butts you use for collecting rainwater for irrigation are fitted with a lid.
- Clear debris from gutters and drains to ensure that there is no standing water after rain and drain unused pools or fountains so that the water cannot become stagnant.
- Eliminate depressions, mud flats and other areas that might hold water by draining or filling them.
- Repair leaking taps and air-conditioning units so that puddles cannot form and ensure that septic tanks, cesspools and sewage systems are properly maintained and in good working order.

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- Avoid over-irrigating lawns and gardens, and keep weeds and grass (where the insects rest) well clipped.
- If you have a pond or lake in the hotel grounds or golf course, fill it with mosquito-eating fish such as top-feeding minnows or goldfish – they will eat the floating rafts before they mature into mosquitos.
- Keep water shorelines clear of vegetation that is likely to harbour larvae, and if possible allow water levels to fluctuate to reduce the production of larvae.
- Some hotels have successfully reduced the number of mosquitoes and other insects by attracting bats to their property. Bats are perfect mosquito catchers as they too are active after dark, and one bat can catch as many as 600–1000 mosquitoes in an hour. Many bats in tropical climates are fruit-eaters so planting banana, fig, date, avocado and mango trees in the hotel gardens will help to encourage them and provide fruit for the restaurant. A simply-built bat house will usually accommodate up to 100 bats.
- To prevent mosquitoes from coming indoors, fit fine-mesh screens to porches, doors and windows. Also, encourage your guests to switch off lights and close their doors and windows before leaving their rooms for cocktails or dinner.

If these measures are insufficient, the use of area repellents such as citronella candles, coils or sprays will repel mosquitoes from porches, patios and other unscreened outdoor areas, although they only work well when the air is still. To kill the mosquito larvae and break the life cycle, mosquito 'dunks' can be placed in still water such as bird baths, water butts, ponds, lakes and other breeding places. In areas with a severe mosquito problem, repellents can be used directly in gardens and on lawns to form an invisible barrier and deter mosquitoes from landing in shrubs and bushes. You may also need to treat areas of water with an insecticide to kill the larvae.

i MOTHS



Moth larvae feed on a wide variety of natural and even synthetic materials. They can be found in kitchens and food storage areas, and clothing, carpets, blankets and upholstery are particularly vulnerable. Holes around the hems of wool blankets are often the first sign of moth attack.

Cleanliness is the key to eradication as the larvae cannot complete their normal life cycle without the necessary nutritional supplement such as food, beverage, sweat or urine stains to provide them with the proteins, mineral salts and vitamin B complex on which they depend. A single egg or caterpillar can start the cycle over again so it is important to be thorough when getting rid of them.

Pantry moths thrive on grain-based foodstuffs in kitchen storage areas. They can be identified by tiny holes in food containers and webs in corners, stickiness in otherwise dry foodstuffs or by an unusual odour. Occasionally the larvae or moths themselves can be seen. The life cycle for these moths is six to eight weeks so it can take some time to eradicate them.

Clean the affected area by vacuuming all surfaces, walls, shelves, cabinets and floors, then scrub hard surfaces rigorously with hot water and detergent, especially in corners and all round the edges of removable shelves. Clean every surface that comes into contact with food. Next rinse the area with white vinegar, either in a spray or by wiping down with a cloth.

Throw away all grain-based food items as well as nuts, raisins, flour, and tea, even if it is in sealed containers. The remaining food items and containers should be thoroughly cleaned with a detergent and water solution and wiped down with a vinegar rinse before being put back. Use air-tight containers made of hard plastic, glass or metal and not plastic bags.

Kill any moths left flying around in the air with a fly swatter or moth traps. There are many commercial traps available.

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After a severe infestation, it may be wise to freeze any new grain products you buy in before putting them into store cupboards and consider storing all of your grain based products in this way.

Peppermint gum, bay leaves, peppercorns and cloves are all said to help deter pantry moths.

Moths in clothing or fabrics need to be treated in much the same way – by killing the eggs and larvae to interrupt the life cycle. Fabrics should be washed or dry cleaned and then put in bags and placed in a freezer. When you take them out to thaw, shake them vigorously to remove the dead larvae.

Clean the areas where the fabrics have been stored using a vinegar and water solution as described earlier. If you are storing blankets and bedding away for any length of time, ensure that they are clean. Ideally they should be stored in a chest made from cedarwood. Alternatively, put chips or blocks containing cedarwood oil into the drawers. Lavender sachets are also a useful deterrent. Air rooms well, allow in plenty of sunlight, vacuum regularly and empty vacuum cleaner bags frequently as they can harbour moths, which can eat through the bags.

You will need to follow these control procedures on a continuous basis if your hotel is in an area where moths are a persistent problem. For acute moth problems, re-usable traps are available that can be baited with a controlled-release pheromone system to lure moths into the trap and disrupt their mating cycle.

Mothballs not only have an unpleasant odour, but they are also poisonous so should be avoided if possible. Insect foggers are not recommended as they can pose a health threat and are not always effective.

j RODENTS



Rodents, such as rats and mice, are attracted to hotel and restaurant premises when litter and food are left lying around. They live in close proximity to us and are found in living quarters, kitchens, storage rooms and outbuildings.

In addition to the fact that rats transmit disease, they can cause substantial structural damage and consume and contaminate large amounts of foodstuffs. A rat will consume 8kg (17 lb) of food (including your waste food) yearly and can produce four to five litters a year. Mice often enter a building looking for food and shelter when the weather begins to get colder. Since mice are deterred by the smell of a rat, the problem is often one or the other rather than both together. Mice can squeeze through holes as small as a quarter of an inch in diameter, so eliminating any gaps in masonry where they can gain access from outside is very important.

Rodent control should start with a survey to determine the source of the problem and the conditions that encourage the infestation. This should be followed up with a programme to kill the rodents, removing their sources of food and water, eliminating their place of refuge and making it rodent-proof, and educating and obtaining the co-operation of employees. If the food supply is removed before you kill them, the rodents will migrate to other areas, making elimination more difficult.

The construction of rodent-proof buildings and the elimination of refuges are key preventive measures. Openings in building foundations and walls should be closed or screened with wire mesh that has holes not more than 1.25 cm (0.5 in) wide. Where pipes enter masonry, force heavy hardware cloth or steel wool into the opening, then fill it with concrete. Continual surveillance is necessary, and places where rodents have been gnawing to gain entry to a building should be sealed with metal flashing. Doors are particularly vulnerable to rodent attack so ensure that external doors and windows (especially basement windows and those near ground level) close tightly with no gaps at the bottom. Materials stored in the open, in sheds or in buildings should be stacked at least 30 cm (1 ft) above the ground.

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Stringent waste disposal practices should be observed – make sure that any food being collected for disposal is in a secure vermin-proof container with a lid and not just in plastic bags. Wash down dustbin areas regularly. Make sure composting bins are designed so that rodents cannot get in.

Traditional mouse and rat traps, or 'snap' traps, kill instantly. If trapping efforts fail it is usually due to too few traps being used and ideally you should use two traps every two to three feet along the wall. Bait should be sticky to ensure that the mouse triggers the trap mechanism even if it only lightly touches the bait. Mice prefer peanut butter or chocolate to cheese, or you can use bacon, oatmeal or apples as bait. An alternative is a battery-operated trap that generates a high-voltage once the rat or mouse is inside. The design is such that it is relatively safe to use in areas where there may also be children, other wildlife or pets. Because the rat or mouse stays in the trap, there is not the problem of having to locate where the animal has died.

Poison bait should ideally only be used by a specialist contractor. Anti-coagulant poisons are preferred because of their low level of toxicity for human and other life, but some rat populations have become immune. Whilst the hazard to humans varies according to the poison employed, extreme care should still be taken in distributing and placing all poison bait. Every possible precaution should be taken to prevent risk to humans and the contamination of food and water.

k SLUGS AND SNAILS



Slugs and snails can ruin the appearance of the best kept grounds and gardens and are a particular problem for hotels that grow their own organic vegetables. There are various non-chemical solutions including putting salt or sharp shingle around vulnerable plants, drowning them in beer or simply throwing them over a neighbouring fence. Another is the use of an elemental copper band on adhesive tape – the natural electric charge in the copper repels snails and slugs.

l WASPS



Wasps are generally a problem where food and drink is being served outside during warmer months of the year. It is important to control them as some people are allergic to the venom in wasp stings and can develop an allergic reaction, ranging from mild to life-threatening. Each year, around four anaphylaxis deaths caused by severe allergic reactions to bee or wasp stings are reported in the UK alone.

A simple trap can be made by putting beer or a solution of jam or honey with water in a jam jar. If this does not work, there are branded traps available containing specially formulated attractant baits.

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8.6.5 Natural control methods for hotel gardens

If you can create a healthy, balanced environment for plants, you will reduce the need to use expensive chemicals in the grounds and gardens. There are many naturally-occurring predators to control pests, and organic solutions to disease, weeds and fungi. Also, if you look after your soil by feeding it with organic compost (including kitchen and garden waste **SEE SECTIONS 4.4.7 AND 4.4.8**), leaf mould and other soil improvers such as horse manure, or fish, blood and bone fertiliser, you will minimise the need for synthetic chemicals of all kinds.

a PREVENTATIVE MEASURES

There are several steps that hotels can take to reduce the risk of problems requiring chemical control:

- Plant at the **right time**, in the **right place**. Seedlings should not be planted too early, nor located in unsuitable conditions. Young plants should not be deprived of their peak growing potential – as it is often their best defence against attack. Putting plants which need a lot of water close to buildings will make them more vulnerable to mildew.
- Select **disease-resistant varieties**. It is often possible to find varieties that are resistant to particular pests or diseases, so if you are aware of a particular local problem, choose plants that will be unaffected.
- **Traditional methods** of planting and maintaining grounds can often reduce the need for biocide use. In particular, mixing plants and avoiding 'monocultures' have long proved to be effective in reducing the numbers of certain pests.

b ATTRACTING NATURAL PREDATORS

Birds, insects, worms and other creatures all help to maintain a **natural balance** in the garden, controlling unwanted visitors such as slugs, snails, aphids and unwanted insects. Aim to provide habitats for creatures that prey on pests, such as nesting sites and supplies of food for birds during winter months, or a pond for frogs and toads.

c BIOLOGICAL CONTROL

Biological control is where natural predators or 'competitors' are **introduced** into an environment to control animal or plant infestations. They can include animals, insects, viruses or fungi. Predatory mites, for example, can counter red spider mites; parasitic wasps will resolve whitefly problems, ladybirds will control aphids. *Bacillus thuringiensis* will put an end to pest caterpillars, by giving them a natural bacterial disease. The use of such natural biological control can be very cost-effective, but needs careful planning. Some experiments in introducing species to new environments (such as cane toads in Australia) have been disastrous. Careful and expert review is essential before taking action as a biological introduction may not be applicable to your hotel environment.

d PHYSICAL CONTROL

Physical control refers to the **blocking or trapping** of insects or other animal pests. Examples include using Ultra Violet (UV) light to attract insects to electrical exterminators and using flame guns to control weeds. You can also provide effective protection to seedlings from insects through the use of plastic bottles cut in half and inverted over the seedlings. Basic sanitation measures will also help such as:

- proper **storage, collection and disposal** of refuse, including manure
- eliminating or reducing **breeding areas** by keeping water collection areas clean, clearing out bushes and ensuring hotel buildings and other structures are rodent-proof
- fitting **screens** on doors and windows to stop the ingress of pests
- effective **food safety and hygiene** precautions for all food storage, preparation and service areas
- **pest-control** operations at regular intervals.

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e WEEDS AND UNWANTED VEGETATION

Weeds are plants that grow where they are not wanted. Even cultivated plants that grow larger than intended and begin to spread out of control become weeds. They can be very persistent and may grow in cracks in paving and walls, gutters, or in soil where no other plants can compete for example. Many species of weeds are not readily killed by mechanical cutting; they quickly recover and continue to grow. Some weeds grow rapidly during times when desirable plants are dormant, and will spread and shade out the species you want. Other weeds may be toxic to livestock or have noxious properties. All these factors need to be taken into account both when planting and when planning vegetation control.

To reduce or avoid the use of herbicides you should:

- Strive to keep the exterior grounds of the hotel **well-maintained** at all times.
- **Remove plants that are out of control.** Common sense and alertness will help you recognise incipient weed problems.
- Consult with a professional weed expert who is knowledgeable about the proper maintenance of desired vegetation. Having a contract with a reputable firm for certain phases of grounds maintenance (fertilising, chemical weed control, etc.) can be more economical than stop-gap attempts by personnel who have to divide their time between various maintenance jobs.

8.7 ASBESTOS

8.7.1 The issues

Asbestos is a naturally occurring, chemically inert mineral which is immune to rot and bacteriological attack. It is mined in much the same way as copper, iron and lead and the main producers are the US Canada, South Africa and former Soviet Union states.

With its many useful properties, asbestos was a very popular product in the 20th Century until the 1970s. Its primary use was as a construction material because of its high resistance to alkalis, corrosion and high temperatures, its high tensile strength, and its properties as a sound attenuator and electric, heat and cold insulator. However, its one serious drawback is the known adverse effects of asbestos on human health. Although asbestos use is banned in the European Union, the US, Japan, Australia and other countries, it is still used in some countries owing to the lack of equivalent replacement materials for many applications.

Asbestos comprises a group of minerals with a crystalline structure, occurring as parallel bundles of fibres. When disturbed, these bundles separate into smaller individual fibres called 'fibrils'. Once inhaled or ingested, the fibrils are not readily broken down or expelled and remain like needles in the body. Asbestosis is a disease is caused by exposure to high levels of airborne asbestos fibres over a long period of time and Mesothelioma is a rare and virulent form of cancer which occurs in those who have been exposed to asbestos fibres as long as 50 years ago. Mesothelioma affects the lining of the lung, lining of the abdominal cavity or the lining around the heart. Some sufferers were exposed at work and others were exposed secondarily through family members who without their knowledge, brought fibre home on their work clothes or on their hair or skin. Mesothelioma International[4] estimates that 250,000 workers in Western Europe alone will have died from the disease by 2029.

When used as a component of other materials, it is not always easy to tell if asbestos is present. The only conclusive way to find out is to take a sample and examine it under a microscope by polarised light or by X-ray diffraction, or both. This should be carried out by a competent laboratory.

[4] See www.mesotheliomainternational.org

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8.7.2 Types of asbestos and where it is found

There are **three basic types** of asbestos: **Chrysolite** (white asbestos), **Crocidolite** (blue asbestos) and **amosite** (brown asbestos). Other varieties include **anthophyllite**, **actinolite** and **tremolite**. They fall into two groups:

SERPENTINE GROUP

Serpentine minerals have a **sheet or layered structure**. Chrysolite or 'white' asbestos is the only asbestos mineral in the serpentine group and is commonly found in buildings or materials that date from the early 20th century to the mid 1970s. Some of the materials in which it is contained include:

- joint compound
- mud and texture coats
- vinyl floor tiles, sheeting, adhesives
- roofing tars, felts, siding, and shingles
- transite panels, siding, countertops, and pipes
- fireproofing, fire blankets, interior fire doors and fireproof clothing for firefighters
- caulking putties
- gaskets
- brake pads and shoes and clutch plates
- thermal pipe insulation

AMPHIBOLE GROUP

Five types of asbestos are found in the amphibole group: **amosite, crocidolite, anthophyllite, tremolite,** and **actinolite**. Amosite, the second most likely type to be found in buildings, is the 'brown' asbestos.

Amosite and crocidolite were used in many products until the early 1980s. The use of all types of asbestos in the amphibole group was banned (in much of the Western world) by the mid-1980s, and by Japan in 1995. These products were mainly:

- low density insulation board and ceiling tiles
- asbestos-cement sheets and pipes for construction, casing for water and electrical/telecommunication services
- thermal and chemical insulation (such as fire doors, limpet spray, lagging and gaskets)

Asbestos can be found in cement, rubbers, plaster, paint, bitumen, mastic, resins or plastics where the fibres are bound into the mix. When it hardens, the fibres are securely sealed, so that they cannot escape into the atmosphere. The end product, whether it is floor tiles, fire blankets, gloves, roofing sheets, pipes or fire partitions, poses no threat to health as long as it remains intact.

The most widespread use of asbestos is in ceiling, floor and wall coverings. It is sprayed together with cement to form a coating on structural steel members for fire protection. It has been used extensively for insulating boilers and tanks and for pipes carrying steam, condensate and hot water, for ventilation ducts and kitchen exhausts.

Vermiculite is a naturally occurring mineral that may contain asbestos. Vermiculite expands into worm-like accordion shaped pieces when heated. The expanded vermiculite is a light-weight, fire-resistant, absorbent and odourless material. These properties allow vermiculite to be used to make numerous products, including attic insulation, packing material and garden products.

More information on asbestos-containing materials can be found in **APPENDIX 7** of this section.

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8.7.3 Hazards of asbestos dust

Today we are aware that breathing in sufficient amounts of asbestos dust for long enough periods can cause serious illness. Legislation concerning air emissions recognises the risk category of asbestos fibres as being of the highest order. However, the mere presence of asbestos-containing materials (ACM) in a building does not automatically constitute a health risk to the occupants.

To pose a risk to health, the ACM must be 'friable' and capable of becoming airborne when disturbed. Friable means that the asbestos can be crumbled or pulverised to a powder by normal hand pressure. It is the airborne particles that are dangerous as only these 'fibrils' can be breathed into the lungs. The effect, in the form of cancer, may not appear until many years later.

Because of its widespread use and application, the atmosphere surrounding us contains asbestos particles – more so in cities than in the countryside. The average particle count for cities is 100–200 per m^3 of air. However, near emission sources, concentrations can be up to 1000 particles per m^3 of air. Within contaminated buildings they well exceed 1,000,000 particles. If frayed asbestos is present in your building, you are potentially exposed to a considerable health risk.

As more has become known about the hazards that asbestos presents, strict controls have been imposed upon its use and management and its use is being phased out. In the UK, owners and occupiers of non-domestic properties (including hotels) have a duty to manage asbestos, which is contained in regulation 4 of the **Control of Asbestos Regulations (CAR) 2006 – The Duty to Manage Asbestos in Non Domestic Premises**.

8.7.4 Asbestos management

a YOUR RESPONSIBILITIES

Most asbestos legislation requires the 'dutyholder' (the person or organisation with clear responsibility for the maintenance or repair of non-domestic premises through an explicit agreement such as a tenancy agreement or contract) to:

- **Find out if there are materials containing asbestos** in non-domestic premises, and if so, the amount, where it is and what condition it is in.
- **Presume** that materials contain asbestos **unless there is strong evidence that they do not**.
- **Maintain an up-to-date record** of the location and condition of the ACMs or materials presumed to contain asbestos.
- **Assess the risk** of anyone being exposed to fibres from the materials identified.
- **Prepare a plan** that sets out in detail how the risks from these materials will be managed.
- **Take the necessary steps** to put the plan into action.
- **Periodically review** and monitor the plan and the arrangements to act on it so that the plan remains relevant and up-to-date.
- **Provide information on the location and condition of the materials** to anyone who is liable to work on or disturb them.

Your **staff also have a duty to co-operate** as necessary to allow the dutyholder to comply with the above requirements.

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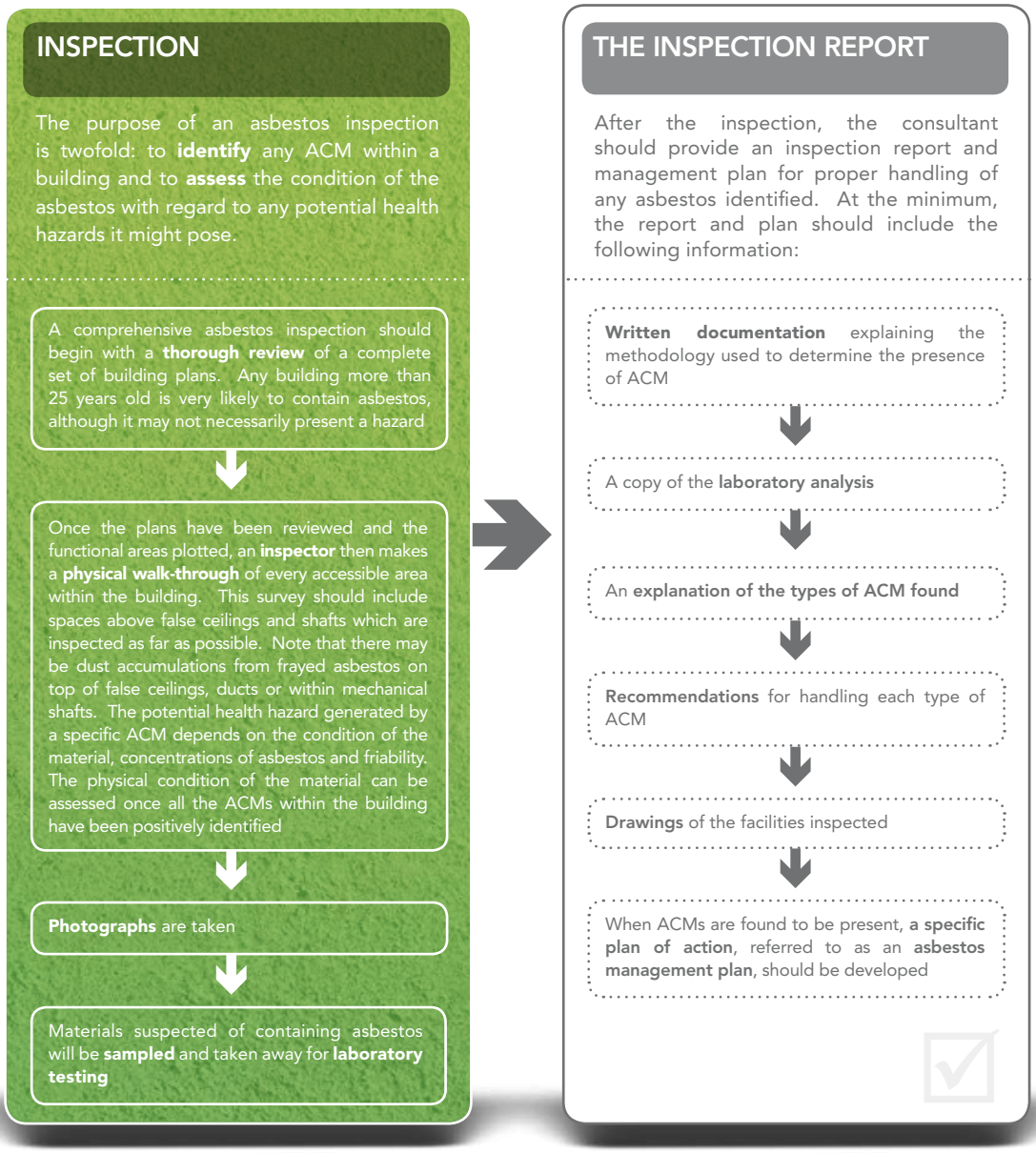
b IDENTIFICATION

Both the identification of ACMs and the follow-up required can be extremely complicated and require an expert. Later in this section we focus on how to select expert assistance and what the main steps are that an asbestos consultant will take on your behalf.



8.7.5 The asbestos management plan

The consultant's inspection report may offer one or a combination of recommendations for managing ACMs within the building.

a REMOVAL

This means physically removing the ACM from the building. Removal is usually recommended for severely damaged materials that cannot be repaired, should not bear further weight or which are present in areas of high-occupancy. The procedure is conducted under strict supervision, generally by trained and experienced asbestos-abatement personnel, following a detailed set of specifications. These will be set out in the contract documents. During removal, all occupants are temporarily relocated and the area is isolated and heavily controlled.

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b LEAVING THE ASBESTOS IN PLACE

This option is no longer permitted if the asbestos is not completely intact unless the risk of removing it is perceived to be a greater risk to health than leaving it in place. Once you have identified ACMs within the building, you will be required to implement a continuous surveillance and maintenance programme throughout the life of the building. Since a limited risk is still there, it may also be difficult to get adequate insurance coverage – if at all. However this needs to be balanced against the fact that removing asbestos that is in good condition is not only creating an unnecessary dust hazard, but also will be expensive.
SEE FIGURE 8.6

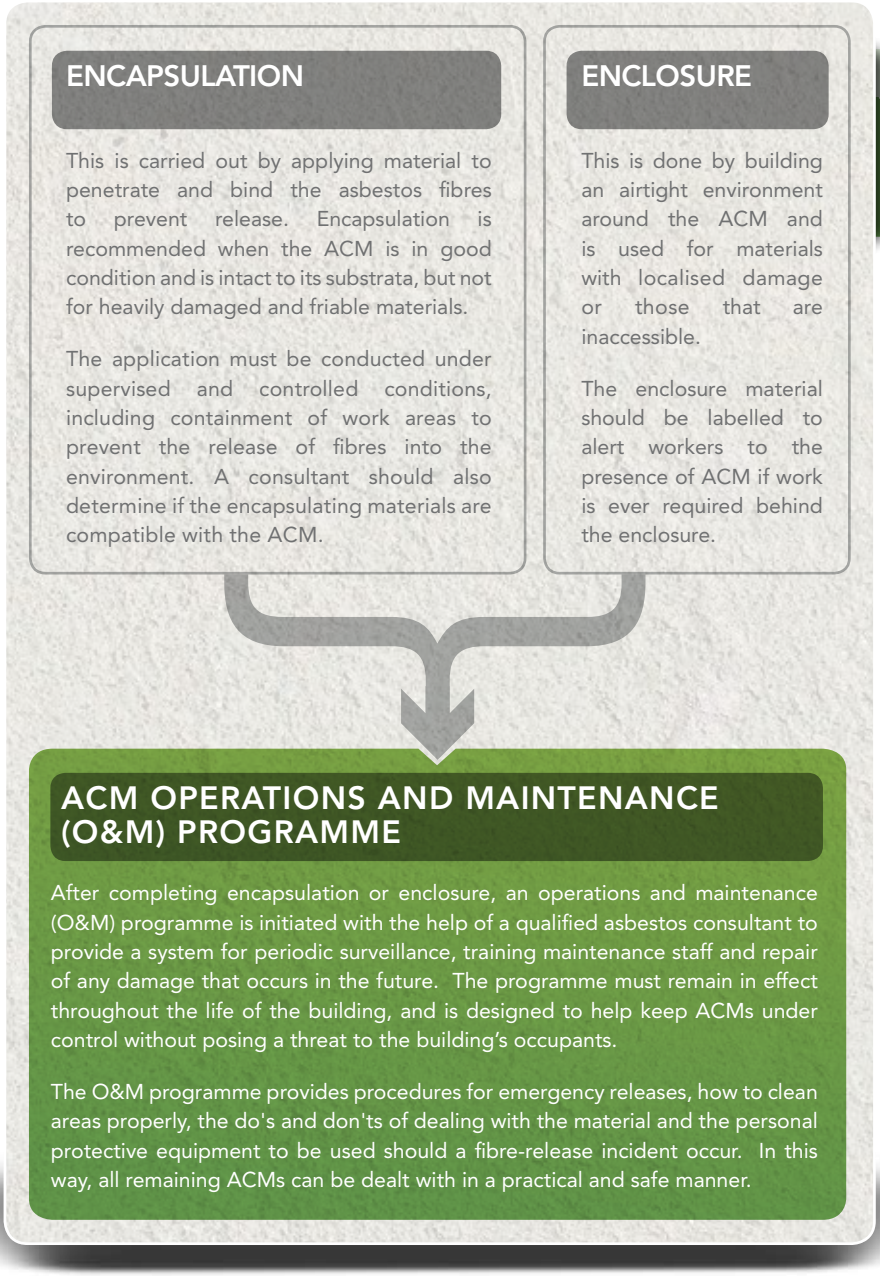

FIGURE 8.6
Techniques for controlling asbestos that must be left in place

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c COSTS ASSOCIATED WITH ASBESTOS REMOVAL

The asbestos consultant will need to prepare professional cost estimates in order to establish a budget. The following considerations have an influence on the total cost of the project:

- whether the removal is to be conducted when piping systems are hot, which will increase the cost
- inaccessibility due to the height or location of the ACM
- whether removal will restrict or limit the operation of the hotel, resulting in revenue loss
- requirements of asbestos-removal contract specifications with regard to bonding, insurance and licensing, and management of removal operations
- work required by other contractors before, during and after the abatement work
- future abatement regulations mandated by state or local legislation
- other abatement alternatives
- future operations and maintenance (O&M) costs.

Once the decision as been taken as to how to remove the ACM, the abatement process must be planned and an abatement contractor retained. Both actions require detailed planning.

d UNDERSTAND AND DEFINE RESPONSIBILITIES

Specific guidelines and regulations have been established by state and local authorities for the proper removal and disposal of asbestos. The use of a qualified contractor is essential – in the past abatement work in some locations in the US was incorrectly carried out, increasing rather than minimising the dangers. Incompetent abatement creates a considerable financial risk for the building owner and operator including the potential liabilities of exposing building occupants to contamination and improper waste disposal, project delays and other schedule problems that keep facilities out of service, creating loss in revenue and cost overruns.

Define the exact responsibility of your consultant versus that of the contractor. The consultant will generally develop the specifications that identify the correct procedures and requirements necessary to remove the ACM. In addition, they will define any substitute materials that may be necessary. The consultant's advice is also valuable in the selection of the contractor. During the execution process they will monitor all actions undertaken by the contractor to ensure that the specifications are met and exposure of building occupants and possible liability are kept to a minimum. This includes regular measurements of the air, where specified concentration levels of asbestos shall not be exceeded.

When you have appointed a consultant, they will be able to help you to establish the asbestos management plan with your team. If the building is to remain in service, the project will need to be divided into several separate phases, calling for specific logistical considerations such as:

- maintaining access
- sequencing and accessing lifts
- providing uninterrupted access to utility vaults in the basement
- maintaining equipment operation and essential services.

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8.7.6 Guidelines for selecting an asbestos removal contractor

The first step is to obtain the services of a qualified consultant or asbestos industry professional to help you seek the right contractor. It is not essential to employ a large firm but it must be a well-qualified firm that can manage, fund and complete your job safely.

How you evaluate contractors will be influenced by the size and complexity of your project. If it is difficult or very large, it will demand more detailed contractor evaluation than if it is small or straightforward.

STEP 1 INITIAL SCREENING

- Establish the **scope of and specifications** for the work that needs to be done
- Draw up a list of **potential candidates** using referrals from the consultant, information from trade associations and from state and local environmental agencies.
- Seek to **answer the following questions**:
  - Does the company have the **necessary accreditation**? In the UK you can check that the organisation is approved by a recognised accreditation body that complies with the International Standard **ISO 17020**. In the case of individual surveyors, he or she should have personnel certification for asbestos surveys from a certification body approved by a recognised accreditation body under **ISO 17024**. You will also need to check which of the three types of survey they are qualified to carry out. Further information can be obtained from the **United Kingdom Accreditation Service (UKAS)**.
  - Individuals undertaking asbestos surveys in the UK should be certified either by the **ABICS (Asbestos Building Inspectors Certification Scheme)** which is operated by the **British Occupational Hygiene Society (BOHS)** or the **National Individual Asbestos Certification Scheme (NIACS)**, a joint venture comprising a specialist division of the **Asbestos Removal Contractors Association (ARCA)** and the **Royal Institute of Chartered Surveyors (RICS)**.
  - Is it a good company in a **sound financial state**, with the necessary **technical competence, experience, responsible practices, good management and responsive administration**?
  - Do they have sufficient **qualified manpower** to carry out the job at the time you want them and to complete it within the specified time frame?
  - Can they respond to and comply with **complex and changing laws** and regulations?
  - Do they have **asbestos-specific insurance** and bonding capability?
  - Can they offer **long-term protection** against claims that may not be filed for 20 years or more?

From this you should be able to draw up a shortlist of two to four bidders. A large bid list may not necessarily produce more price value, but may increase your workload and drive away responsible contractors.

STEP 2 CONTRACTOR EVALUATION

- **Involve** your risk managers, legal advisers, financial experts, engineers and asbestos consultant in the process of understanding and verifying the information received.
- **Check references** from both owners and consultants.
- Review the amount, size and success of contractors' **past abatement projects** and construction management efforts, paying particular attention to projects similar to your own in size, complexity and arrangement.
- **Review the quality and experience** of their project managers, supervisors and workers. Are all the contractor personnel properly trained and licensed and able to handle specific areas of responsibility?
- Can they meet your **scheduled deadline**?

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- Obtain a copy of their **proof of insurance** (a certified copy of the insurance certificate) and bonding capability. Some contractors are insured with occurrence-type policies, under which the insurer pays claims for all covered injuries and property damage occurring during the policy period. The major advantage to the policyholder (and additional persons insured under the policy) is that once the policy is written, claims can be made at any time afterwards. The insurer is responsible for paying claims even after the policy is no longer in force. This is in contrast to a 'claims-made' policy which does not cover claims, injuries or damages filed after the policy has expired, even if the injury or damage took place during the policy period. Extended claims coverages (known as 'tails') can be purchased, but these can be very expensive and are not necessarily available.
- Do the insurance and bonding carriers have the **quality, reserves and financial soundness** to back up the coverage they write? Check how long they have been in business and their financial statements. The insurance and bonding carriers are two very important third-party entities which are also making a critical evaluation of the contractor. The involvement of high-quality firms with sound coverages is a good indicator of contractor performance.
- Does the contractor have comprehensive **employee training, medical, respiratory protection and industrial safety programmes** in place? Do they respond to the latest regulations, specifications and standards of care? Your consultant's assistance will be invaluable here.
- **Review** the documentation and quality assurance programmes that the contractor will provide. The records generated during your job must be maintained for 30 years or longer. Is the contractor reasonably likely to accomplish this?
- **Review the credentials** of the contractors' proposed hygiene, waste-hauling and disposal providers. Since you 'own' your asbestos waste forever, it is essential to be insured that this hazardous material is properly handled and buried in approved disposal facilities.

STEP 3 CONTRACTOR SELECTION

- Is the contractor's proposed work plan and schedule **well thought out** and **realistic**?
- Does it correspond to your **concerns and expectations**?
- Arrange for a **pre-bid meeting** with proposed contractors to answer any questions about the scope of work and to visit the project site.
- Use an **evaluation sheet** to weight the selection criteria and decide which contractor can produce the results most important to you. A full committee review, with all your participating advisers, may be appropriate.
- **Avoid using price as the primary criterion**. Failure to perform adequately on an abatement project can result in widespread asbestos contamination and its associated health hazards and liability implications. Consider negotiating on the price if one firm is clearly the most capable and desirable for your project but is much more expensive.
- Sit down with the contractor's representatives and your advisers to arrive at a **mutually agreeable contract** with fair financial terms.

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8.7.7 Safety of personnel

a Where ACMs are present, ensure that you are complying with relevant **Health and Safety regulations** regarding asbestos in the workplace. Most legislation requires the duty holder to ensure that the hazards relating to asbestos are effectively communicated to anyone likely to come into contact with it.

b **Under no circumstances** should **hotel employees** be allowed to remove asbestos or carry out any other work associated with it. They should be told about the project and any hazards it presents, the purpose of sealing off the asbestos area and why they must keep out.

c **Time spent** by the hotel's environmental and/or safety committee discussing plans with the contractor and briefing employees to explain what is to be done will be well worthwhile. The precautions that will be taken during the removal process, in order to protect any building occupant against hazardous dust, should be described. Any hotel employee who will be affected in any way by the asbestos work should attend training sessions and be given written information and guidance as to the do's and don'ts during the removal process.

d **Tenants, guests** and **other occupiers** of the building should also be notified in accordance with regulations.



All parties need to understand what will happen during the asbestos removal process in order to prevent the release of hazardous airborne fibres

8.7.8 The removal process

It is important for **everyone to understand** what will happen during the asbestos removal process, both for the preparation and execution of the risk-management plan. This will enable you to prevent hazardous airborne fibre release and possible liability suits and will involve:

a ISOLATION TECHNIQUES

In order to keep the services of the building operating, several **isolating techniques** may be employed:

- **Erecting walls or partitions** which separate the asbestos work area from the public and service areas. Health regulations require the creation of a 'regulated area' to prevent employees adjacent to the abatement work from being exposed to asbestos fibres. Additionally, there are concerns about dust, debris and noise generation from the removal activities. Typical walls are constructed with stud framing and plywood sheathing. Often sound insulation and gypsum board are also used to minimise noise and vibration, or to add a fire barrier to further separate the construction from the occupied areas.

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- **Erecting isolation barriers.** Since some demolition activities do not necessarily involve asbestos, the 'regulated' area must be further separated from the general demolition and construction activities. These partitions, again often constructed of wood framing and sheathed, are then covered with one or two layers of impermeable 6 ml thick plastic sheeting.
- **Building tunnels** using construction techniques similar to those described above. Once the active work areas are appropriately partitioned and isolated, each 'regulated area' is fully established by providing a **containment**. Containment is a means of isolating and controlling a work area to affect the behaviour and migration of contaminants and hazardous materials.
- The work area will then be **isolated** to prevent entry by unauthorized personnel by locking all relevant doors in agreement with the operator. Rerouting of emergency exits may be necessary. Locked access to the work area will only be provided for the contractor's personnel and the doors must have 'panic' release systems from the inside.
- **Warning signs** will then be installed at each locked door leading to the work area. Critical doors opening into the work area must be marked in accordance with regulations, along the lines of the examples shown below:



b EQUIPMENT ROOMS

If asbestos is sprayed on the building structure within a **plant room**, another key logistical consideration is the HVAC equipment itself. The chiller, boiler and most of the air-handling equipment stay in operation during the removal activities in the plant-room. Their very presence and location often mean they make accessing the asbestos fireproofing difficult.

To overcome this, a specialised scaffolding company may be called in to erect tube-and-clamp scaffolding around the equipment and overhead to provide access to the material. The scaffolding is arranged so that the framework ban he used as a 'reverse containment', i.e. plastic sheeting is applied over the scaffold framing and sealed. Airflow ducts are then used to discharge air via-high efficiency particulate air filters into this enclosure to pressurise it positively against inward asbestos leakage and also to ventilate the enclosure to prevent equipment overheating.

Asbestos removal activities can then proceed around the equipment without it being directly in the work area or subjecting it to contamination. This technique is also frequently used with active switchgear, control panels or any stationary items within a work area that cannot be moved, must stay in service or must not be subjected to asbestos contamination.

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Asbestos removal may also be required on the HVAC equipment itself, where ACMs have been used. The abatement of this equipment is usually scheduled over a weekend or at a time when the equipment can be shut down. It is important to discuss this scheduling carefully with the contractor to ensure on-time completion. Time must be allowed for decontaminating the area, clearance testing and reapplication of enough insulation materials to permit restarting all the pieces of equipment.

c DECONTAMINATION

Decontamination units must be installed to enable asbestos removal from persons and materials as they leave the work area.

d WET REMOVAL

Asbestos-containing materials are **thoroughly wetted** before stripping and/or tooling to reduce fibre dispersal into the air. Wetting is accomplished by a fine mist spray.

The material is sufficiently saturated to the substrate without causing excess dripping. Material that has been painted over is perforated and clean water injected. Where necessary, the ACM is stripped away while simultaneously spraying water.

e AIR-MONITORING

Air-monitoring should be carried out **continuously and under the supervision of the consultant**, who is independent of the contractor. If there is no appropriate laboratory nearby, portable equipment will be brought and an analytical laboratory set up on site. This permits continuous air-sample analysis, and will identify a high-fibre release incidence so that it can be promptly remedied.

f DISPOSAL

All removed asbestos is **packed into marked disposal bags while still in wet condition**, and not allowed to dry out. Air is removed from the disposal bags with a High Efficiency Particulate Air (HEPA) vacuum cleaner before sealing. All bags are then sealed in leak-tight fibreboard drums. They should not be stored outside the work area.

They are then removed by a **licensed waste haulier** in fully enclosed skips or trucks to an approved site. Receipts and full documentation must be obtained from waste haulier and the final disposal area.

8.8 POLYCHLORINATED BIPHENYLS (PCBs)

8.8.1 The issues

Polychlorinated biphenyls (PCBs) belong to a family of organic chemicals known as chlorinated hydrocarbons.

PCBs are man-made and are stable against heat, excellent insulators, colourless and do not dissolve in water. They are relatively inert, being difficult to break down or to make react with other chemicals. They range in consistency from heavy oily liquids to waxy solids. In cooling applications they are frequently mixed with solvents such as dichlorobenzene to decrease viscosity. These solvents frequently emit a characteristic odour.

PCBs were used from the 1930s until the 1970s as coolants and insulating fluids for transformers and capacitors because they do not readily burn or conduct electricity. They were also used as stabilising additives in flexible PVC coatings of electrical wiring and electronic components, pesticide extenders, cutting oils, flame retardants, hydraulic fluids, sealants, adhesives, paints, de-dusting agents, and in carbonless copy paper.

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Two catastrophes, in Japan and Northern Italy revealed the considerable hazard posed by PCBs, and since then governments have phased out their production and use and research has focused on finding replacements. Around the world, PCBs are gradually disappearing from the market and from use.

8.8.2 Hazards of PCBs

PCBs are classified as **persistent organic pollutants (POPs)** (SEE APPENDIX 3) because when they are released into the environment they do not easily biodegrade. As they have a strong tendency to persist and build up in living tissue, they easily make the leap between predator and prey in the food chain. Their half-life value (period of decay to 50 per cent of original strength) is 20–100 years.

Laboratory data show that PCBs cause cancer in animals, and despite the absence of statistical proof that they cause cancer in humans, it is prudent to consider any animal carcinogen a possible human carcinogen.

Animal studies show adverse reproductive and development effects from repeated exposure to PCBs. In addition, it has been shown that PCBs are toxic to fish at very low levels of exposure. Their bioconcentration factor is 85,000–100,000, meaning that very low concentrations in the ocean gradually build up to over 85,000 times this amount in the body of fish up the food chain. The survival rate and the reproductive success of fish can be adversely affected. It is believed that there may be similar cause for concern when humans are exposed to large doses of PCBs.

The 'Yusho' accident in Japan in 1968 affected the health of 1,600 people after they had consumed rice oil contaminated with Kanechlor 400, a 48% chlorinated biphenyl, at 2,000–3,000 mg/kg, which entered the oil through a leak in the heat exchanger. Their complaints ranged from dizziness, nausea, eye irritation, bronchitis and digestive problems to more serious ones such as liver damage and chloracne, a painful disfiguring skin illness and a weakened immune system.

The worst accident occurred in 1976 in Seveso with the accidental release of a highly toxic gas – TCDD. The amount was estimated at only 2–3 kg distributed over an 18 km^2 area. Nevertheless, a large number of animals died as a result. Humans had the same problems as observed in the Japanese incident, but on a larger scale. The polluted soil had to be disposed of over many years.

TCDD is a gas of the chlorinated dioxin family, frequently referred to simply as dioxin. The same gas can be formed when PCB is exposed to heat. Accidents such as a transformer explosion or fire have made the buildings in which they were housed uninhabitable.

Similar to PCBs, TCDD is non-biodegradable, and therefore finds its way into the food chain. TCDD is considered to be one of the most toxic substances in the world.



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8.8.3 Legislation

The **US Environmental Protection Agency** banned PCB production in 1979 and they are subject to the **Toxic Substances Control Act (TSCA)**. A number of countries have set regulations for the use, marking, storage, recording and disposal of PCBs. Both the owning company and operator are legally responsible. The responsibility for investigation, notification and corrective action rests with the hotel.

Because of the millions of items of equipment containing PCBs, complete phase out will take a long time. Disposal has also been handled differently from country to country.

8.8.4 Dealing with PCBs

	START WITH AN INSPECTION	RESPONSES

TRANSFORMERS (OIL-COOLED) AND VOLTAGE REGULATORS	• **Check the nameplate data** and **technical service manual** to verify if your transformers contain PCBs. If verification is not possible, check with the manufacturer or your local electricity company
	• If a PCB is present, **check the transformer** and its **vault for oil leaks.**
		• If PCBs are present, the **transformers should be replaced and disposed of** by a licensed company at a state-approved disposal plant. The oil is removed there and burnt at temperatures exceeding 1,200°C. Only at this high temperature can PCBs be destroyed as at lower temperatures, highly toxic dioxin gases will form
		• **Replacement transformers** should be air-cooled, if adequate ventilation can be provided
		• Review your **future renovation and construction plans** to evaluate if a change in capacity is appropriate
		• **If leakage has occurred** or is still occurring, proceed as follows:
		  ◦ **Place a pan underneath** the leaking equipment
		  ◦ Call in a **qualified and licensed consultant** to evaluate the extent of leakage and migration
		  ◦ As a first-aid measure, carry out **required repairs** to the transformer to **stop leakage** until replacement takes place
		  ◦ Depending on the extent of contamination of the concrete basin, **removal** and **disposal** of all affected material to an approved plant must be carried out by a licensed contractor.

CAPACITORS	Capacitors may be installed in **different sizes**: larger ones are for power factor correction near the main distribution panel or at major equipment such as chillers. Smaller ones are often used as ballasts within fluorescent light fixtures • **Check the nameplate data and service manuals** to verify whether the capacitors contain PCBs.	• Capacitors found to be defective and/or leaking should be **treated in the same way as transformers** • Capacitors installed in **fluorescent tube lights** can remain there as long as they are intact. Fluorescent light ballasts manufactured prior to 1980 may contain about 17 millilitres of PCB sealed inside the capacitor of the ballast. The capacitor is wrapped in paper and sealed in asphalt inside the ballast case. High temperatures may cause the asphalt to soften and leak out of the ballast case. Often this leakage of asphalt is mistakenly believed to be PCB. Asphalt, when cooled to room temperature, will re-harden, whereas PCB dielectric from a leaking capacitor would remain as a heavy oil. Sometimes the ballast has the date of manufacture on it, and sometimes it is marked 'No PCBs' by the manufacturer. If the light fixture has no manufacture date and is not marked to say it does not contain PCBs, assume that it does.

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8.9 MORE INFORMATION

8.9.1 Contacts

1. **Agency for Toxic Substances and Disease Registry (ATSDR)**
   www.atsdr.cdc.gov
2. **American Conference of Governmental Industrial Hygienists (ACIGH)**
   www.acgih.org
3. **The Asbestos Institute**
   http://theasbestosinstitute.com
4. **Asbestos Testing and Consultancy**
   www.atac.org.uk
5. **International Association for Soaps, Detergents and Maintenance Products**
   www.aise.eu
6. **British Occupational Hygiene Society (BOHS)**
   www.bohs.org
7. **Chemical Abstract Service (CAS)**
   www.cas.org
8. **European LPG Association**
   www.aegpl.com
9. **Royal Institute of Chartered Surveyors (RICS).**
   www.rics.org
10. **UK Accreditation Service (UKAS)**
    www.ukas.com
11. **UK Department for Environment, Food and Rural Affairs**
    www.defra.gov.uk
12. **UK Health and Safety Executive**
    www.hse.gov.uk
13. **US Occupational Safety & Health Administration (OSHA)**
    www.osha.gov
14. **US Environmental Protection Agency**
    www.epa.gov
15. **US National Institute for Occupational Safety and Health (NIOSH)**
    www.cdc.gov/niosh
16. **US National Toxicology Program**
    http://ntp.niehs.nih.gov
17. **US Office of Pollution Prevention and Toxics, TSCA Hotline**
    tsca-hotline@epa.gov
18. **REACH (the registration, evaluation and authorisation of chemicals)**
    www.hse.gov.uk/reach/
19. **World Health Organization**
    www.who.org

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8.9.2 Resources

1. **Asbestos and Man-Made Mineral Fibres in Buildings: Practical Guidance**
   http://products.ihs.com/Ohsis-SEO/310734.html
2. **Asbestos Hazard Emergency Response Act (AHERA)**
   www2.epa.gov/asbestos/asbestos-laws-and-regulations
3. **Carriage of Dangerous Goods and Use of Transportable Pressure Equipment (Amendment) Regulations 2005**
   www.hse.gov.uk/cdg/pressure.htm
4. **Chemicals in Products - Safeguarding the Environment and Human Health**
   www.iupac.org/publications/ci/2004/2601/bw3_duffus.html
5. **Control of Asbestos Regulations 2006**
   www.opsi.gov.uk/si/si2006/20062739.htm
6. **Control of Pesticides Regulations 1986 (amended 1997)**
   www.opsi.gov.uk/si/si1997/19970188.htm
7. **Control of Substances Hazardous to Health Regulations 2002 (COSHH)**
   www.hse.gov.uk/coshh/
8. **Easy steps to control health risks from chemicals**
   www.coshh-essentials.org.uk
9. **EU Directive 2002/95/EC on the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment**
   http://ec.europa.eu/environment/waste/weee/legis_en.htm
10. **Directive 2012/19/EU of the European Parliament on waste electrical and electronic equipment (WEEE)**
    http://ec.europa.eu/environment/waste/weee/legis_en.htm
11. **Globally Harmonised System of Classification and Labelling of Chemicals (GHS)**
    www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html
12. **Guidance note for the Control of Pollution (Oil Storage) (England) Regulations 2001**
    www.gov.uk/government/uploads/system/uploads/attachment_data/file/69255/pb5765-oil-storage-011101.pdf
13. **Guide to Occupational Exposure Values, 2007**
    www.acgih.org/Store/ProductDetail.cfm?id=1911
14. **ISO 17020**
    www.iso.org/iso/catalogue_detail?csnumber=29342
15. **ISO 17024**
    www.iso.org/iso/catalogue_detail?csnumber=29346
16. **Methods for the Determination of Hazardous Substances**
    www.hse.gov.uk/pubns/mdhs
17. **NIOSH Asbestos Bibliography**
    www.cdc.gov/niosh/docs/97-162/
18. **OSHA Hazard Communication Standard (HCS)**
    www.osha.gov/dsg/hazcom/
19. **UK Health and Safety at Work Act (HASAW or HSW)**
    www.hse.gov.uk/legislation/hswa.pdf
20. **Managing Above Ground Storage Tanks to Prevent Contamination of Drinking Water**
    www.epa.gov/safewater/sourcewater/pubs/ast.pdf
21. **NetRegs**
    www.netregs.gov.uk
22. **Pesticides - Use them Safely**
    www.hse.gov.uk/pubns/indg257.pdf
23. **Plant Protection Products Directive (PPPR) (91/414/EEC)**
    https://osha.europa.eu/en/legislation/directives/exposure-to-chemical-agents-and-chemical-safety/osh-related-aspects/council-directive-91-414-eec
24. **Restriction of Hazardous Substances Directive (RoHS)**
    www.rohs.gov.uk
25. **Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) - EC Regulation 1907/2006**
    http://ec.europa.eu/enterprise/reach/index_en.htm
26. **Gas Safety**
    www.hse.gov.uk/pubns/gasindex.htm
27. **Stockholm Convention on Persistent Organic Pollutants (POPs)**
    www.pops.int/documents/pops/default.htm
28. **Sustainable Cleaning – A guide for users of professional cleaning products**
    http://www.ukcpi.org/pdfs/sustainable_cleaning.pdf
29. **UK Health and Safety Executive - Asbestos management**
    www.hse.gov.uk/asbestos/campaign/duty.htm
30. **US Environmental Protection Agency (Asbestos)**
    www.epa.gov/asbestos

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APPENDIX 1 Materials Safety Data Sheets (MSDS)

The **US Occupational Safety & Health Administration's (OSHA) Hazard Communication Standard (HCS)** requires chemical manufacturers and importers to evaluate the hazards of the chemicals they produce or import. This involves the preparation of **labels** and **material safety data sheets (MSDS)** to convey the hazard information to their customers. All employers with hazardous chemicals in their workplace must have labels and MSDSs for their exposed workers and train them to handle the chemicals appropriately. The requirements do not apply to materials packaged for consumer use.

The MSDS should include precautions for normal use, handling, storage, disposal, and spill cleanup for each material. The hazards identified need to be reasonably foreseeable health and toxicity concerns arising from the product's use and the MSDS should not include recommendations for protective measures that are more strict than needed.

CONTENT

Chemical manufacturers and importers must obtain or develop a MSDS for each hazardous chemical they produce or import. Employers must also have a MSDS, in English, in the workplace for each hazardous chemical they use. OSHA's HCS specifies what a MSDS must contain:

1. The product name used on the label, and the chemical and common name(s) of ingredients which have been determined to be health hazards, and which comprise one per cent or more of the composition. Carcinogens shall be listed if the concentrations are 0.1 per cent or greater.
2. The chemical and common name(s) of all ingredients which have been determined to present a physical hazard when present in the mixture.
3. Relevant physical and chemical characteristics of the hazardous chemical (such as vapour pressure, flash point).
4. Relevant physical hazards, including the potential for fire, explosion, and reactivity.
5. Relevant health hazards, including signs and symptoms of exposure, and any medical conditions generally recognised as being aggravated by exposure to the chemical.
6. The primary route(s) of entry into the body.
7. The OSHA permissible exposure limit and **American Conference of Governmental Industrial Hygienists (ACIGH) Threshold Limit Value (TLV)**. Additional applicable exposure limits may be listed.
8. Whether the hazardous chemical is listed in the **National Toxicology Program (NTP)** Annual Report on Carcinogens (latest edition) or has been found to be a potential carcinogen.
9. Precautions for safe handling and use, including appropriate hygienic practices, protective measures during repair and maintenance of contaminated equipment, and procedures for clean-up of spills and leaks.
10. Appropriate control measures, such as engineering controls, work practices, or personal protective equipment.
11. Emergency and first aid procedures.
12. The date of preparation of the MSDS or the latest change to it, together with the name, address and telephone number of the chemical manufacturer, importer, employer or other responsible party preparing or distributing the MSDS, who can provide additional information on the hazardous chemical and appropriate emergency procedures, if necessary.
13. If no relevant information is found for any given category, it should be marked to indicate that no applicable information was found.
14. If significant new information becomes available regarding the hazards of a chemical, or ways to protect against the hazards, it must be added to the MSDS within three months.
15. A MSDS must be provided with the initial shipment of a hazardous chemical, and with the first shipment after a MSDS is updated.

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APPENDIX 1
.../continued

STANDARDISATION

Since the HCS does not impose a specific format on MSDSs, the information varies widely in presentation and amount, which can range from two to eight or more pages. Some companies have transferred the information on vendor MSDSs into their own format, with the result that they then become the 'responsible party' for the content of the MSDS.

In an effort to improve completeness, accuracy, and consistency, the **Chemical Manufacturers Association (CMA)** developed a 16-part voluntary standard for MSDS preparation, which was published in 1993 as **ANSI Z400.1-1993, American National Standard for Hazardous Industrial Chemicals, Material Safety Data Sheets, Preparation**. Its sections can be summarised as follows:[5]

SECTION 1: CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Names the material and relates the MSDS with the label and shipping documents. Must include a mailing address and telephone number for the manufacturer or distributor.

SECTION 2: COMPOSITION, INFORMATION ON INGREDIENTS

Identifies the hazardous components of the material. If non-hazardous ingredients are listed, they should be listed separately. Chemical Abstract Service (CAS) numbers should be included, as well as **OSHA Permissible Exposure Limits** and American Conference of Government Industrial Hygienists (ACGIH) TLVs. If the identity of any ingredient is claimed to be a trade secret, it should be indicated.

SECTION 3: HAZARDS IDENTIFICATION

Describes the material's appearance, odour, and health, physical, and environmental hazards that may be of concern for emergency response personnel.

SECTION 4: FIRST AID MEASURES

Should include emergency and first aid procedures in easy to understand language. Procedures for each potential route of exposure should be included. A 'Notes to Physicians' sub-section should be included if the information is available.

SECTION 5: FIRE-FIGHTING MEASURES

Should describe fire and explosive properties of the material, the extinguishing media to be used and fire-fighting instructions. It applies to anyone who may be in the area of the fire.

SECTION 6: ACCIDENTAL RELEASE MEASURES

Information needed to prevent or minimise adverse effects on employees, neighbours, property, and the environment, including waterways. It is intended for emergency response personnel.

SECTION 7: HANDLING AND STORAGE

Provides guidelines for minimising any potential hazards from storing the material, information to minimise handling when appropriate, temperature, inert atmosphere, and conditions to avoid.

[5] **Source:** Reference Data Sheet on Material Safety Data Sheets by Richard Gullickson, CIH, May 1996. See **www.msdssearch.com/msdshistory.htm**

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APPENDIX 1
.../continued

SECTION 8: EXPOSURE CONTROLS, PERSONAL PROTECTION

Discusses the degree of engineering control that may be needed when handling the material, and the personal protective equipment that should be used if there is a potential for exposure above the regulatory or suggested limits. Exposure guidelines should be included.

SECTION 9: PHYSICAL AND CHEMICAL PROPERTIES

These should be included to assist users to determine proper handling and storage. Appearance, odour, physical state (liquid, solid, gas), pH, vapour pressure and density, melting and freezing point, solubility, and specific gravity should be included. Additional properties may be included if they are useful.

SECTION 10: STABILITY AND REACTIVITY

Should describe conditions that may result in a potentially hazardous reaction, such as evolution of hazardous gases, production of heat, or other hazardous conditions.

SECTION 11: TOXICOLOGICAL INFORMATION

Should include any known information resulting from animal testing or human experience on the toxicity of the material, information on its potential for causing cancer and data for acute, sub-chronic, and chronic exposures, if available.

SECTION 12: ECOLOGICAL INFORMATION

Should list impacts to the environment that may occur if the material is released to the environment, or in evaluating waste treatment practices.

SECTION 13: DISPOSAL CONSIDERATIONS

Should provide guidance to environmental and other technical people responsible for waste management for the product.

SECTION 14: TRANSPORT INFORMATION

Information concerning classification for shipping the material. It should include **US Department of Transportation (DOT)** classifications, or an indication that it is not regulated. It may include information for shipment into other countries.

SECTION 15: REGULATORY INFORMATION

Should contain information regarding the regulatory status of the material. It should include OSHA and **EPA** regulations. It may also include other regulatory agencies, and state agencies, if appropriate.

SECTION 16: OTHER INFORMATION

For other material the preparer feels is pertinent, that should not be included in the other 15 sections, such as label information, hazard ratings, revision dates, and references to other related information.

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APPENDIX 2 Hazardous materials sheet

NAME(S):

GENERIC NAME / TRADE NAME:

CHEMICAL NAME:

SUPPLIER:

COMPOSITION:

APPEARANCE AND ODOUR:

USAGE:

PHYSICAL PROPERTIES (at 20°C, 1,013 mbar):

Density (kg/m^3):		Vapour density (air = 1):	
Boiling point (°C):		Vapour pressure (mbar):	
Melting point (°C):		Kinematic viscosity (mm^2/s):	
Flashpoint (°C):		Solubility (kg/m^3):	
Auto-ignition temp. (°C):		Particle size (micron):	
Flammability limits (% v/v):		pH:	

IMPORTANT CHARACTERISTICS:

ACIGH Threshold Limit Value (TLV):

Incompatibilities:

OCCUPATIONAL EXPOSURE LIMIT:

OSHA permissible exposure limit:

SAFETY HAZARDS:

Fire:

Stability:

PRECAUTIONS:

Fire:

Stability:

FIRE-EXTINGUISHING AGENTS:

FIRE PRECAUTIONS:

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APPENDIX 2
.../continued



HEALTH HAZARDS:

Inhalation:

Skin:

Eyes:

Ingestion:

FIRST AID:

Inhalation:

Skin:

Eyes:

Ingestion:

PERSONAL PROTECTION:

ENVIRONMENTAL HAZARDS:

PRECAUTIONS:

SPILLAGE MITIGATION (SEE ALSO PERSONAL PROTECTION):

DISPOSAL OPTIONS:

Preferred:

Acceptable:

NOTE: Disposal should be acceptable within requirements of operative legislation.

STORAGE:

PACKING AND LABELLING:

SUPPLEMENTARY INFORMATION:

na = data not available, **n/a** = not applicable, **ne** = not established

DATE OF ISSUE:

DATE REVISED:

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APPENDIX 3 The 12 Persistent Organic Pollutants (POPs) listed under the Stockholm Convention[6]

1. Aldrin	A pesticide applied to soils to kill termites, grasshoppers, corn rootworm, and other insect pests.
2. Chlordane	Used extensively to control termites and as a broad-spectrum insecticide on a range of agricultural crops.
3. DDT	Perhaps the best known of the POPs, DDT was widely used during World War II to protect soldiers and civilians from malaria, typhus, and other diseases spread by insects. It continues to be applied against mosquitoes in several countries to control malaria.
4. Dieldrin	Used principally to control termites and textile pests, dieldrin has also been used to control insect-borne diseases and insects living in agricultural soils.
5. Dioxins	These chemicals are produced unintentionally due to incomplete combustion, as well as during the manufacture of certain pesticides and other chemicals. In addition, certain kinds of metal recycling and pulp and paper bleaching can release dioxins. Dioxins have also been found in automobile exhaust, tobacco smoke and wood and coal smoke.
6. Endrin	This insecticide is sprayed on the leaves of crops such as cotton and grains. It is also used to control mice, voles and other rodents.
7. Furans	These compounds are produced unintentionally from the same processes that release dioxins, and they are also found in commercial mixtures of PCBs.
8. Heptachlor	Primarily employed to kill soil insects and termites, heptachlor has also been used more widely to kill cotton insects, grasshoppers, other crop pests, and malaria-carrying mosquitoes.
9. Hexachlorobenzene (HCB)	HCB kills fungi that affect food crops. It is also released as a byproduct during the manufacture of certain chemicals and as a result of the processes that give rise to dioxins and furans.
10. Mirex	This insecticide is applied mainly to combat fire ants and other types of ants and termites. It has also been used as a fire retardant in plastics, rubber, and electrical goods.
11. Polychlorinated Biphenyls (PCBs)	These compounds are employed in industry as heat exchange fluids, in electric transformers and capacitors, and as additives in paint, carbonless copy paper, sealants and plastics.
12. Toxaphene	This insecticide, also called camphechlor, is applied to cotton, cereal grains, fruits, nuts, and vegetables. It has also been used to control ticks and mites in livestock.

[6] **Source:** The Stockholm Convention **www.pops.int/documents/pops/default.htm**

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APPENDIX 4 Common ingredients in cleaning products and their impacts

This table provides a guide to some of the raw materials commonly found in cleaning products. The subject is complex and there will always be differences in scientific opinion. It is not possible to be definitive, particularly when it comes to certain chemical categories. Within each chemical family group there are numerous different environmental classifications and great variation in performance for each.

It should be noted that the classification of raw materials is not always the final classification of a finished product. For example, a raw material classified as harmful, when added to a formulation in a very small percentage (e.g. 0.2 per cent), would not make the final formulation harmful.

More detailed information on ingredients, functions and issues relating to professional cleaning products can be found in **Sustainable Cleaning – A guide for users of proffesional cleaning products** which is listed under Resources in **8.9.2**.

Substance	What it does	Examples	Impact on humans	Impact on environment
Abrasive	Insoluble materials that provide a mechanical action to the cleaning function	Calcium carbonate	Non-hazardous	
Acid	Used for the removal of mineral soils	Phosphoric acid, citric acid	Corrosive or irritant depending on substance	Non-hazardous
Alcohol	See solvent	Isopropanol	Irritant, highly flammable	Non-hazardous
Alkalis	Help to break down fats, oils, and other organic soils	Sodium hydroxide, sodium carbonate	Corrosive or irritant depending on substance	Non-hazardous
Bacteria	Micro-organisms for drain cleaning are responsible for resolving the fatty deposits and for building a protective film inside the drain system	Bacillus type micro-organisms	Non-hazardous	
Chlorine	Can be used either as bleaching agent or disinfectant/sanitiser. Chlorine helps to break down organic soils	Sodium hypochlorite	Corrosive	Hazardous
Enzyme	Complement the detergent activity by digesting certain soil types	Protease	Harmful	Non-hazardous
Perfume	Mask bad odours or provide a pleasant smell to the detergent	Natural (lemon, lavender, pine) Artificial (limonene, musks)	Non-hazardous	
Peroxygen	Can be used either as bleaching agent or disinfectant/sanitiser	Hydrogen peroxide	Corrosive, oxidising	Non-hazardous
Phosphate	Provides a source of moderate alkalinity and supports the cleaning process whilst tying up water hardness minerals	Sodium tripolyphosphate	Non-hazardous	
Quaternary Ammonium Compound (QAC)	The quaternaries are cationic surfactants with germicidal (disinfectant) properties	QAC	This is a family of substances and both hazardous and non-hazardous types exist	
Sequestering agents	Series of organic chemical compounds that have the ability to tie up water hardness and other metallic salts	NTA, polyacrylate	Can be harmful or non-hazardous depending on substance	Non-hazardous
Solubiliser	Improve the solubility of some constituents of cleaners and disinfectants in an aqueous solution	Sulfonates, glycols	Non-hazardous or irritant depending on the substance	Non-hazardous
Solvent	Used in detergent formulas to complement the cleaning efficiency	Isopropanol	Irritant, highly flammable	Non-hazardous
Surfactant	Reduces the surface tension of water so it can quickly wet a surface to enable dirt to be loosened and removed. Provide foaming and emulsification. Made from petrochemicals or oleochemicals	Anionic, cationic, non-ionic, amphoteric	Depends on which surfactant	Varies greatly

FIGURE 8.7
Common ingredients in cleaning products and their impacts

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APPENDIX 5 Hazardous materials: terminology

B

BEI
Biological Exposure Indices covering more than 80 chemical substances.

BIO-ACCUMULATION
The ecological process through which chemical products accumulate throughout the food chain.

BIODEGRADATION
Biodegradable material is susceptible to degradation, usually by micro-organisms, leading to the release of heat, carbon dioxide, organic residues and methane. This term usually refers to surfactants and most commonly defines a level of biodegradability specified by legislation. This is a complex area but there are basically two forms: **primary biodegradability**, which deals with a first cleavage of the molecule and **ultimate biodegradability**, which involves complete breakdown into simple salts, water and oxygen.

C

CARCINOGENIC
A substance thought to cause cancer.

CONCENTRATE
A liquid product that contains less than 20 per cent water by weight.

CORROSIVE
Can destroy living tissues such as skin, eyes, the lungs and stomach. Oven cleaners, for example, may be corrosive.

COSHH
The Control of Substances Hazardous to Health Regulations 2002 which require employers to control exposure to hazardous substances to prevent ill health.

D

DIRTY DOZEN
Twelve of the most toxic chemical substances such as polychlorinated biphenyls (PCBs), outlawed under the Stockholm Convention.

F

FLAMMABLE
Can be easily ignited by sparks or flames. Of particular concern are liquids with low flashpoints e.g. solvents and fuels.

H

HARMFUL
A substance which if inhaled, ingested or penetrates the skin may incur limited health risks.

I

IRRITANT
A non-corrosive substance which can cause inflammation through immediate, prolonged or repeated contact with the skin or mucous membranes.

M

MONTREAL PROTOCOL
International agreement to which nearly all countries in the world are signatories. Covers the phase-out of ozone depleting substances (ODS) such as halons and certain refrigerants that damage the earth's protective ozone layer.
SEE SECTION 5

MSDS
Under an internationally established system, all manufacturers of chemical products have to provide materials safety data sheets (MSDS). Issued by the manufacturer or supplier they contain comprehensive technical information on storage, handling, use and disposal of the product.

O

OLEOCHEMICALS
Derived from fats and oils from plants or animals.

OXIDISING
Destroys organic matter by breaking down the cell walls.

P

PETROCHEMICALS
Derived from crude oil or natural gas – often termed synthetic chemicals even though oil and gas are natural resources.

POISONOUS
Toxic to humans and/or hazardous during transportation.

S

STOCKHOLM CONVENTION
Global treaty ratified in May 2004 to protect human health and the environment from persistent organic pollutants.

SDS
Safety Data Sheets (see MSDS) the more common term for MSDS in Europe.

T

TLV
Threshold Limit Value for occupational exposure.

TOXIC/TOXICITY
Can cause physical or mental impairment or even death when inhaled, ingested or absorbed in very small, specified concentrations. Classified as either acute or chronic. Tests for **acute toxicity** (typically carried out on three different water-living organisms: fish, *Daphnia* and algae) reveal the diminished survival (lethal) effects, or sub-lethal physiological effects on reproduction, growth etc. The result is expressed as LC50, which means Lethal Concentration (mg/l) at which 50 per cent of the tested organisms died. The higher the figure the higher the toxicity. **Chronic toxicity** testing provides a more comprehensive understanding of the toxicity of the defined substance and encompasses assessments on the organism's entire life cycle to determine its long term effects.

V

VOCS
Volatile Organic Compounds. Typically emitted from fuels, solvent and aerosol cans, when released to atmosphere they contribute to the formation of photochemical smog which is believed to be a contributory factor in respiratory diseases.

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APPENDIX 6 Pest control chemicals: checklist for staff

BEFORE APPLYING

1. What is the pest problem?
2. What are the best methods or products to control the pests?
3. What is the least toxic and the least persistent pesticide/herbicide available?
4. What health surveillance is in place for those mixing and applying pesticides/herbicides?
5. Quantity of pesticide to be used:

   Area: Department:
6. Protective clothing to be worn:

NOTE: Do you know the symptoms of acute pesticide poisoning related to the chemicals that you are using? If you feel ill, even with a headache or cold-like symptoms, stop work.

DURING THE APPLICATION

7. Equipment being used:
8. Has all equipment been checked for the health and safety of the operator?
9. Are you using the best and safest equipment available?
10. Have you checked that sprayers are not too heavy to be lifted when full?
11. Is the correct protective clothing being worn?
12. Have you notified others and cordoned off the area?
13. Time control:

    Time: Duration:
14. How many persons are working in the spraying area?

NOTES:
- Never work alone when handling toxic pesticides.
- Never eat, drink or smoke when applying or mixing pesticides.
- Do not breathe in pesticide spray, dust or fumes.

AFTER APPLICATION

15. Have all unused pesticides/herbicides been returned to the store?

    Yes No Why not?
16. Have you ensured that no pest control chemicals are left in sprayers/other containers?
17. Have you disposed of the empty containers safely and according to the best possible practice laid down nationally/internationally?

NOTE: All recommended protective clothing must be worn and replaced at regular intervals. Soap and water should be used to wash skin and clothing where necessary. Never use empty pesticide containers for the storage of food or water.

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APPENDIX 7 Asbestos-containing materials in buildings

FIGURE 8.8
Asbestos-containing materials in buildings

Generic name	% asbestos content	Dates when used
SURFACING MATERIAL		
Sprayed or trowelled on	1–95	1935–1970
PRE-FORMED THERMAL INSULATING MATERIALS		
Batts, blocks, pipe covering:		
85% magnesia	15	1926–1949
Calcium silicate	6–8	1949–1971
TEXTILES (CLOTH)		
blankets (fire)	100	from 1910
felts	90–95	from 1920
blue stripe	80	from 1920
red stripe	90	from 1920
green stripe	95	from 1920
Sheets	50–95	from 1920
Cord/rope/yarn	80–100	from 1920
Tubing	80–85	from 1920
Tape/strip	90	from 1920
Curtains (theatre safety; welding)	60–65	from 1945
CEMENTITIOUS CONCRETE-LIKE PRODUCTS		
Extrusion panels	8	1965–1977
corrugated	20–45	from 1930
flat	40–50	from 1930
flexible	30–50	from 1930
flexible perforated	30–50	from 1930
laminated (outer surface) roof tiles	20–30	from 1930
Clapboard and shingles		
clapboard	12–15	1944–1945
siding shingles	12–14	?–onwards
roofing shingles	20–32	?–onwards
Pipe	15–20	from 1935
PAPER PRODUCTS		
High temperature	90	from 1935
Moderate temperature	35–70	from 1920
Indented	98	from 1935
Millboard	80–85	from 1925
ROOFING FELTS		
Smooth surface	10–15	from 1910
Mineral surface	10–15	from 1910
Shingles	1	from 1971
Pipeline	10	from 1920
ASBESTOS CONTAINING COMPOUNDS		
Caulking putties	30	from 1930
Adhesive (cold applied)	5–25	from 1945
Joint compound roofing asphalt	5	?–onwards
Mastics	5–25	from 1920
Asphalt tile cement	13–25	from 1959
Roof putty	10–25	?–onwards
Plasters/stucco	2–10	?–onwards
Spackles	3–5	1930–1975
Sealants, fire/water	50–55	from 1935
Cement, insulation	20–100	1900–1973
Cement, finishing	55	1920–1973
Cement, magnesia	15	1926–1950
FLOORING TILE AND SHEET GOODS		
Vinyl/asbestos tile	21	from 1950
Asbestos/asbestos tile	26–33	from 1920
Sheet goods/resilient	30	from 1950
WALL COVERING		
Vinyl wallpaper	6–8	?–onwards
PAINTS AND COATINGS		
Roof coating	4–7	from 1900
Air-tight	15	from 1940

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Appendix 12: Metocean Conditions and Coastal Vulnerability Assessments (Moffatt & Nichol)

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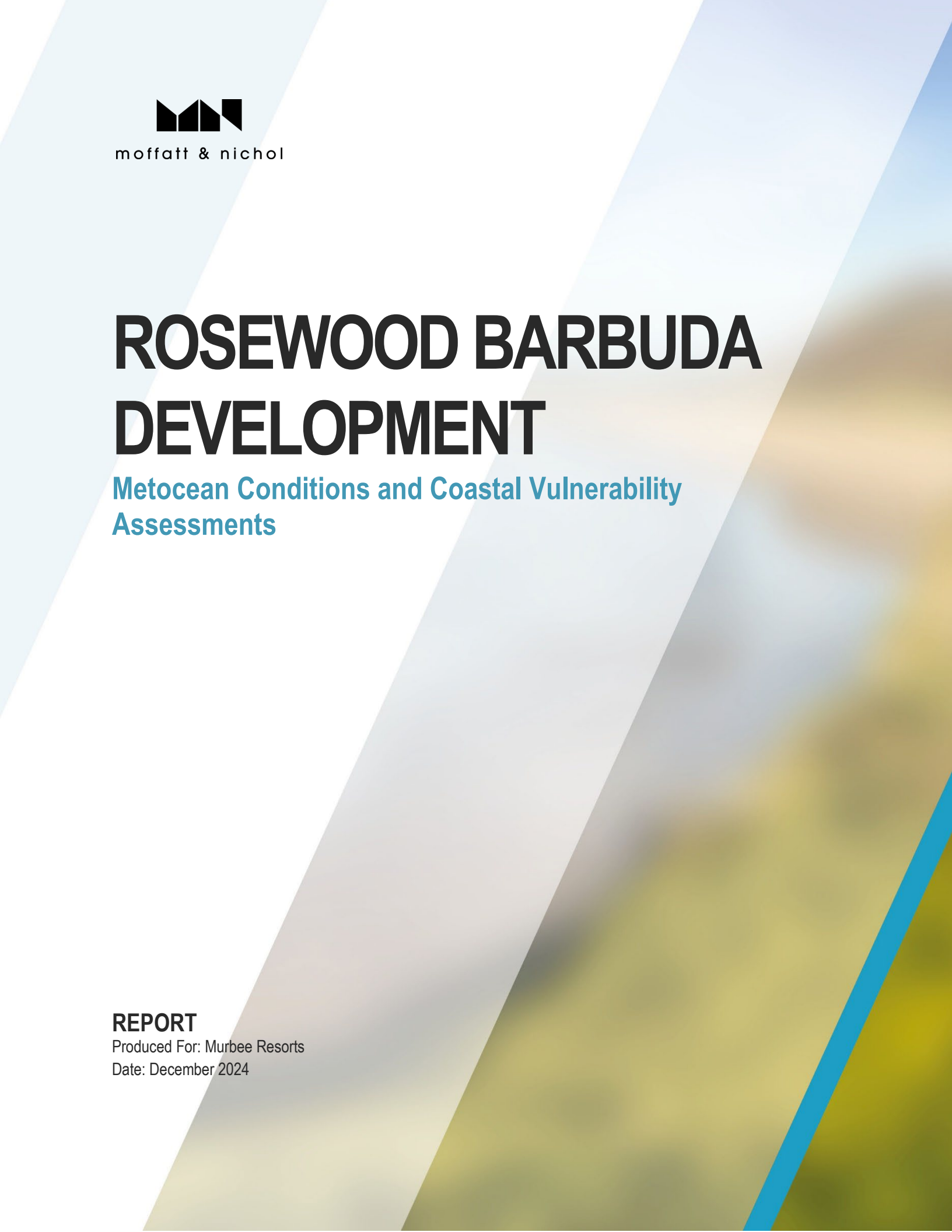
ROSEWOOD BARBUDA DEVELOPMENT

Metocean Conditions and Coastal Vulnerability Assessments

REPORT

Produced For: Murbee Resorts

Date: December 2024



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This study is qualified in its entirety by, and should be considered in light of, these limitations, conditions and considerations.

Glossary

AR6	IPCC's 6th Assessment Report
Avg.	Average(d)
BLHSM	Bottom of Lowest Horizontal Structural Member
CDMP	Caribbean Disaster Mitigation Project
CEDAS	Coastal Engineering Design and Analysis Systems
CSE	Coastal Science & Engineering Inc.
DFE	Design Flood Elevation
FEMA	Federal Emergency Management Agency
FHBM	Flood Hazard Boundary Map
FIRM	Flood Insurance Rate Map
Ft	Feet
GEV	General Extreme Value
GFDRR	Global Facility for Disaster Reduction and Recovery
HAT	Highest Astronomical Tide
Ha	Hectare (= 10,000 m2)
IPCC	Intergovernmental Panel on Climate Change
Km	Kilometer
Kph	Kilometers per Hour
Kts	Knots
LAT	Lowest Astronomical Tide
LiMWA	Limit of Moderate Wave Action
M	Meter
M^2	Square Meters
MIKE 21 FM	MIKE21 Flexible Mesh
MIKE 21 HD	MIKE21 Hydrodynamic module
MIKE 21 SW	MIKE21 Spectral Waves module
MHHW	Mean Higher High Water
MHW	Mean High Water
MLLW	Mean Lower Low Water
MLW	Mean Low Water
MiWA	Minimal Wave Action
Mm	Millimeters
MoWA	Moderate Wave Action
Mps	Meters per Second
MRI	Mean Recurrence Interval
MSL	Mean Sea Level
MTL	Mean Tide Level
NASA	National Aeronautics and Space Administration
NFIP	National Flood Insurance Program
NOAA	National Oceanic and Atmospheric Administration
OAS	Organization of American States
OWI	Ocean Weather International

SFHA	Special Flood Hazard Areas
SLC	Sea Level Change
SBEACH	Storm-induced Beach Change
SSP	Shared Socioeconomic Pathway
SWEL	Stillwater Elevation
USACE	United States Army Corps of Engineers
USAID	United States Agency for International Development
W.r.t	With respect to
WW3	WAVEWATCH III

1. Introduction

1.1. Property Background

1.1.1. Project Sitting

The project site is situated in Antigua and Barbuda, covering 160 acres of land along the southwestern coast of Barbuda (see Figure 1.1). . It stretches from Pink Sand Beach on Palmetto Peninsula to the Barbuda Port, also referred to as the Ferry Dock.

Presently, approximately 145 acres of the total 160 acres of the site is undeveloped. Parts of this land were previously cleared for potential agricultural use, but there is no evidence of recent or ongoing agricultural activities. The remaining ~15 acres have been heavily developed for industrial and commercial use next to the port area, including areas for sand mining-related activity, cement batch plant operations, and small buildings for drink and food vendors.

The project shoreline extends along the Pink Sand Beach and some areas (particularly those in the vicinity of the Ferry Dock) are used for local fishing boats and occasionally by swimmers.

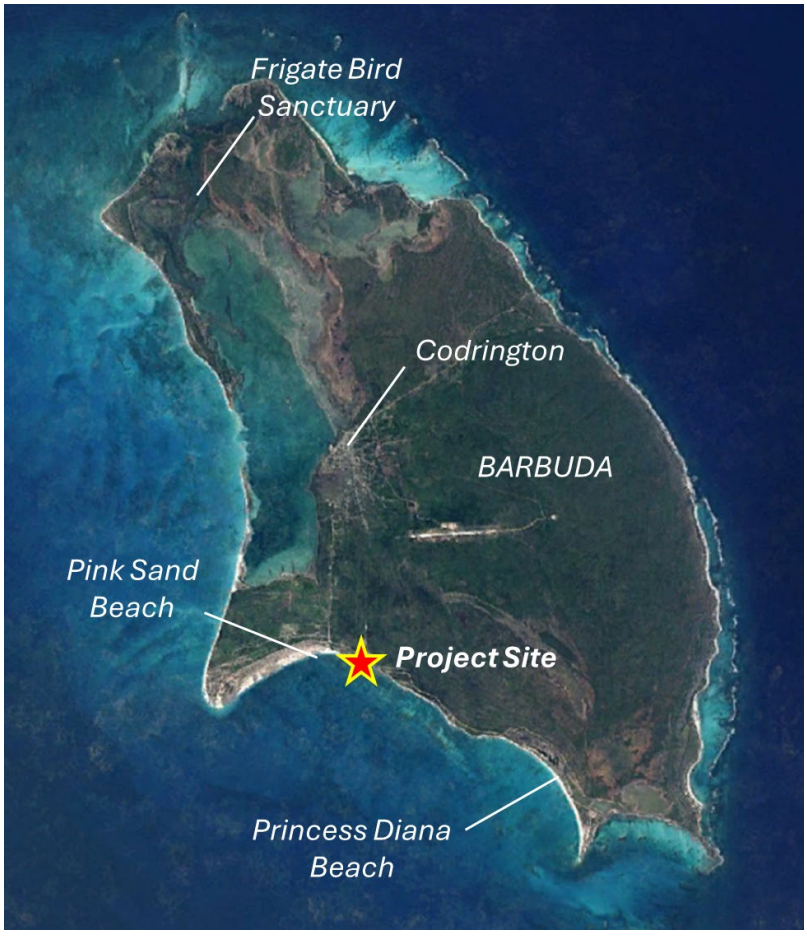

FIGURE 1.1: LOCATION OF PROJECT SITE.

1.1.2. Project Shoreline[1]

Shoreline changes in the vicinity of Dulcina Beach were evaluated using rectified imagery from Google Earth and other sources (CSE, 2023). A baseline with stationing was established from near Codrington Lagoon to Upcoast Fillet and separated into several reaches to isolate key trends from historical shorelines dating from 1985 to 2023. Figure 1.2 shows the historical shorelines for the Dulcina Beach area. Note that the 2017 shoreline image was obtained immediately after Hurricane Irma. Significant trends along the Owner's property include:

- Increasing accretion from east to west along Dulcina Beach.
- Some focused erosion downcoast of the loading jetty at a relatively low rate of ~1 meter per year.
- One spike of accretion at the loading jetty after 2017 which may be due to jetty reconfiguration or poor quality of the 2017 post-storm imagery over the jetty (Figure 1.3).

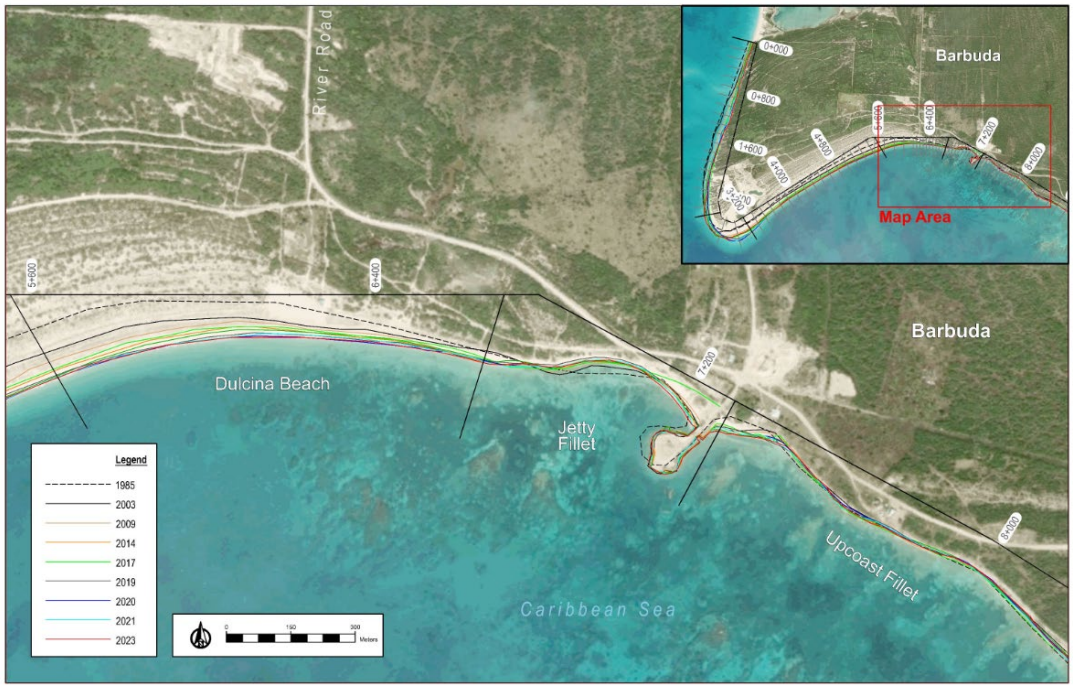

FIGURE 1.2: DULCINA BEACH AREA SHOWING HISTORICAL SHORELINES (1985-2023) (SOURCE: CSE).

The Project's beach accumulated sand from 1985 to 2014 and has been relatively stable (see Figure 1.4). Shoreline recession occurred during Hurricane Irma (2017), but the shoreline was able to recover to its pre-storm position within two years. This suggests there is sufficient wave action to produce a storm-post-storm "beach cycle" instead of a net recession of the beach in a storm. The shoreline trends around the loading jetty are more variable, but there is little evidence of sand buildup at the jetty (Figure 1.5). Shoreline recession approximately 200 meters west of the jetty may be related to wave diffraction and focusing on the lee of the jetty. One implication of this observation is that a section of the beach west of the jetty will likely experience more fluctuation due to wave shadowing. Therefore, the building setback should be as landward as practicable in this area to accommodate future changes.

[1] This Section provides a summary of the work completed by Coastal Science & Engineering Inc. in October 2023.

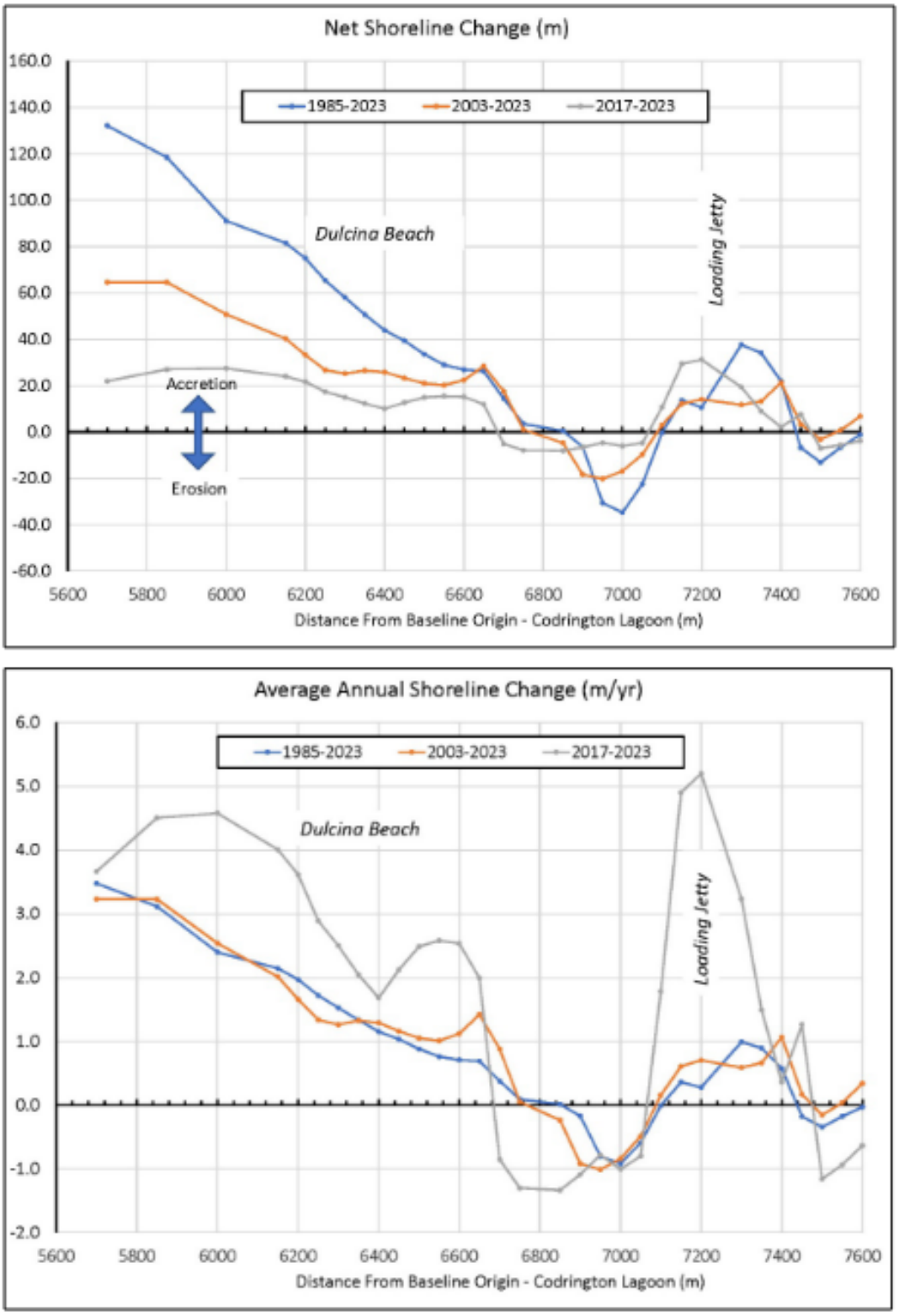

FIGURE 1.3: NET (UPPER) AND AVERAGE (LOWER) ANNUAL SHORELINE CHANGE ALONG THE OWNER'S PROPERTY WEST OF THE LOADING JETTY (SOURCE: CSE).

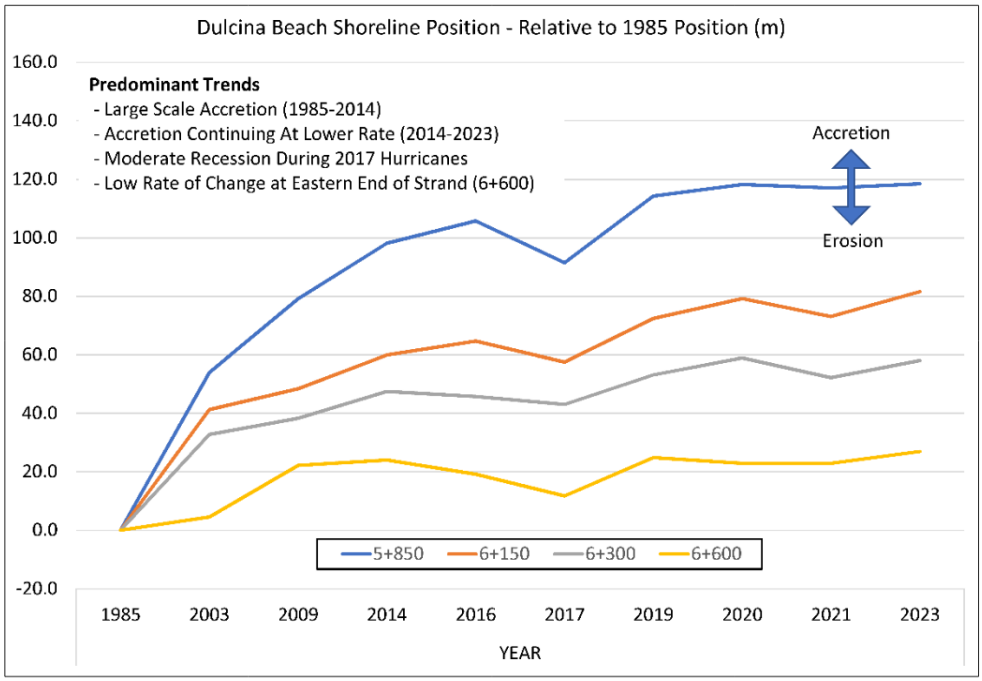

FIGURE 1.4: REPRESENTATIVE SHORELINE CHANGE FOR DULCINA BEACH FOR THE PERIOD OF 1985-2023 RELATIVE TO THE 1985 SHORELINE POSITION. PREDOMINANT TRENDS ARE LISTED ON THE GRAPH (SOURCE: CSE).

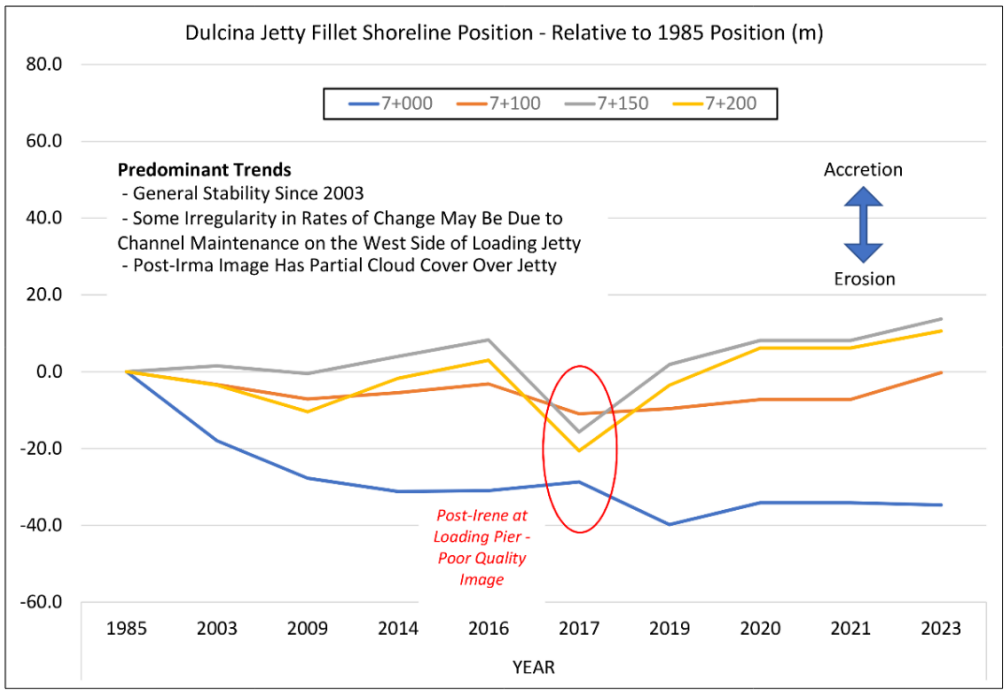

FIGURE 1.5: REPRESENTATIVE SHORELINE CHANGE FOR DULCINA JETTY FILLET FOR THE PERIOD OF 1985-2023 RELATIVE TO THE 1985 SHORELINE POSITION. PREDOMINANT TRENDS ARE LISTED ON THE GRAPH (SOURCE: CSE).

1.1.3. Project Topography and Bathymetric Data

A topographic and bathymetric survey and high-resolution drone imagery were completed at the Project site by DASS Surveying and Consulting in September 2023.

These surveys show that the Project site appears to have overall upland elevations in the range of 1.5 to 2.0 meters with higher elevations at the dune crest in the order of 2.5 meters. The existing access roads appear to be at an elevation in the order of 1.5 meters (all elevations are referred to Mean Sea Level - MSL).

The bathymetric survey shows relatively shallow water depths (<2 meters) within 90 meters of the Project's shoreline, and overall areas on the eastern half of the property generally present shallower water depths than areas located to the west of the property. The exceptions to this trend are evident on the eastern side of the property, at areas surrounding the existing River Dock. These areas appear to have been dredged to allow boat access to the existing berth located on the leeward part of the peninsula.

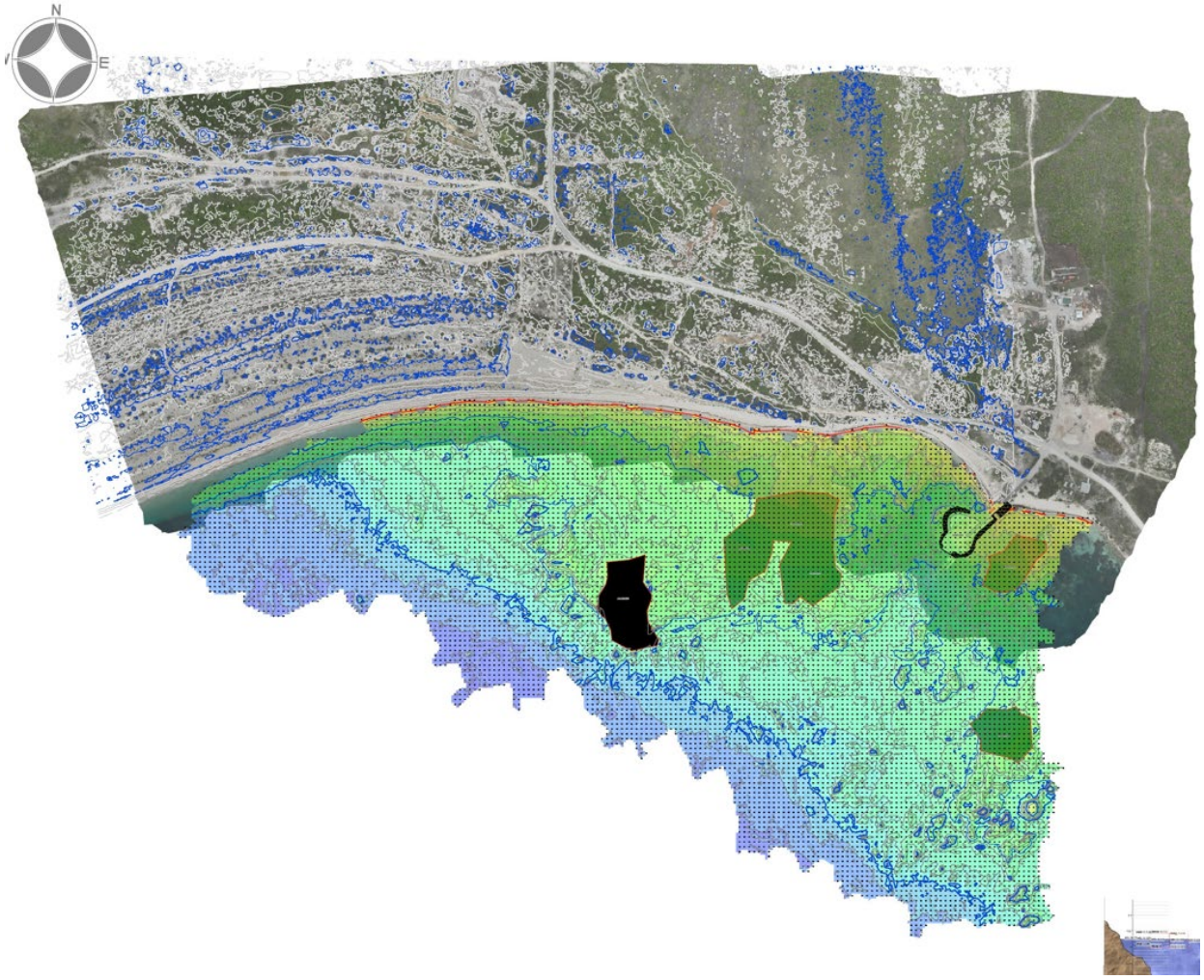

FIGURE 1.6: TOPO-BATHY SURVEY COVERAGE (SOURCE: DASS SURVEYING AND CONSULTING).

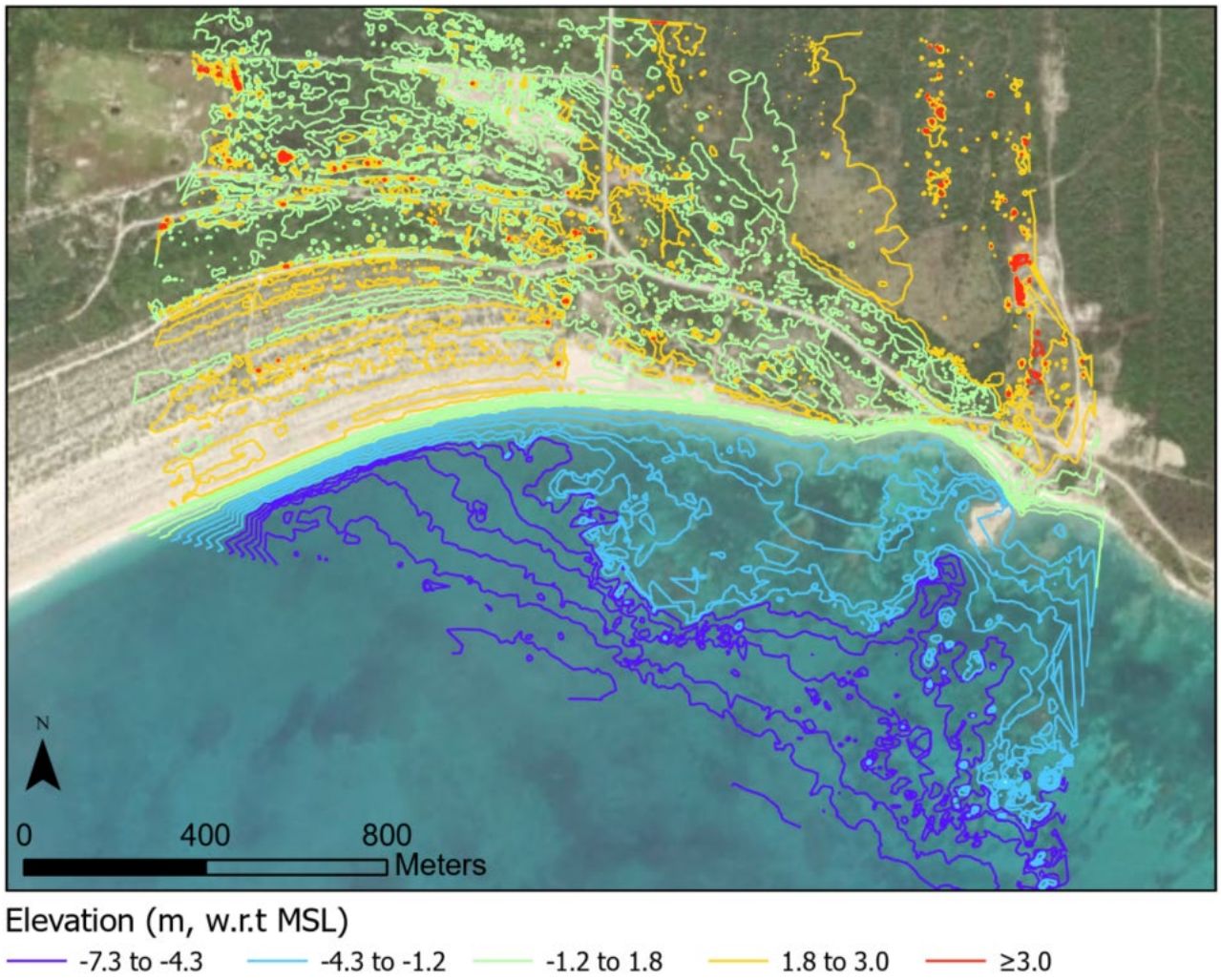

FIGURE 1.7: TOPO-BATHY CONTOURS (SOURCE: DASS SURVEYING AND CONSULTING).

1.2. Proposed Development Description

The proposed Project will consist of hospitality and real estate development. The hotel will be a Rosewood property and will comprise 50 keys/suites, guest pools, an organic farm, restaurants, a spa and fitness facility, a kids club, sports courts, employee housing, and a house area.

In addition, to the hotel the proposed project will also have a real estate component that will include different types of residences, including approximately thirty-five (35) beachfront homes, sixteen (16) homes adjacent to the dunes, and sixty-four (64) lagoon-front residences.

2. Metocean Conditions

2.1. Water Levels

2.1.1. Tides

Tides in close proximity to the Project site were obtained from the National Oceanic and Atmospheric Administration (NOAA) Station 9761115 Barbuda, Antigua and Barbuda. This station was operated by NOAA between 2011 and 2015 and was located at the existing River Dock, approximately 350 ft. (110 m.) from the southeast limit of the Project site. Table 2.1 provides the tidal and orthometric datums for this station based on the present tidal epoch (1983 – 2011). These datums are deemed representative of tidal conditions at the Project site, given the proximity to the station.

TABLE 2.1: TIDAL DATUMS AT NOAA STATION 9761115 (BARBUDA, ANTIGUA AND BARBUDA).

Datum	Value [w.r.t. MSL]		Value [w.r.t. MLLW]		Description
	Feet [ft.]	Meters [m.]	Feet [ft.]	Meters [m.]	
MHHW	0.30	0.09	0.74	0.23	Mean Higher High Water
MHW	0.28	0.09	0.72	0.22	Mean High Water
MTL	-0.02	-0.01	0.42	0.13	Mean Tide Level
MSL	0.00	0.00	0.44	0.13	Mean Sea Level
MLW	-0.32	-0.10	0.12	0.04	Mean Low Water
MLLW	-0.44	-0.13	0.00	0.00	Mean Lower Low Water
Max. Tide	1.35	0.41	1.79	0.55	Highest Observed Tide
Min. Tide	-1.02	-0.31	-0.58	-0.18	Lowest Observed Tide
HAT	0.59	0.18	1.03	0.31	Highest Astronomical Tide
LAT	-0.99	-0.30	-0.55	-0.17	Lowest Astronomical Tide

These datums are reported to NOAA as *"provisional"* as they have not been fully vetted nor have received final approval. However, these datums are consistent with previous data collected by surveyors in other projects in Antigua and Barbuda and are considered representative of the water levels at the Project site.

2.1.2. Sea Level Change (SLC)

Sea levels around the world have been rising and are projected to continue rising in the future, caused predominantly by warming climate. Due to the waterfront nature of the Project, projections of future sea level rise are important in informing structure setbacks, structure elevations, and operational criteria for water-based activities. .

The United Nations's Intergovernmental Panel on Climate Change (IPCC) has developed regular scientific assessments on climate change, its implications and potential future risks. The IPCC surveys and distills scientific literature and provides consensus projections on future sea levels across the globe under a range of possible future scenarios or *Shared Socioeconomic Pathways* (SSPs). The 6th Assessment Report (AR6) from Working Group I (August, 2021) is the most recent iteration of the IPCC's work.

The National Aeronautics and Space Administration (NASA) Sea Level Projection Tool was used to visualize and download the sea level projection data from AR6. This tool provides information

related to global and regional sea level projections from 2020 to 2150, along with how these projections differ depending on future emission scenarios, for non-US communities

For the SLC rates at the Project site, contributions from the three closest tidal stations – Charlotte Amalie (USVI), Lime Tree Bay (USVI) and Pointe-a-Pitre (Guadeloupe) were considered. The plot below (Figure 2.1) shows the projection and uncertainties for 'Total Sea Level Change'. Sea level change for the different SSPs scenarios considered by IPCC's AR6 result from processes in whose projection there is medium confidence, and the shaded ranges show the 17th-83rd percentile ranges.

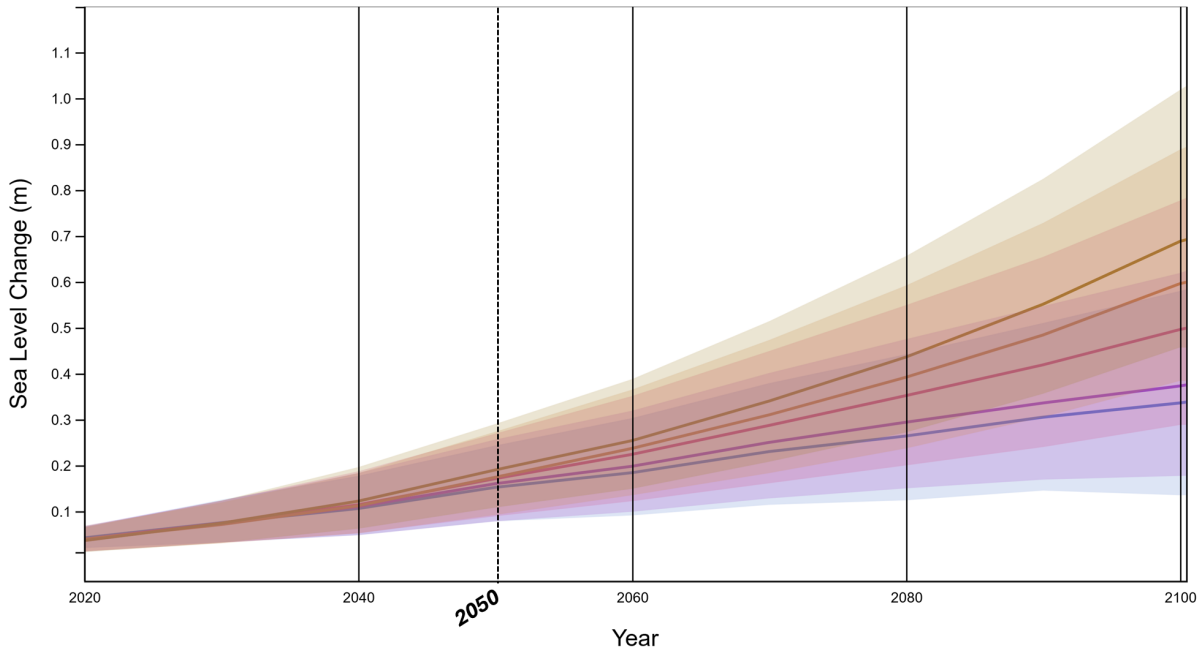

FIGURE 2.1: RELATIVE SEA LEVEL CHANGE [M. W.R.T. TO MSL] AT THE PROJECT VICINNITY (SOURCE: IPCC'S AR6).

TABLE 2.2: RELATIVE SEA LEVEL CHANGE [FT. (M.)] FOR VARIOUS DESIGN SCENARIOS AND TARGET YEARS (MEDIAN CONFIDENCE – 50TH EXCEEDANCE PERCENTILE)[2].

Year	Scenario				
	SSP1-1.9 *"Very Low"*	**SSP1-2.6** *"Low"*	**SSP2-4.5** *"Intermediate"*	**SSP3-7.0** *"High"*	**SSP5-8.5** *"Very High"*
2030	0.25 (0.07)	0.25 (0.07)	0.25 (0.07)	0.25 (0.07)	0.25 (0.07)
2040	0.35 (0.11)	0.36 (0.11)	0.37 (0.11)	0.37 (0.11)	0.40 (0.12)
2050	0.50 (0.15)	0.52 (0.16)	0.56 (0.17)	0.57 (0.17)	0.62 (0.19)
2100	1.10 (0.34)	1.22 (0.37)	1.63 (0.50)	1.96 (0.60)	2.26 (0.69)

This area appears to experience positive vertical land motion, which would have a negative impact (decrease) on total rates of SLC. When considering a project design life of 25 years (see Section

[2] SLC Projections are relative to a 1995-2014 baseline and do not include a correction to account for the SLC that occurred between the tidal datum epoch considered for the project (1983 – 2001) and the origin of the IPCC's AR6's estimates (estimated at +0.09m).

3.1.1 for additional information), the estimated (median) SLC value will range between 0.24 and 0.28 m. (0.78 and 0.92 ft.) - includes the +0.09 m. correction.

2.1.3. Storm Surge

The Project site is located in a hurricane-prone area, and given its proximity to the ocean, and relatively low elevations, it is expected that it will be affected by hurricane-induced flooding during extreme events. A storm surge is an abnormal rise of water, generated by a storm, over and above normal tides.

Estimation for previous or expected levels of storm surge at a Project site is challenging given the plethora of variables involved in this phenomenon. Existing information from previous storms is generally incomplete and unreliable as it is predominantly based on mudline and debris line elevation readings following the storm event and anecdotal evidence since tidal stations are scarce and, in some cases, do not remain operational during these events.

Previous estimates of storm surge in the area have relied on publicly available information such as The Caribbean Disaster Mitigation Project (CDMP) developed by the Organization of American States (OAS) and United States Agency for International Development (USAID), or reports by the Global Facility for Disaster Reduction and Recovery (GFDRR). These reports provide global estimates of storm surge that can be used as a first step try to assess the coastal vulnerability for specific regions in the Caribbean but are based on incomplete and outdated information and should not be used to estimate design values of storm surge, given the high sensitivity of this parameter to local conditions.

The expected storm surge at the Project site was numerically modeled based on metocean data collected at two offshore locations within 7 to 8 miles of the Project site. These conditions include sea state information (wave heights, wave periods, wave directions), storm surge information, water currents information, and wind and pressure fields for the approximately 400 storm events (tropical storms and hurricanes) that have affected the Caribbean Sea from 1930 until the 2023 Caribbean hurricane season (including Tropical Storm Philippe and Hurricane Tammy). The total number of events that have affected the Project site is approximately 47.

Based on this information the design team ‘propagated’ these offshore conditions to the Project site. Out of the 47 identified storms within the dataset, the data was further filtered to include only those with peak wind speeds propagating from the southeast to northwest, which are the storm directions expected to affect the coastal dynamics of the Project. This amounted to a total of 11 storms.

The team used the MIKE21 Flexible Mesh (FM) from the DHI modeling suite to propagate storm conditions from the offshore datapoints to the Project site. The MIKE modeling domain is shown in Figure 2.2..

Storm surge levels and the associated water currents were analyzed using the MIKE21 Hydrodynamic module (HD) module. Boundary conditions to the MIKE21 model were applied along all three open ocean boundaries using the provided data from Ocean Weather International (OWI). The model was forced by offshore hurricane wind date throughout the domain.

The offshore bathymetry data of the MIKE21 model was defined using C-MAP data, and the nearshore bathymetry data was defined using the topographic and bathymetric surveys that were completed for the Project.

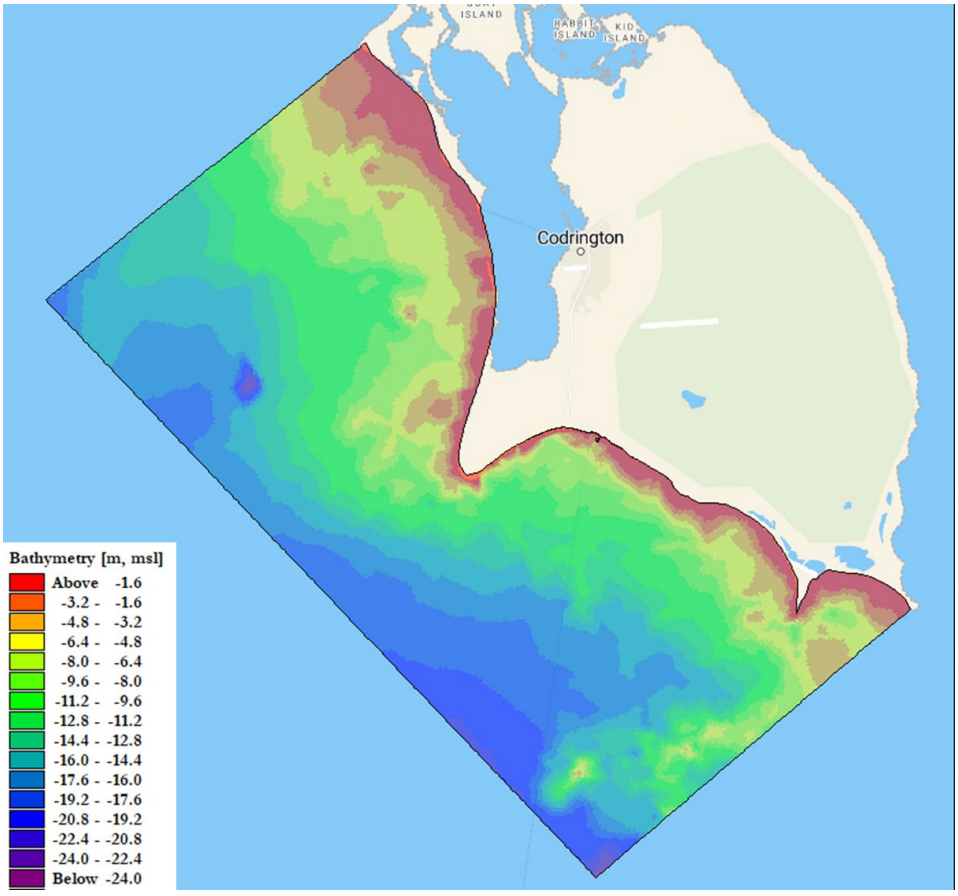

FIGURE 2.2: MIKE21 HD MODEL DOMAIN.

Once the metocean conditions were obtained at the project site, a General Extreme Value (GEV) analysis of the historic storms was performed to develop design storm surge values for select return periods.

These values were developed considering high tides and with and without SLC. The values summarized in Table 2.3, represent the upper threshold for the likely (medium confidence – 83rd percentile) range of expected storm surge elevations at the project site based on historic data.

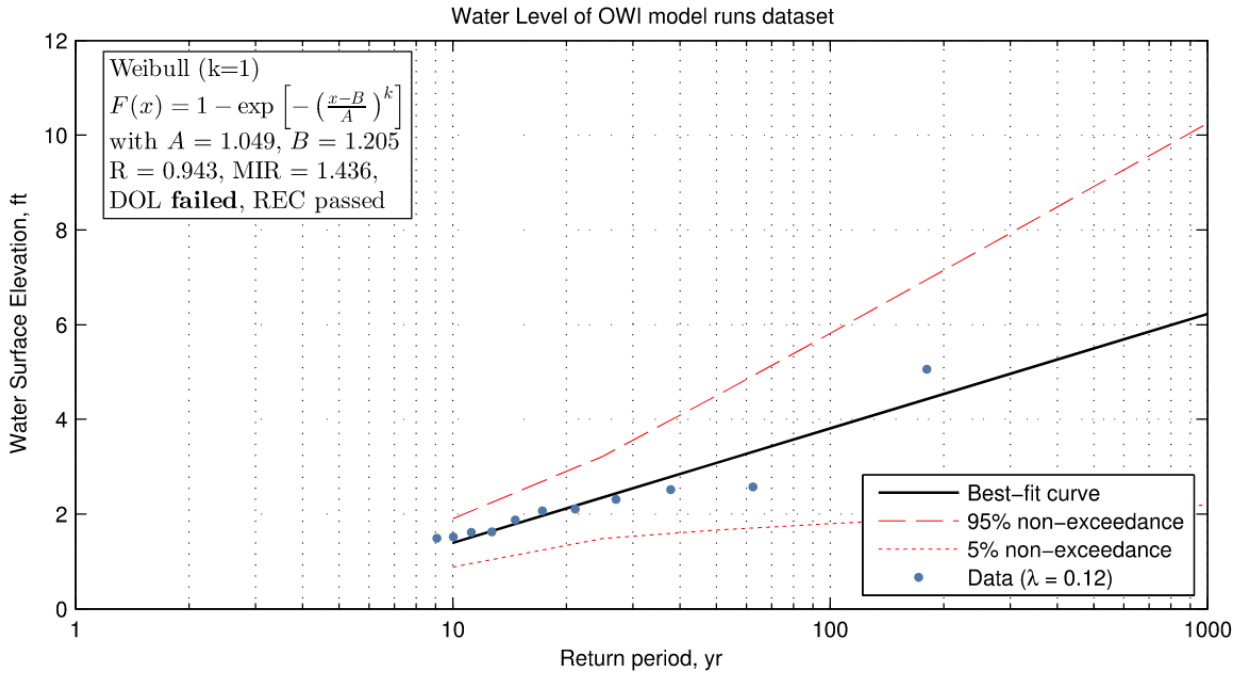

FIGURE 2.3: GEV ANALYSIS FOR THE EXTREME STORM SURGE ELEVATIONS.

These values represent the value of the storm surge elevation nearshore, and do not include typical wave-induced phenomena that affect the final water level expected at the project site.

Section 3.3 reviews the impact of the design extreme events (hurricanes) to the existing shoreline and provides dynamic values for the total Stillwater Elevation (SWEL), including wave-driven effects.

TABLE 2.3: STORM SURGE ELEVATIONS [FT. (M.)] FOR VARIOUS RETURN PERIODS.

Return Period	Scenario	
	No SLC	With SLC
10	1.3 (0.4)	1.8 (0.5)
25	2.4 (0.7)	3.0 (0.9)
50	3.3 (1.0)	4.1 (1.3)
100	4.3 (1.3)	5.3 (1.6)

2.2. Water Currents

2.2.1. Operational (daily) Conditions

Generally speaking, water currents in Barbuda are primarily driven by several contributing factors:

- Tidal component: The rising and falling of tides, resulting in the movement of water into and out of bays, inlets, and the lagoon and flow along the coastline.
- Wind shear: Winds blowing across the surface of the ocean can push water in the direction of the wind. This process is known as wind set-up, and it can cause water levels to elevate at the coast, leading to changes in currents and water levels. The strength and duration of the wind play a key role in determining the extent of the wind set-up. In areas where the

wind blows consistently in one direction, it can cause the water to accumulate, increasing the height of the water above its normal tidal level.

- Caribbean Current: This regional current moves from east to west across the Caribbean Sea, influencing the waters around Barbuda. It transports warm water from the Atlantic Ocean into the Caribbean, with its strength varying based on seasonal and climatic conditions. The current generally flows toward the Gulf of Mexico and the Yucatán Peninsula.
- North Equatorial Current: This regional current flows westward across the Atlantic Ocean, and as it approaches the Caribbean Sea, the current splits, with part of it moving toward the south and part toward the north. This current also influences water temperatures and flow around Barbuda, especially along its northern and eastern coasts.
- Trade winds: These winds that generally blow from the northeast, have a significant effect on the ocean's surface currents due to the Ekman transport phenomenon. This results in a general movement of surface waters to the right (due to the Coriolis effect), which influences coastal currents around Barbuda.
- Gulf Stream influence: While Barbuda is not directly in the path of the Gulf Stream, the Gulf Stream (a warm, fast-moving ocean current that flows along the eastern coastline of North America) has some influence on the surrounding waters. It impacts water temperature and overall circulation patterns in the Atlantic, indirectly affecting currents near Barbuda.

Overall, water currents are relatively minor in Barbuda, however, localized currents can be observed in certain areas, depending on the local geography, the presence of reefs and shallow waters.

Local current effects at the Project site were evaluated using a hydrodynamic numerical model for operational (daily) and extreme (storm events) conditions. The water currents at the project site during the 'operational' regime were modeled considering the main contributor: tidal forcing.

Operational current speeds were analyzed during several typical tidal cycles from the time period of October 1st, 2024 to December 31st, 2024. Due to the small tidal range and the open nature of the coastline at the project site, the associated currents are minor, less than 0.1 kts. (0.05 mps.) typically.

2.2.2. Extreme Conditions

Extreme water currents at the site occur during the storm/hurricane events and were evaluated via numerical modeling. A GEV analysis, based on the peak current speed from individual storm events, was completed to establish maximum water currents during the design events (see Figure 2.4 and Table 2.4).

TABLE 2.4: WATER CURRENT SPEED [KTS. (MPS)] FOR VARIOUS RETURN PERIODS (BEST-FIT/50% CURVE).

Return Period	Peak Water Current Speed
10	0.52 (0.27)
25	0.86 (0.44)
50	1.05 (0.54)
100	1.23 (0.63)

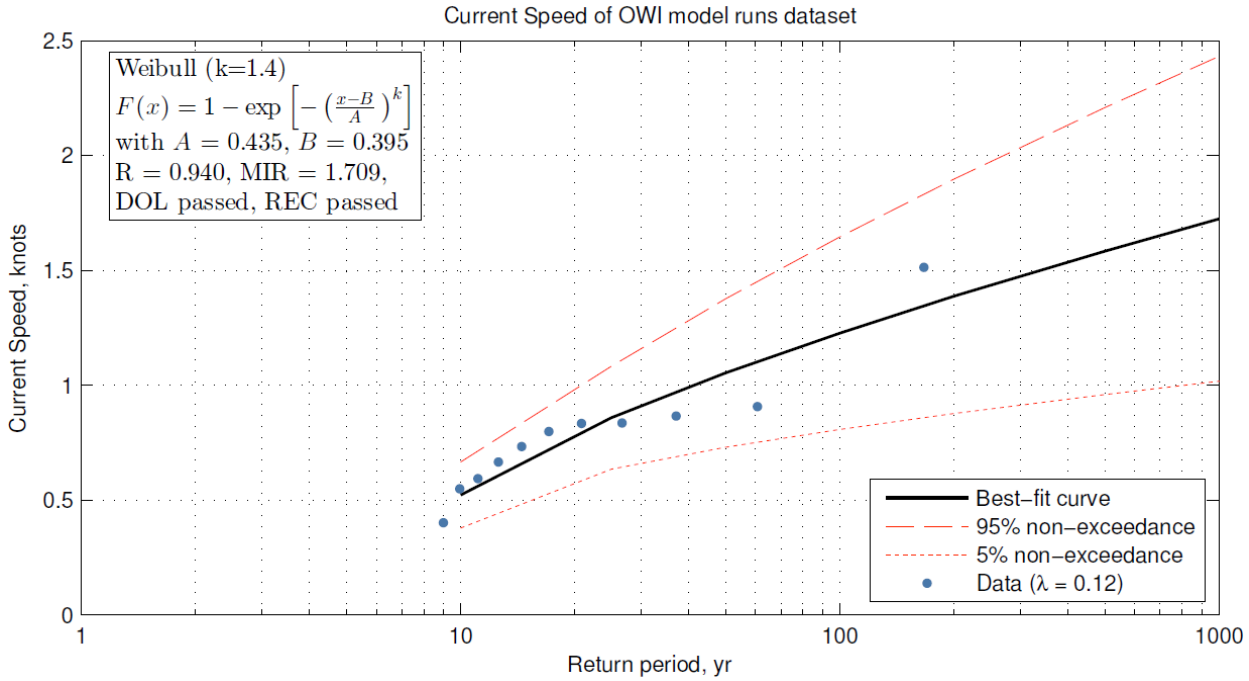

FIGURE 2.4: GEV ANALYSIS FOR WATER CURRENTS AT THE PROJECT SITE (KTS.).

2.3. Winds

2.3.1. Operational (daily) Conditions

Local wind data was obtained from the NOAA meteorological station 998441 Barbuda AC, located approximately 0.5 miles east. The Barbuda AC station wind dataset consists of continuous two-minute averaged wind data at a standard 10-meter height (two-minute averaging) for a period of 11 years (2011 to 2022).

The wind rose depicted in Figure 2.5 shows the majority of the wind approaches from the East (approximately 48% of time between East Northeast and East Southeast), with scattered winds approaching occasionally from the North or the South. This data indicates that winds approaching from the Southwest through the North North-West are statistically negligible.

Figure 2.6 shows that only 35% of the time wind speed exceeds 6 kts. (3.09 mps.) in speed and only 0.35% of the time winds speed exceeds 18 kts. (9.26 mps.).

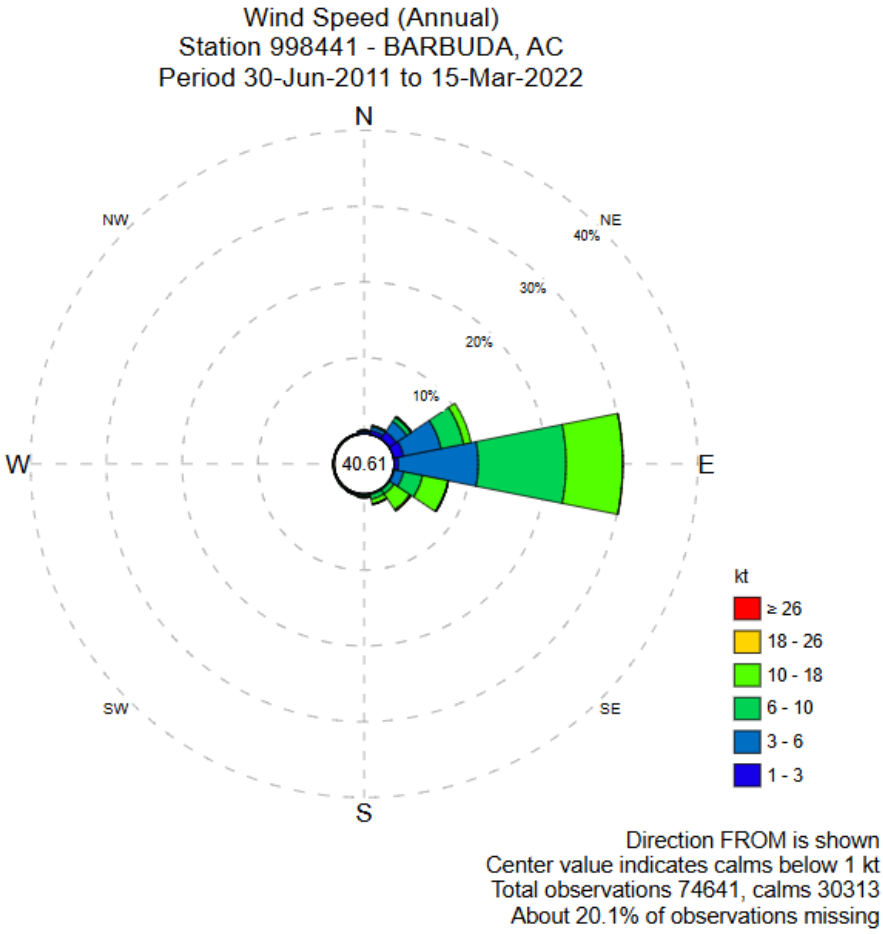

FIGURE 2.5: WIND ROSE FOR OPERATIONAL WIND SPEEDS (2-MINUTE WINDS EXPRESSED IN KTS.).

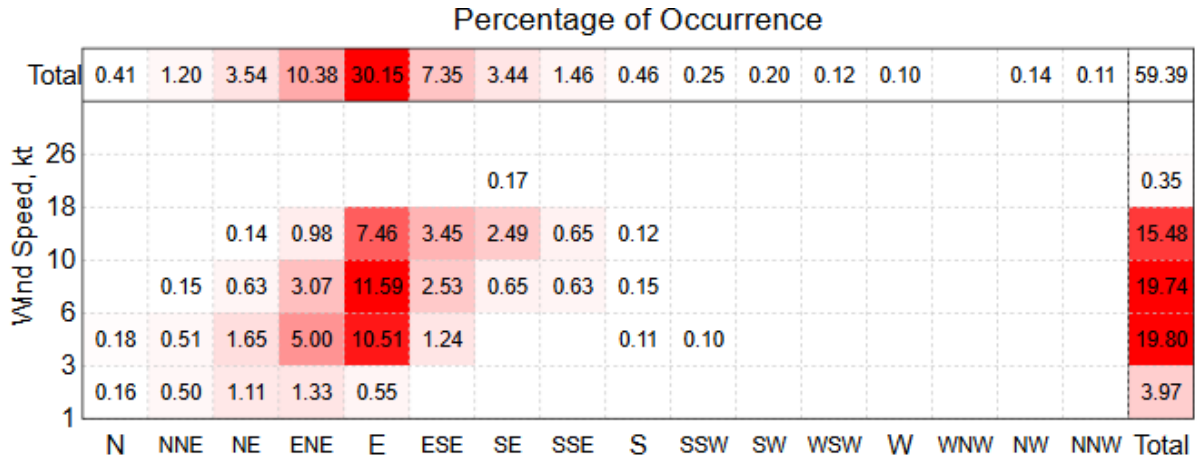

FIGURE 2.6: WIND SPEED PERCENTAGE OF OCCURRENCE (2-MINUTE WINDS EXPRESSED IN KTS.).

2.3.2. Extreme Conditions

Extreme wind conditions at the site are caused during storm/hurricane events and were determined by performing a GEV analysis of peak wind speeds.

Global models do not resolve storm/hurricane events and in some cases, data from meteorological stations is not reliable during these events given the manufacturer limitations on the maximum wind speed that can be recorded reliably or because anemometers may get damaged during storm events.

A GEV analysis was completed for peak wind speeds from historic hurricane data in the Caribbean Sea from 1930 until 2023 (including Tropical Storm Philippe and Hurricane Tammy). Figure 2.7 and Table 2.5 show the results of the GEV analysis.

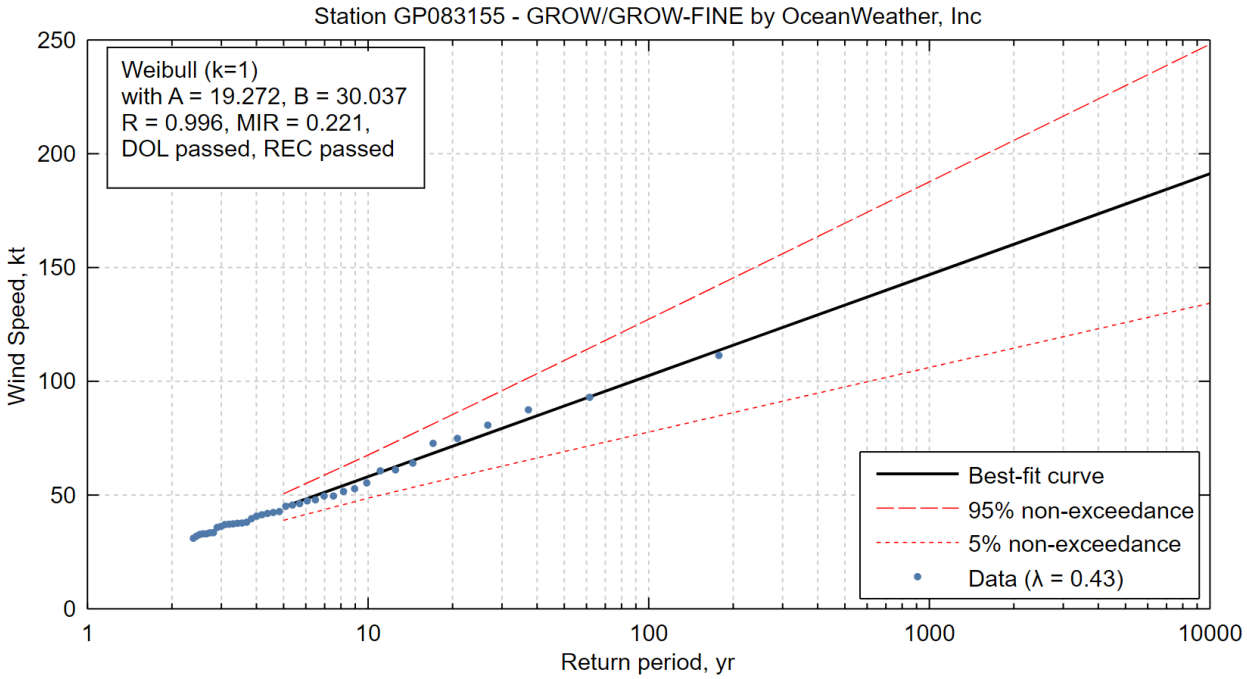

FIGURE 2.7: GEV ANALYSIS FOR MAXIMUM WIND SPEED AT THE VICCINITY OF THE PROJECT SITE (1-MINUTE AVG. EXPRESSED IN KTS.).

TABLE 2.5: MAXIMUM WIND SPEED [KTS. (KPH.)] FOR VARIOUS RETURN PERIODS (BEST-FIT/50% CURVE).

Return Period	Peak Wind Speed
10	58.1 (107.6)
25	75.8 (140.4)
50	89.1 (165.0)
100	102.5 (189.8)

2.4. Waves

Waves at the project site were developed for two conditions, operational (daily) and extreme (storm events). Both sets of conditions were developed using the MIKE21 Spectral Wave (SW) model. The operational MIKE21 SW model extends offshore of the project site to capture both offshore and nearshore areas as seen in Figure 2.2. The MIKE21 SW model used to model the extreme conditions is the same model used to evaluate storm surge at the project site. For operational conditions, the MIKE21 SW model was forced with a spatially constant wind and offshore wave data from WAVEWATCH III (WW3). To evaluate extreme conditions, the MIKE21 SW model was forced with offshore wave spectra and spatially constant-time varying wind data from OWI. Water levels were computed by coupling the SW model the MIKE21 HD model.

2.4.1. Operational (daily) Conditions

As indicated previously, wave operational conditions at the Project site were developed by applying wind data taken from the nearby Barbuda Airport to the MIKE SW model and offshore WW3 data. Significant wave heights and periods were extracted from the model at the three locations shown in Figure 2.8. This data was used to develop statistics related to the sea state at the nearshore of the Project during operational (daily) conditions.

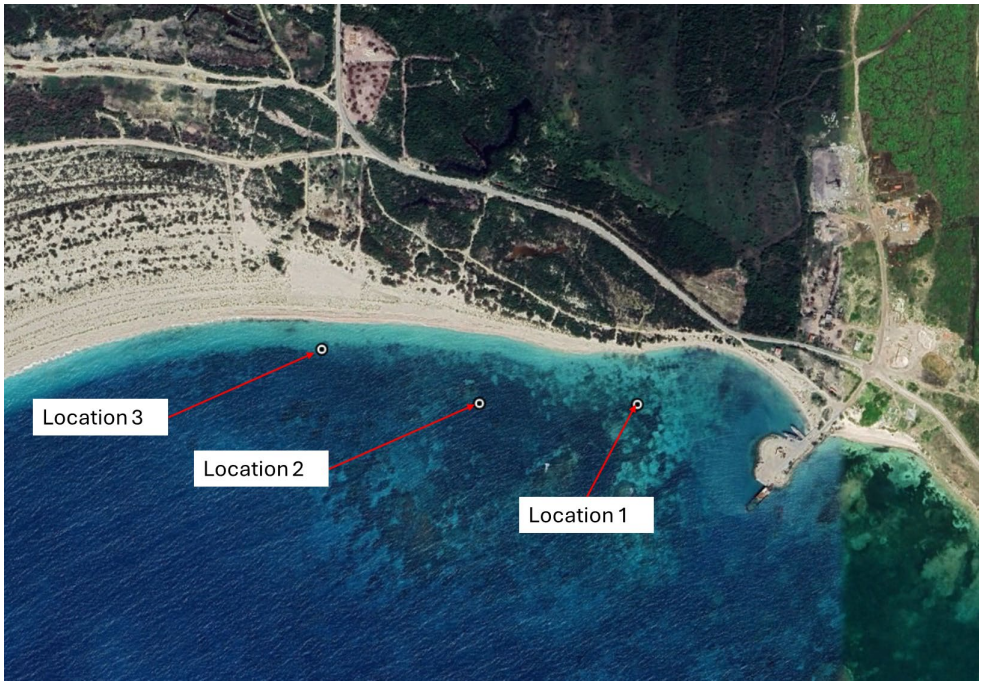

FIGURE 2.8: LOCATION OF NUMERICAL MODEL OUTPUT STATIONS.

Wave roses and percentage of exceedance information for typical sea state conditions (significant wave height, peak period and main wave direction) are shown in Figure 2.9 through Figure 2.14. The operational wave model results show that waves approach the project site from the South to Southeast direction, with significant wave heights on the order of 0.15 to 0.5 m.(0.5 to 1.5 ft.) and peak periods from 1.5 to 2.5 seconds.

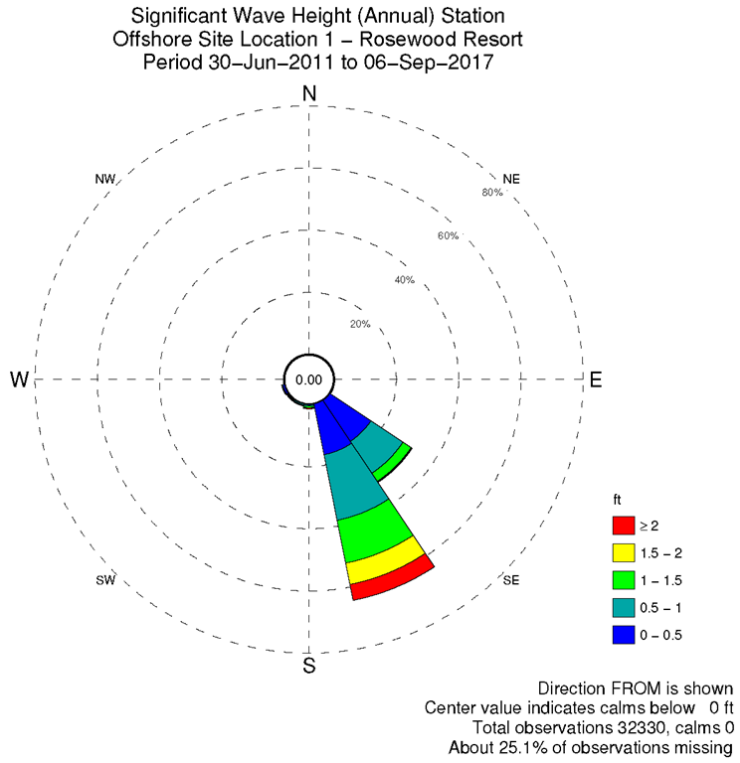

FIGURE 2.9: WAVE ROSE FOR OPERATIONAL WAVES AT LOCATION 1 (SIGNIFICANT WAVE HEIGHTS ARE EXPRESSED IN FT.).

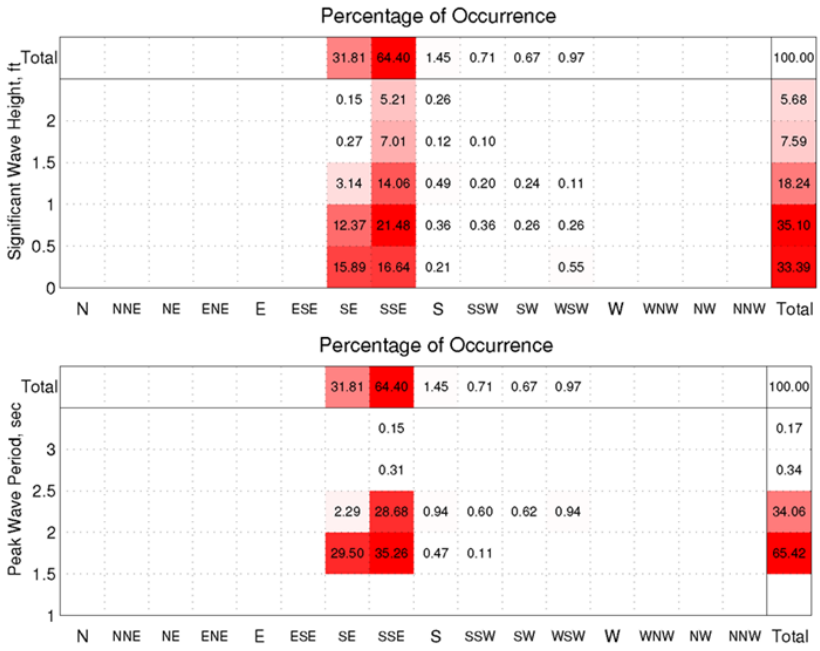

FIGURE 2.10: SIGNIFICANT WAVE HEIGHT (UPPER) AND PEAK PERIOD (LOWER) PERCENTAGE OF OCCURRENCE AT LOCATION 1.

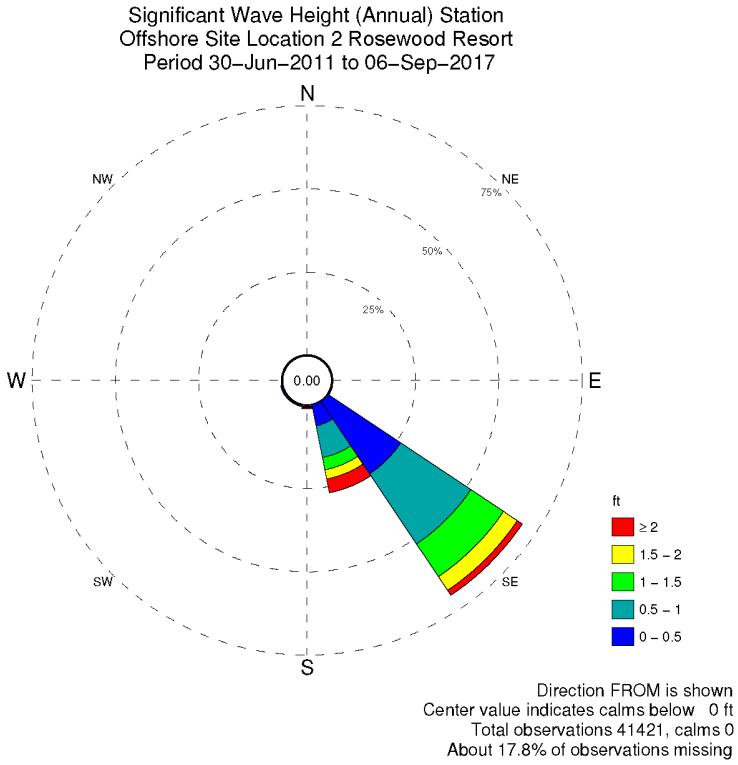

FIGURE 2.11: WAVE ROSE FOR OPERATIONAL WAVES AT LOCATION 2 (SIGNIFICANT WAVE HEIGHTS ARE EXPRESSED IN FT.).

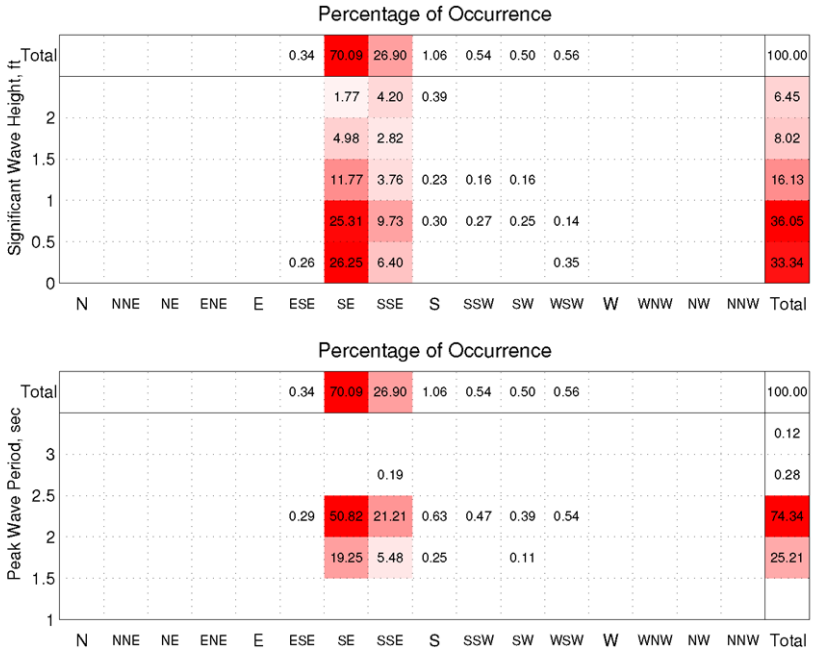

FIGURE 2.12: SIGNIFICANT WAVE HEIGHT (UPPER) AND PEAK PERIOD (LOWER) PERCENTAGE OF OCCURRENCE AT LOCATION 2.

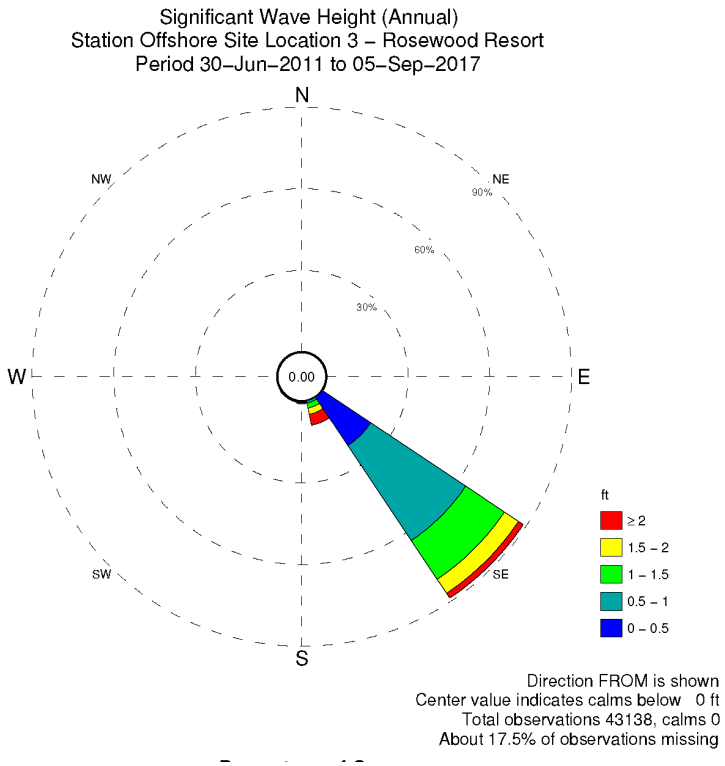

FIGURE 2.13: WAVE ROSE FOR OPERATIONAL WAVES AT LOCATION 3 (SIGNIFICANT WAVE HEIGHTS ARE EXPRESSED IN FT.).

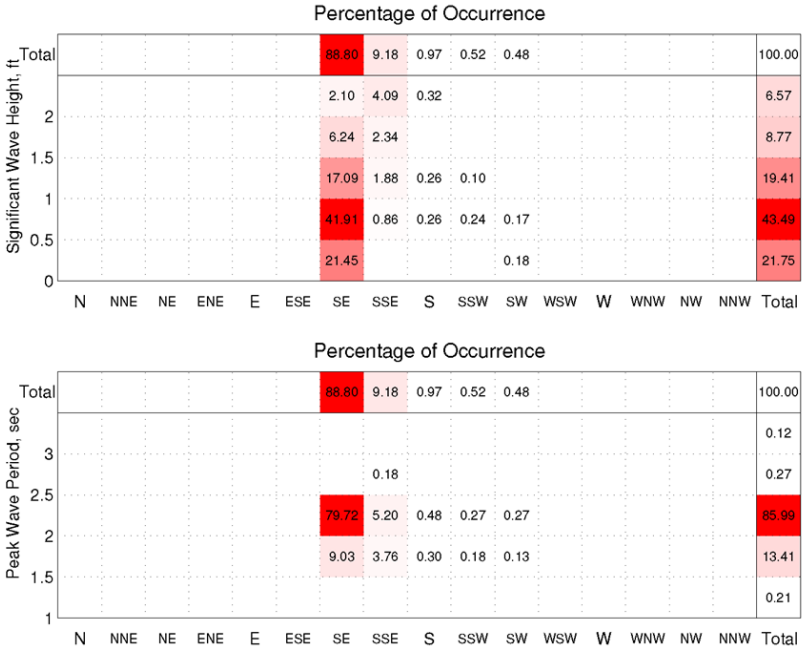

FIGURE 2.14: SIGNIFICANT WAVE HEIGHT (UPPER) AND PEAK PERIOD (LOWER) PERCENTAGE OF OCCURRENCE AT LOCATION 3.

2.4.2. Extreme Conditions

The eleven (11) hurricane events that were identified for the storm surge analysis (see Section 2.1.3) were propagated to the Project site. The MIKE21 SW model was forced with offshore wave spectra data, wind and water level time series for these selected events.

The peak wave conditions at each of these conditions were extracted for each model run, and the modeled data were then used to perform a GEV analysis for the significant wave heights and peak periods. The results of these GEV analysis at the *"Location 2"* station, are shown in Figure 2.15 and Figure 2.16, for the significant wave height and peak period, respectively.

These values were developed considering high tides. The values summarized in Table 2.6., representing the upper threshold for the *likely* (medium confidence – 83rd percentile) range of expected storm surge elevation at the project site based on historic data.

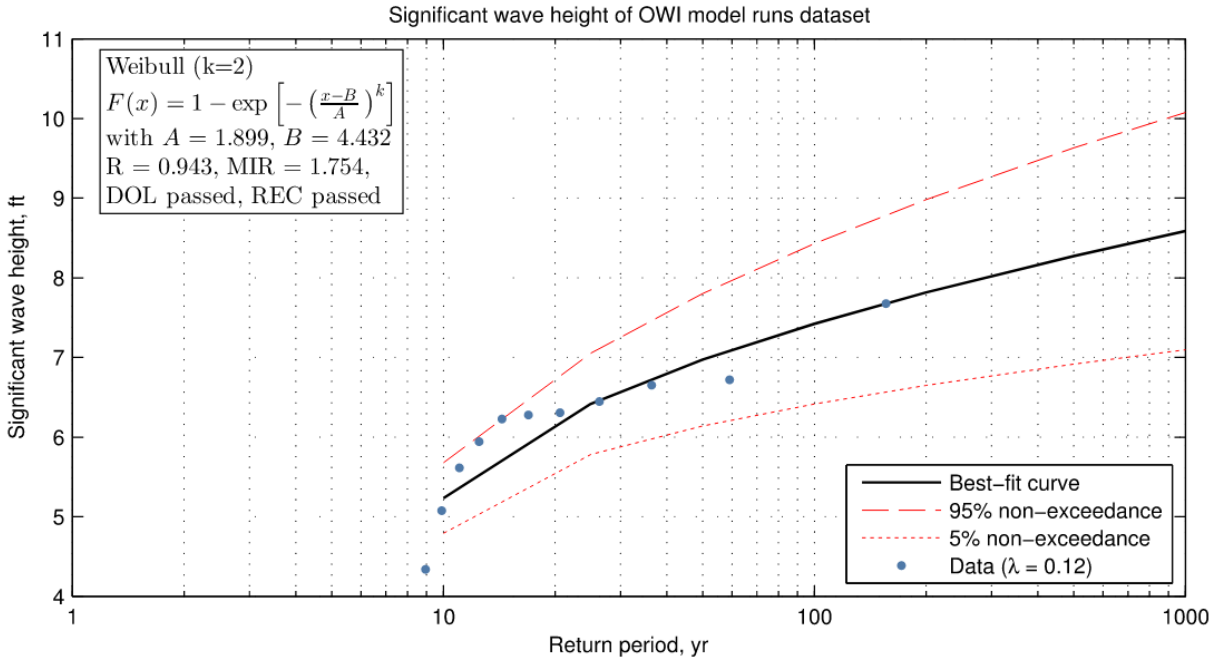

FIGURE 2.15: GEV ANALYSIS FOR THE SIGNIFICANT WAVE HEIGHT AT THE VICCINITY OF THE PROJECT SITE (EXPRESSED IN FT.).

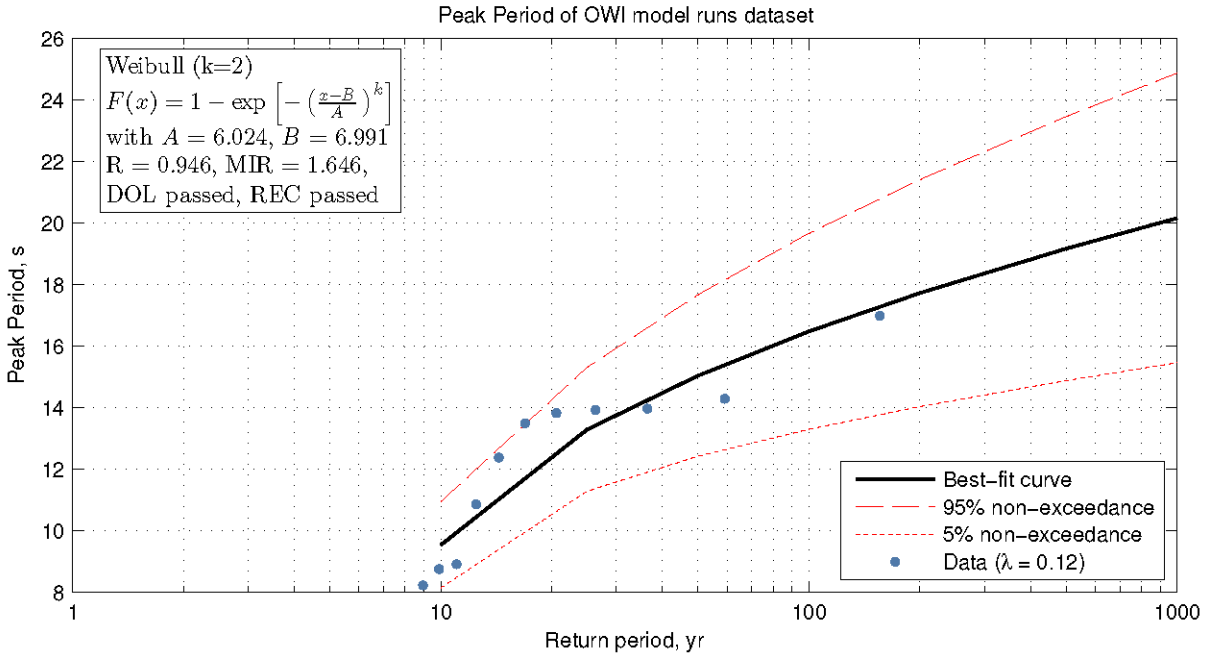

FIGURE 2.16: GEV ANALYSIS FOR THE PEAK PERIOD AT THE VICCINITY OF THE PROJECT SITE (EXPRESSED IN SECONDS).

TABLE 2.6: SIGNIFICANT WAVE HEIGHTS [FEET (METERS)] AND PEAK PERIODS (SECONDS) FOR VARIOUS RETURN PERIODS.

Return Period	Significant Wave Height	Peak Wave Periods
10	5.53 (1.69)	10.6
25	6.85 (2.09)	14.9
50	7.52 (2.29)	17.1
100	8.09 (2.47)	19.0

2.5. Sediment Transport Processes[3]

The analysis of the local shoreline changes and operational and wave data offers insight regarding the sediment transport processes affecting the Dulcina Beach area. The typical upland elevations are two meters above MSL with water depths nearshore around two to three meters maximum. It is assumed that the typical active beach zone extends from elevation +1.0 to -2.0 m. This is the zone over which waves break, run up and produce measurable change in bottom elevation. Dulcina Beach, which encompasses about 1,050 meters of shoreline, has gained ~5,000-7,500 m^3/year on average from 1985-2023.

The shoreline of the Loading Jetty Reach (400 meters) with the Project has changed relatively little, with about 300 m^3/year lost between 1985-2017. After Hurricane Irma, the reach has regained about 1,000 m^3/year.

[3] This Section provides a summary of the work completed by Coastal Science & Engineering Inc. in October 2023.

The sediment volume and shoreline change suggest the following significant trends:

- Dulcina Beach continues to gain sand but at a lower rate than Pink Sand Beach.
- Shoreline change along Dulcina Beach increases (positively) from east to west.
- The sand fillet in the shadow of the Loading Jetty has a moderately low erosion rate (<1m^3/m/year since 1985).
- Sediment losses from the Loading Jetty Reach area are a tiny fraction of the sediment gains along Dulcina Beach.
- The upcoast area has been relatively stable and does not provide a large sediment supply to downcoast areas, as evidenced by limited fillets at the Loading Jetty.
- Predominant wave direction from the eastern quadrant tends to drive sand away from the Loading Jetty toward Dulcina Beach.
- Excess sand buildup along Pink Sand Beach has augmented the supply of sand at the west end of Dulcina Beach but is not tending to move into the Loading Jetty Fillet on the Project side of the pier.
- Volumes eroding or accreting each year along the Loading Jetty Reach (400 m) are relatively low and could be managed economically.

2.6. Tsunami Exposure

While tropical hurricanes pose a greater risk to the region, tsunamis are also a potential threat. As of 2002, 24 tsunamis were recorded in the Lesser Antilles over the last 400 years (Zahibo and Pelinovsky, 2001). These events were caused by tsunamigenic earthquakes and volcanic activity; however, tsunamis caused by landslides and tele-tsunamis are also possible (UWI Seismic Research Centre, 2010).

The most likely tsunamis to affect the Caribbean are those caused by shallow earthquakes of a magnitude greater than 6.5 (UWI Seismic Research Centre, 2010). The last documented destructive tsunami in the Caribbean was in 1946, and it was caused by an 8.1 magnitude earthquake in the Dominican Republic.

Barbuda is located near the tectonic plate boundary between the North American plate and Caribbean plate. One of the earliest reported tsunamigenic earthquakes near Barbuda was in 1690, with a magnitude of 7.5 and a depth of less than 50 km. (Zahibo and Pelinovsky, 2001). The most recent tsunami recorded near Barbuda, in Antigua, was in 1969 caused by an earthquake with a magnitude of 7.0 (Zahibo and Pelinovsky, 2001).

In the event of a tsunami striking the Project site, the clientele and employees will be at similar risk to those in adjacent properties; however, a warning time of at least 30 to 60 minutes (UNESCO 2012) is anticipated to allow for evacuation.

The National Office of Disaster Services for Antigua and Barbuda is responsible for risks associated with natural disasters. In 2014, the agency conducted tsunami exercises to test specific aspects of its procedures informed by the Intergovernmental Coordination Group for the Tsunami and other Coastal Hazards Warning System for the Caribbean and Adjacent Regions (ICG/CARIBE-EWS). The ICG/CARIBE-EWS was established in response to the 2004 Indian Ocean tsunami with the goal to mitigate damage and casualties caused by tsunamis and implement working plans throughout the Caribbean (UNESCO).

It is recommended that the facility refer to *"A Guide to Tsunamis for Hotels: Tsunami Evacuation Procedures"* created by the Intergovernmental Oceanographic Commission of UNESCO (2012) when developing their safety and evacuation protocols.

3. Coastal Vulnerability Assessment

3.1. General Project Criteria

Barbuda's location makes it highly susceptible to hurricane conditions. Since 1851, 95 storms have passed within 50 nautical miles of the island, including 34 hurricanes and 13 Major hurricanes (Category 3 or higher), see Figure 3.1.

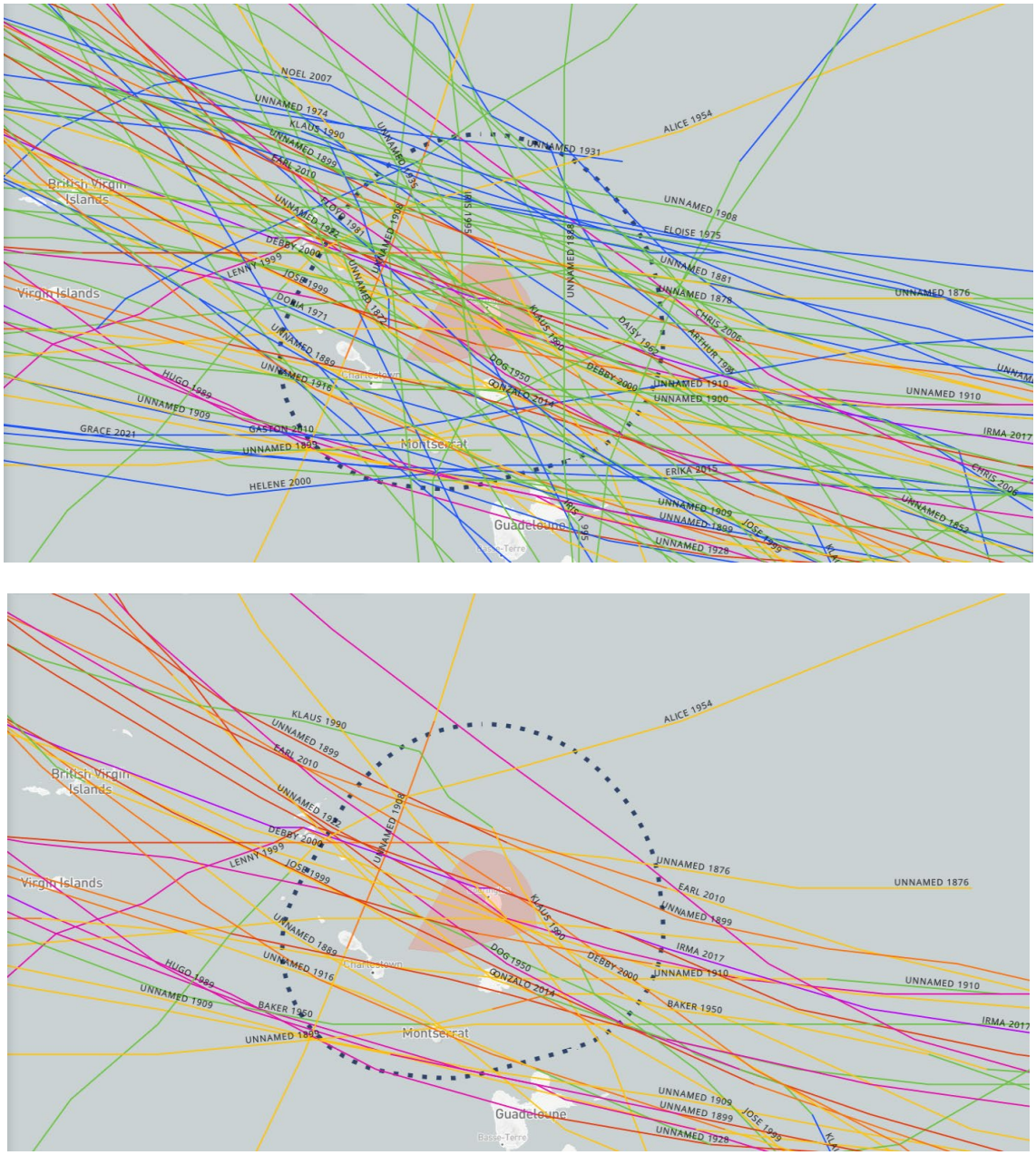

FIGURE 3.1: STORM (UPPER) AND HURRICANE EVENTS (LOWER) WITHIN 50 NAUTICAL MILES OF THE ISLAND OF BARBUDA SINCE 1851.

The most recent storm was Hurricane Tammy (Category 1) in October 2023, while the most devastating was Hurricane Irma (Category 5) in September 2017. Irma caused catastrophic damage across the island, with around 95% of buildings suffering severe damage, and nearly half becoming uninhabitable (UNDRR, 2017). Shortly after, Hurricane Jose struck, followed by Hurricane Maria just two weeks later. In response to Hurricane Jose, all Barbuda residents were evacuated to shelters in Antigua.

Given the property's vulnerability to hurricane damage, a comprehensive assessment of the vulnerability to coastal hazards is essential. This evaluation will help identify the coastal risks associated with hurricane events (storm surges, flooding, winds, waves and erosion) which can severely impact the Project site.

Understanding these potential hazards is crucial for developing a Project masterplan that considers the Project's vulnerability to coastal hazards, and incorporates effective mitigation strategies, ensuring the safety of the property and minimizing future damage. This assessment will also provide valuable insights for designing resilient infrastructure and implementing preparedness measures to protect the property in the event of extreme design conditions.

The following sections provide a description of the general project criteria selected by the design team based on the *Recommendations for Maritime Works* (by Puertos del Estado).

3.1.1. Design Life (L_f)

The design life shall be determined for each project according to the time the structure is projected to be in service. The evaluation of the design life shall consider the initial construction cost, the possibility, ease and economic feasibility of repairs, the probability and possibility of changes in the circumstances, and conditions of the project's foreseen use as a consequence of operations.

The selection of the design life for a project can be based on the following parameters:

Nature of the proposed work:

- General use infrastructure – Include 'general character' works that are not associated with the use of an industrial installation or of a deposit.
- Specific industrial infrastructure – Works in the service of a particular industrial installation or associated with the use of transitory natural deposits of resources.

Require Safety Level:

- Level 1 – 'Local or auxiliary interest' works and installations. Small risk of loss of human life or environmental damage in case of failure (coastal defense and regeneration works, works in minor ports or marinas, local outfalls…).
- Level 2 – 'General interest' works and installations. Moderate risk of loss of human life or environmental damage in case of failure (works in large ports, outfalls of large cities…).
- Level 3 – 'International interest or flooding protection' works and installations.

Based on the nature of the proposed development (non-industrial use and local or auxiliary interest), a design life of 25 years is recommended (see Table 3.1). This design life of 25 years is typical for residential developments, and approximately matches a typical mortgage term period of 30 years.

In some cases, there are certain elements of the project site related to critical infrastructure (or *'general interest'*) that could potentially require a larger design life. For these assets, a design life of 50 years is recommended.

TABLE 3.1: MINIMUM DESIGN LIVES FOR WORKS OR STRUCTURES OF DEFINITIVE CHARACTER (IN YEARS).

TYPE OF WORK OR INSTALLATION	REQUIRED SAFETY LEVEL		
	LEVEL 1	LEVEL 2	LEVEL 3
GENERAL USE INFRASTRUCTURE	25	50	100
SPECIFIC INDUSTRIAL INFRASTRUCTURE	15	25	50

3.1.2. Admissible Risk (E)

The admissible risks shall be set for each structure or structural element as a function of its physical and economic characteristics, the direct and indirect economic repercussions in case of partial or total incapacitation, and the estimation of human loss in case of destruction or failure for each significant phase of the project and work hypothesis.

The admissible risk will depend on:

- The possibility of human loss:
  - Reduced – when human loss is not expected in the case of failure or damage
  - Expected – when human loss is foreseeable in the case of failure or damage
- The economic repercussion is evaluated based on the Cost Index (r), based on the formula:

$$Cost\ Index\ (r) = \frac{Cost\ of\ indirect\ or\ direct\ losses}{Original\ investment}$$

  - Low – cost index (r) below or equal to 5
  - Medium – cost index (r) above 5 but below or equal to 20
  - High – cost index (r) above 20
- Type of damage: The damage initiation or total destruction risk shall be adopted as admissible risk according to the 'deformation' characteristics and ease of repair:
  - Damage Initiation: For flexible, semi-rigid, or generally repairable works.
  - Total Destruction: For rigid or fragile works without possibility of repair.

Based on the nature of the proposed development (reduced possibility of human loss[4], the indirect or direct costs do not exceed five times the original investment, and limited possibility of repair given the remoteness of the site), a maximum admissible risk of 0.2 is (conservatively) recommended (see Table 3.2 - lower).

[4] Assumes the proposed development's hurricane plan includes evacuation of guests, preventing loss of human lives.

TABLE 3.2: MAXIMUM ADMISIBLE RISK TO DETERMINE CHARACTERISTIC VALUES OF VARIABLE LOASDS IN THE SERVICE PHASE (DAMAGE INITIATION RISK – UPPER AND TOTAL DESTRUCTION RISK - LOWER).

		POSSIBILITY OF HUMAN LOSS	
DAMAGE INITIATION RISK		REDUCED	EXPECTED
ECONOMIC REPERCUSSION IF WORK IS DISABLED r INDEX	LOW	0.50	0.30
	MEDIUM	0.30	0.20
	HIGH	0.25	0.15

		POSSIBILITY OF HUMAN LOSS	
TOTAL DESTRUCTION RISK		REDUCED	EXPECTED
ECONOMIC REPERCUSSION IF WORK IS DISABLED r INDEX	LOW	0.20	0.15
	MEDIUM	0.15	0.10
	HIGH	0.10	0.05

3.1.3. Return Period (T)

For projects that are exposed to variable loads/events, the functionality calculation needs to be carried out considering the typical maximal value for these loads/events, which corresponds to the mean return period (T) that is associated with the admissible risk probability (E) during the design life of the project (L_f).

The relationship between admissible risk, design life and return period is provided by the following equation:

$$E = 1 - \left(1 - \frac{1}{T}\right)^{L_f}$$

Based on the values derived on Sections 3.1.1 and 3.1.2 for the project's design life (L_f) and admissible risk (E), respectively, the estimated return period for the design event would be approximately 112 years.

In order to be consistent with guidelines and recommendations related to design requirements for upland development in hurricane-prone areas by the Federal Emergency Management Agency (FEMA) a return period value of 100 years was selected. When using this return period, an updated admissible risk (E) of 0.22 is obtained, which is believed to be comparable to the 0.20 value obtained in the previous Section (see Table 3.2 - lower).

As indicated in Section 3.1.1, and for the more critical infrastructure, a design life of 50 years may be preferred, which results in return period for the design event of approximately 224 years.

When discussing the design return periods for a project, it is important to consider that this metric represents an *average time or an estimated average time between design events*. As a result, some events that may result in design conditions that exceed the return period conditions may occur within the (much shorter) design life of the project.

Figure 3.2 shows the expected probability of a design event with an associated return period to occur during a specific period of time. For example, when considering the 100-year return period event, the dark blue line in Figure 3.2 shows the probability (y-axis) of a flood event that will result

in floodwaters above the 100-year flood level during a given time period (x-axis). As shown on the figure, there is an 18% chance the 100-year flood level will be exceeded in a 20-year period, a 26% chance it will be exceeded in a 30-year period, and a 51% chance it will be exceeded in a 70-year period.

Note that the figure does not represent a water surface elevation but rather the probability of exceedance for a given mean recurrence interval (MRI). While the probability of exceedance of the MRI does not change with sea level rise, erosion, and land use change, the water surface elevation associated with the MRI may change

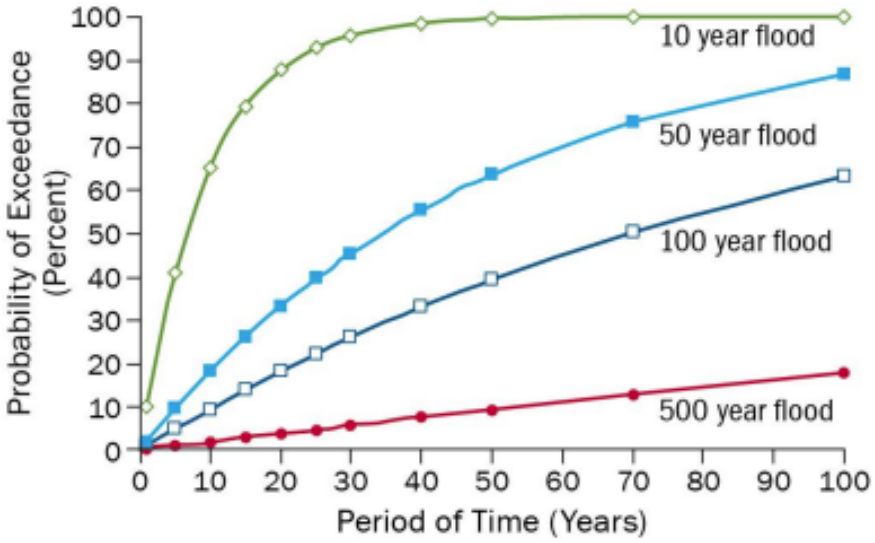

FIGURE 3.2: PROBABILITY UNDER CURRENT CONDITIONS OF A DESIGN EVENT EXCEEDING THE 10-YEAR, 50-YEAR, 100-YEAR AND 500-YEAR FLOOD LEVEL DURING A GIVEN PERIOD OF TIME (ASSUMING NO SEA LEVEL RISE) (SOURCE: FEMA).

3.2. Summary of Design Parameters

Based on the analysis completed by the design team, Table 3.3 provides a summary of the metocean design conditions proposed for the project for select return periods. Design values for the design event (100-year return period) are highlighted.

TABLE 3.3: PROPOSED PROJECT DESIGN PARAMETERS FOR VARIOUS RETURN PERIODS).

Return Period	Wind Speed *[kts. (kph.) 1-min. avg.]*	SWEL *[ft. (m) w.r.t. MSL]*	Significant Wave Height *[ft. (m)]*	Peak Period *[s.]*	Water Currents *[kts. (mps.)]*
10	58.1 (107.6)	1.8 (0.5)	5.53 (1.69)	10.6	0.52 (0.27)
25	75.8 (140.4)	3.0 (0.9)	6.85 (2.09)	14.9	0.86 (0.44)
50	89.1 (165.0)	4.1 (1.3)	7.52 (2.29)	17.1	1.05 (0.54)
100	102.5 (189.8)	5.3 (1.6)	8.09 (2.47)	19.0	1.23 (0.63)

3.3. Dune – Beach Stability Analysis

3.3.1. SBEACH Model Setup

The United States Army Corps of Engineers' (USACE) Coastal Engineering Design and Analysis System's (CEDAS) Storm-induced Beach Change (SBEACH) numerical model was applied to determine maximum wave setup, maximum wave crest elevations, and potential erosion at the project site. The SBEACH model is a one-dimensional model that simulates cross shore beach and dune erosion under storm wave action. Results from MIKE SW in the nearshore were used as wave inputs for SBEACH to evaluate storm waves, water levels, and erosion at three transects on the project site (see Figure 3.3) These transects were chosen to represent the typical conditions along the shoreline based on the existing (pre-project) and proposed (post-project) conditions. Results from MIKE SW show that the governing nearshore wave conditions for the project site generally approach from the south-southeast. For the model, these waves are assumed to act perpendicular to the shore along the project coastline. The design conditions for the 100-year storm design event were determined to be the following:

- Peak storm surge elevation – 5.3 ft. (1.6 m)
- Significant wave height – 8.09 ft (2.29 m)
- Peak wave periods – Range of periods between 6 and 12 seconds.

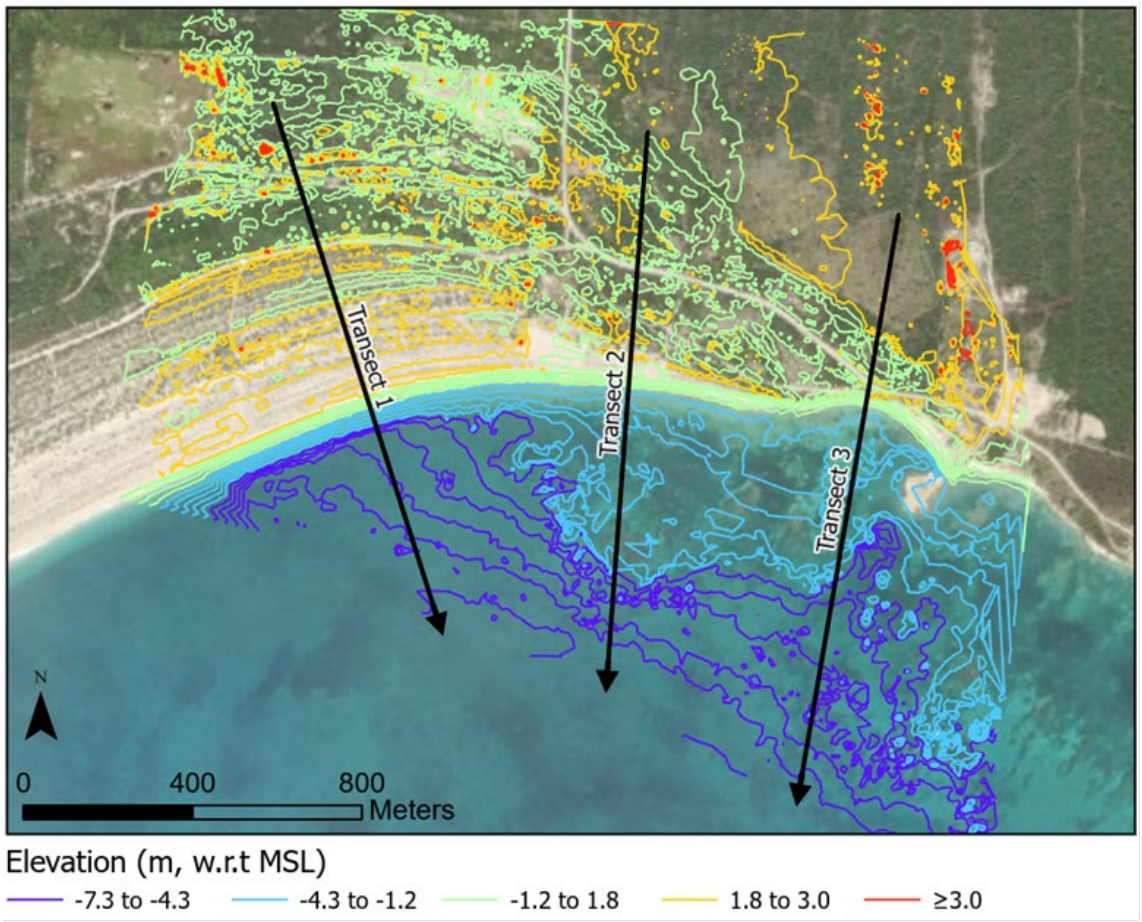

FIGURE 3.3: TRANSECT LAYOUT AND SURVEY CONTOURS FOR PROJECT SITE.

Additional relevant parameters for the SBEACH model include sediment grain size, maximum profile slope before avalanching occurs, and sediment transport characteristics.

The median grain size for the project site was evaluated considering a *fine* and *medium* sand size with average particle sizes of 0.2 and 0.4 mm, respectively. The maximum slope angle was set to 30 degrees, such that if the model profile reaches an angle greater than this during the simulation, avalanching occurs, and the slope is reduced. Sediment transport parameters, including transport rate coefficient, transport rate decay coefficient, and overwash transport, were assumed to be *typical* values.

3.3.2. SBEACH Results

The SBEACH simulation was run with 100-year storm conditions for a six-hour storm duration. The SWEL, initial wave height, and wave period were held constant throughout the simulation using the values mentioned above obtained from MIKE SW. Results from the SBEACH model are presented below. The simulation was run for each of the three transects shown in Figure 2.3, and the resulting eroded beach profile, maximum water level, and maximum wave elevation are shown in Figure 3.4, Figure 3.5, and Figure 3.6. These following figures show a "zoomed" view of each transect to highlight the areas that experienced erosion.

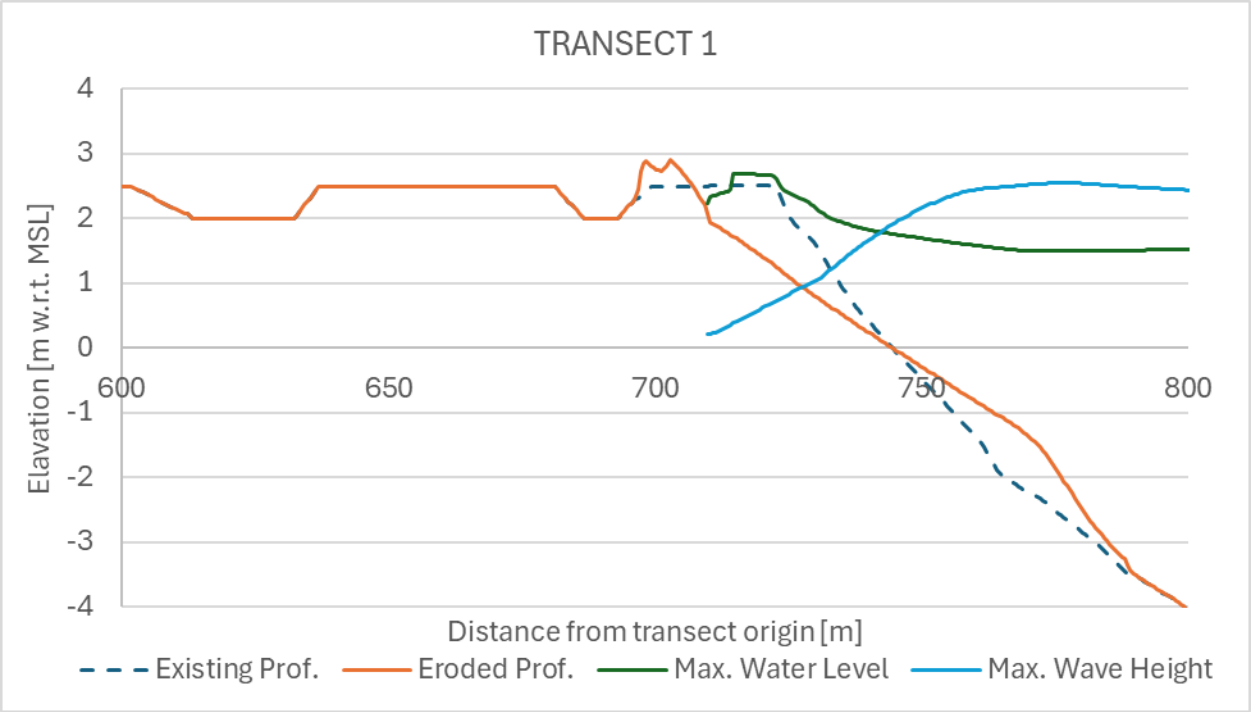

FIGURE 3.4: SBEACH RESULTS (EXISTING CONDITIONS - TRANSECT 1).

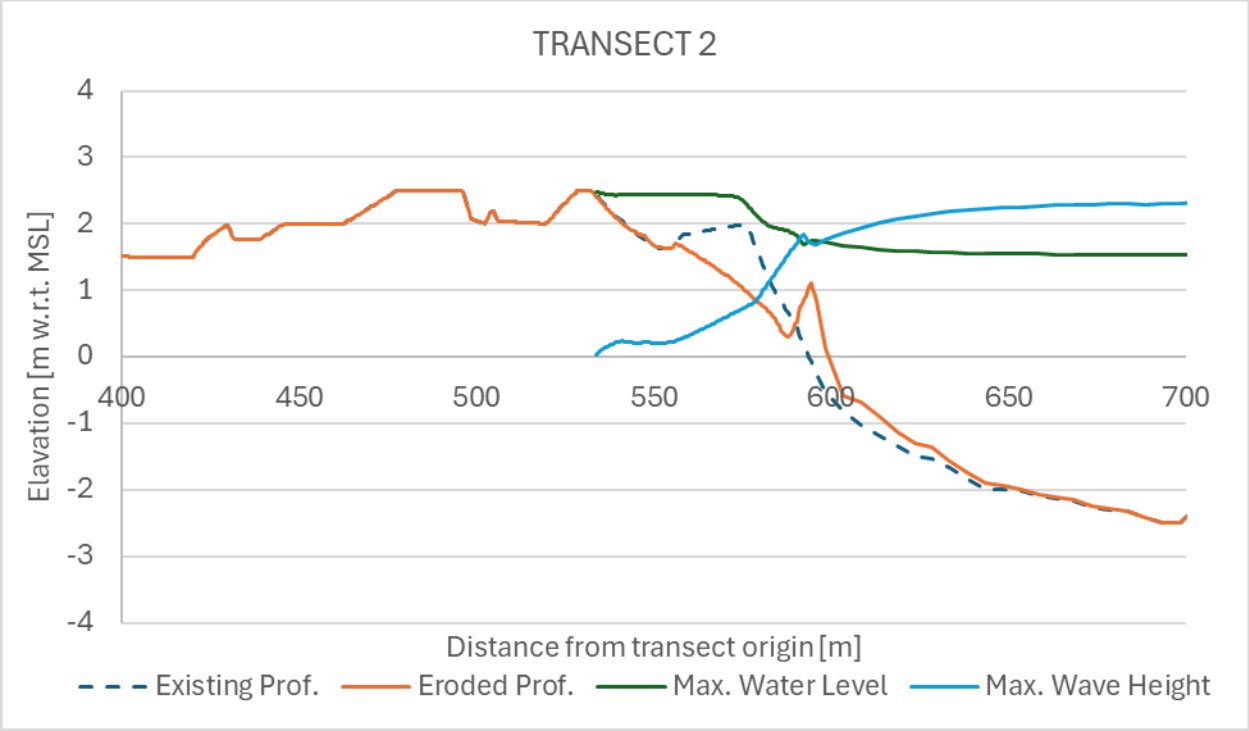

FIGURE 3.5: SBEACH RESULTS (EXISTING CONDITIONS - TRANSECT 2).

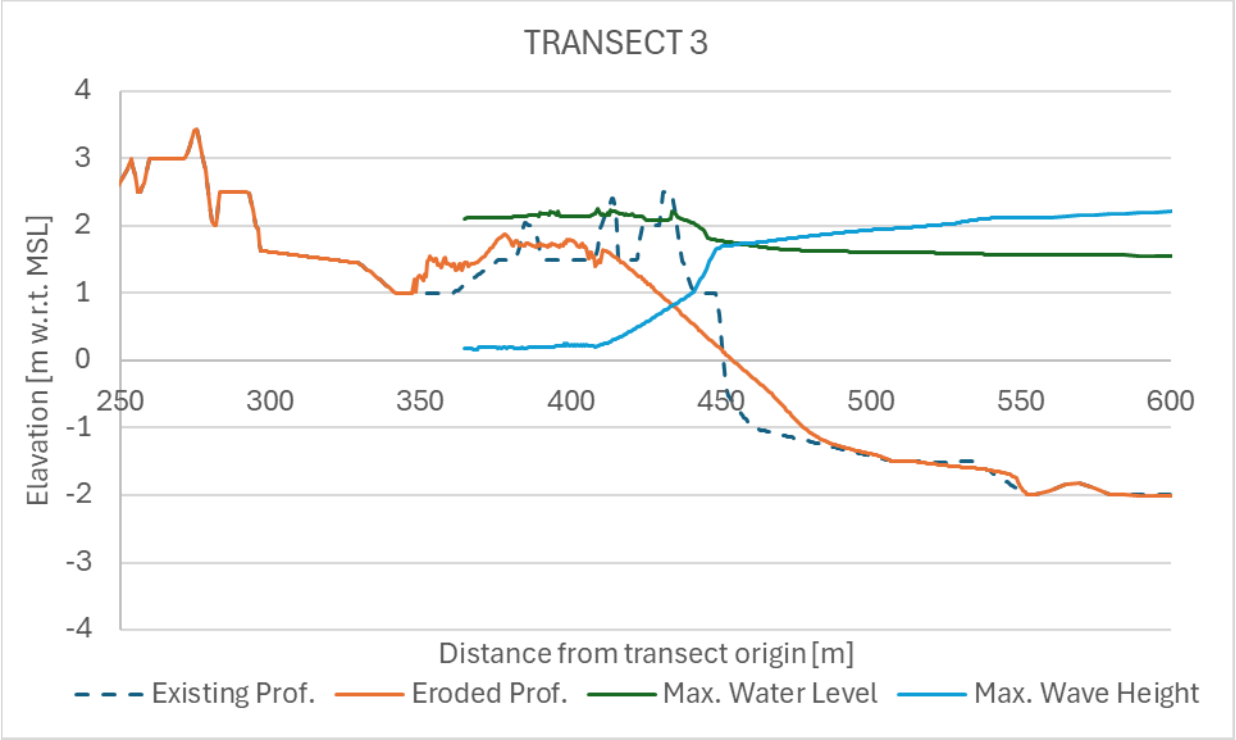

FIGURE 3.6: SBEACH RESULTS (EXISTING CONDITIONS - TRANSECT 3).

Results from the SBEACH runs when considering the existing conditions show severe erosion and removal of most of the frontal dune to an inland extent that ranges between 40 and 50 m. from the existing shoreline. Given the relatively similar dune structure and elevation along the western and central portions of the Project shoreline, model results for Transects 1 and 2 show similar results with the final water elevation (including wave setup) not exceeding the maximum elevation of the secondary dune (in the order of 3.0 and 2.5 meters, respectively).

The areas adjacent to the River Dock (modeled by Transect 3) appear to show overall lower dune elevations and dune footprint and hence, results show that this area would be more prone to upland flooding.

The SBEACH simulation was also run for a transect that includes the latest proposed upland grading plan for the site under the same 100-year storm conditions and six-hour storm duration. Target proposed upland grade elevations vary throughout the site, but range between 3 and 4 meters MSL. The results for this simulation are shown in Figure 3.7.

Due to the fact that the proposed upland plan is currently located landward of the secondary dune, the presence of the upland infrastructure and target grade elevations would not appear to be affected by the considered design storm. If the masterplan is updated as the project progresses, an evaluation of potential impacts that dune erosion may have on the proposed upland plan would be performed.

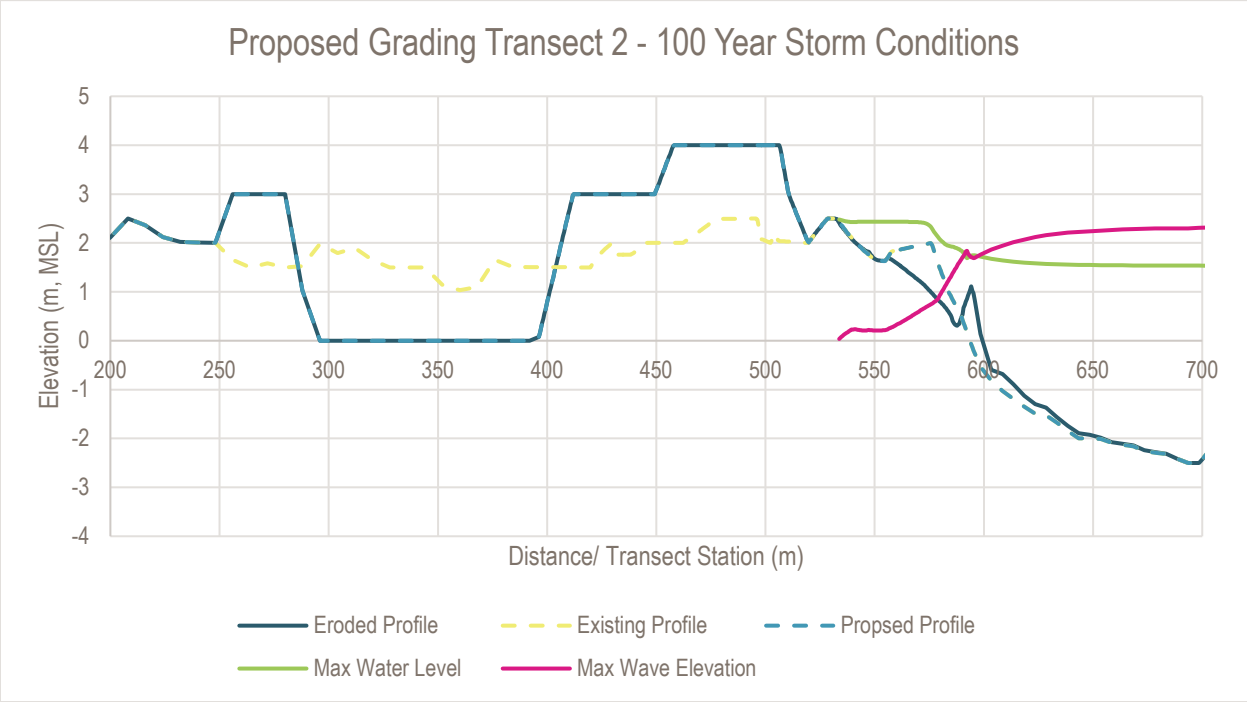

FIGURE 3.7: SBEACH RESULTS (PROPOSED CONDITIONS - TRANSECT 2).

3.4. Upland Design Recommendations for Coastal Construction

3.4.1. Introduction

The coastal vulnerability assessment aligns with FEMA guidelines for the Special Flood Hazard Areas (SFHAs). As defined by FEMA, a SFHA is an area having special flood, mudflow or flood-related erosion hazards during the design event. For U.S. territories, these areas are shown on the Flood Hazard Boundary Maps (FHBMs) or the Flood Insurance Rate Map (FIRMs). The SFHA is also the area where the National Flood Insurance Program's (NFIP's) floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies.

Although the proposed development is situated outside of U.S. territory and, therefore, not directly under FEMA's jurisdiction, the regulations and guidelines set forth by FEMA's National Flood Insurance Program (NFIP) offer valuable insight for enhancing the project's resilience to hurricane events. These guidelines are widely recognized as best practices for floodplain management and disaster preparedness, and their application can significantly strengthen the development's ability to withstand extreme weather conditions.

By incorporating NFIP standards, the project can benefit from a well-established framework for assessing flood risks, designing resilient infrastructure, and implementing effective mitigation measures. These measures include elevating structures above anticipated flood levels, providing for proper drainage, and using materials and construction techniques that minimize damage during storm surges and high winds. Additionally, following NFIP guidance helps establish a proactive approach to risk management, contributing to long-term sustainability and safety for the proposed development. While not required by law in non-U.S. jurisdictions, adopting NFIP's best practices can provide a robust foundation for reducing vulnerability and improving the resilience of the project against the impacts of hurricanes and other severe weather events.

The following sections outline design recommendations for coastal construction considering potential impacts from coastal hazards like storms and hurricanes. Additionally, assets within the proposed project may need to be designed to address other natural hazards, including upland flooding, earthquakes, and wildfires.

3.4.2. Project Flood Zones

The definition of the flood zones allows for geographical understanding of the magnitude and severity of flood hazards throughout the Project site. These flood zones are also used by FEMA to establish the NFIP construction regulatory requirements and recommendations that are further described in Section 3.

The flood zone designations that apply to coastal flood hazard areas are listed below (and summarized in Figure 3.8), in decreasing order of magnitude and severity:

- **VE Zones:** These zones, collectively referred to as Zone V, identify the Coastal High Hazard Area, which is the portion of the SFHA that extends from offshore to the inland limit of a primary frontal dune along an open coast and any other portion of the SFHA that is subject to high-velocity wave action from storms or seismic sources. The boundary of Zone V is generally based on wave heights (3 ft./ 0.91 m. or greater) or wave runup depths (3 ft./ 0.91 m. or greater). Zone V can also be mapped based on the wave overtopping rate (when waves run up and over a dune or barrier).

- **AE Zones:** These zones, collectively referred to as Zone A or AE, identify portions of the SFHA that are not within the Coastal High Hazard Area. AE Zones are used to designate both coastal and non-coastal SFHAs. Regulatory requirements of the NFIP for buildings located in Zone A are the same for both coastal and riverine flooding hazards.
- **Limit of Moderate Wave Action (LiMWA):** Zone AE in coastal areas is divided by the LiMWA. The LiMWA represents the landward limit of the 1.5-ft. (0.46 m.) wave. The area between the LiMWA and the Zone V limit is known as the Coastal A Zone for building code and standard purposes and as the Moderate Wave Action (MoWA) area by FEMA flood mappers. This area is subject to wave heights between 1.5 and 3 ft. (0.46 and 0.91 m.) during the base flood. The area between the LiMWA and the landward limit of Zone A due to coastal flooding is known as the Minimal Wave Action (MiWA) area, and is subject to wave heights less than 1.5 ft. (0.46 m.) during the base flood.
- **X Zones**: These zones identify areas outside the SFHA.

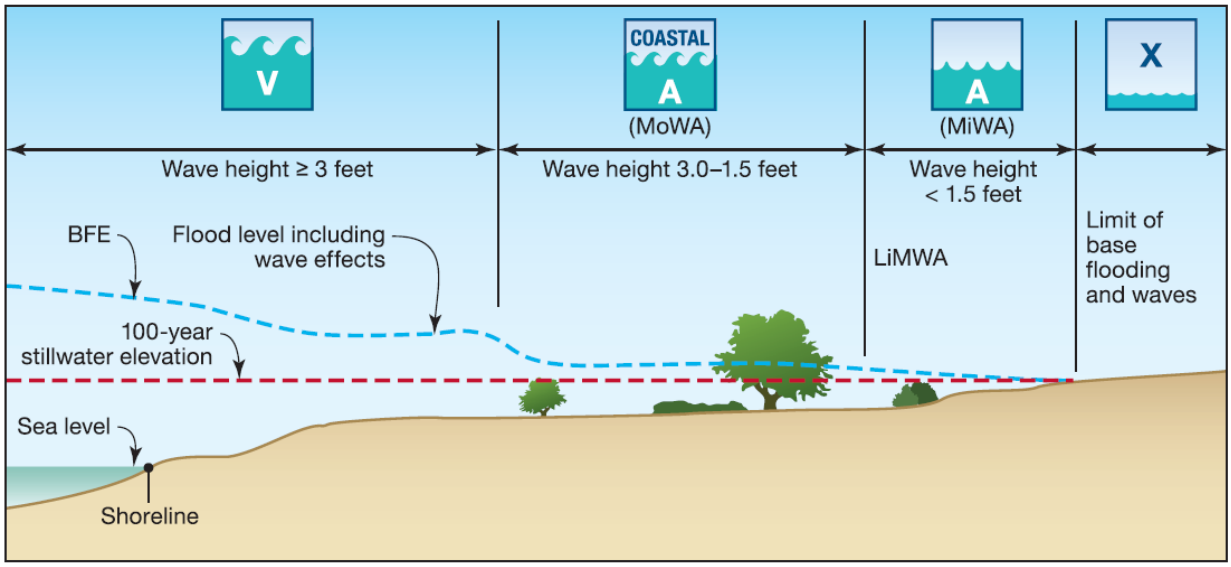

FIGURE 3.8: TYPICAL SHORELINE-PERPENDICULAR TRANSECT SHOWING STILLWATER AND WAVE CREST ELEVATIONS AND ASSOCIATED FLOOD ZONES (SOURCE: FEMA).

Based on FEMA's definitions and the results from the SBEACH runs (see Section 3.3.2), preliminary coastal flood hazard areas were identified for the site.

Results for each of the transects considered are shown in Figure 3.9 through Figure 3.11. Based on these results, flood zones in the project shoreline transition from VE Zone to AE Zone around 10 to 15 m. from the existing shoreline, and AE Zones would extend inland approximately 30 to 85 m. from the shoreline. Areas adjacent to the River Dock do not appear to have a well-established and higher dune, experiencing further inland flooding than areas located in the central and western quadrants of the project site.

Figure 3.9 through Figure 3.11 also include the values for the Base Flood Elevations (BFEs) along the considered transects (shown in blue), which will be discussed in Section 3.4.3

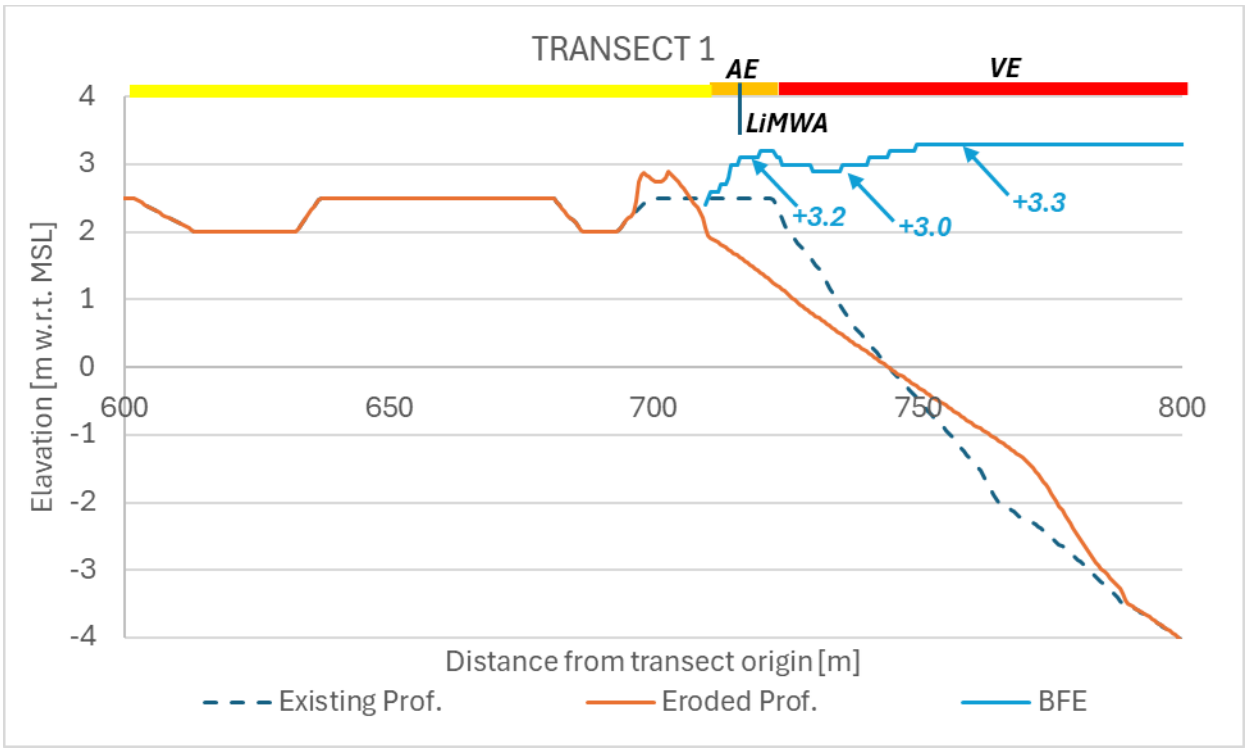

FIGURE 3.9: FLOOD ZONES AND BFES RESULTS (EXISTING CONDITIONS - TRANSECT 1).

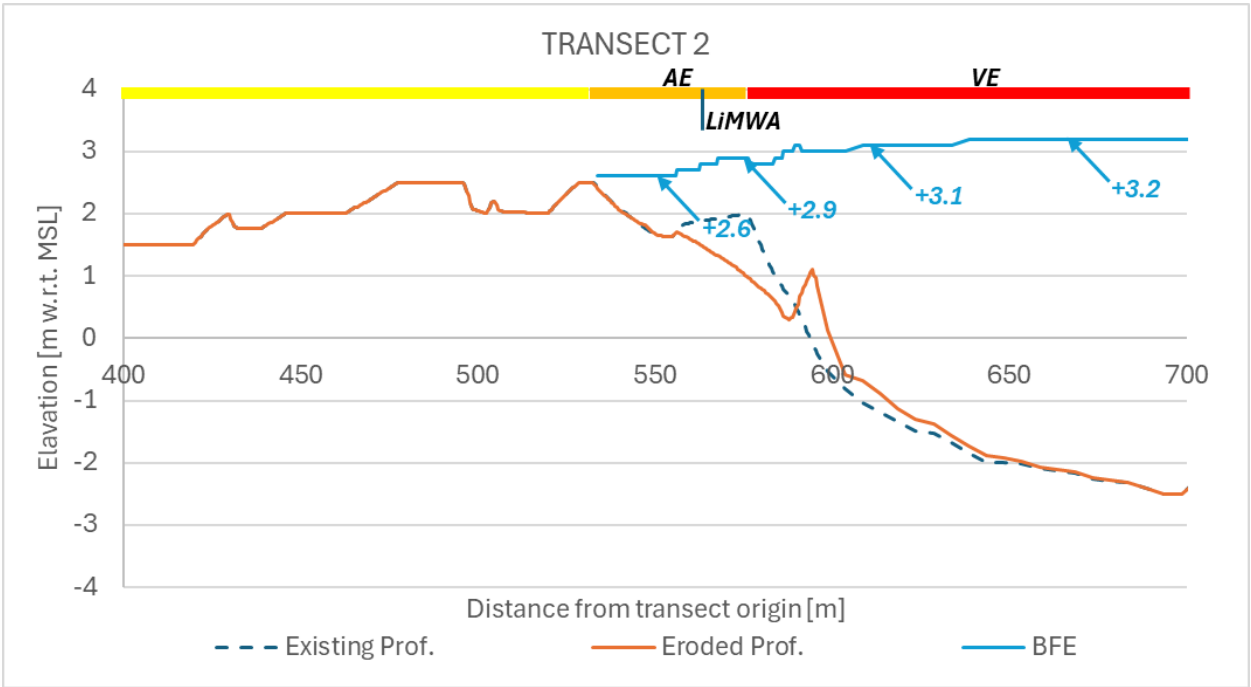

FIGURE 3.10: FLOOD ZONES AND BFES RESULTS (EXISTING CONDITIONS - TRANSECT 2).

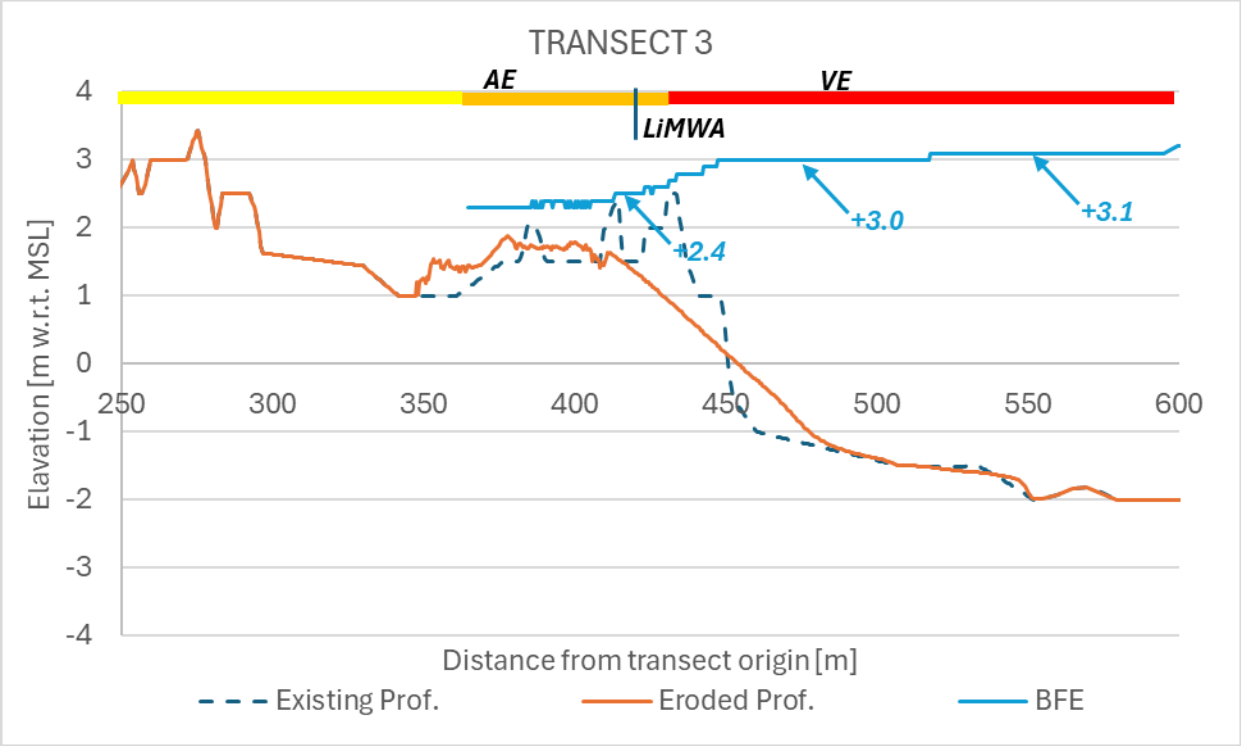

FIGURE 3.11: FLOOD ZONES AND BFES RESULTS (EXISTING CONDITIONS - TRANSECT 3).

Areas upland from the secondary dune (shown as yellow) in Figure 3.9 through Figure 3.11, are areas that are not expected to be affected by direct wave impacts, but could potentially be affected by overtopping of waves or rainfall flooding. Results for the Project site's coastal flood zones are shown in Figure 3.12.

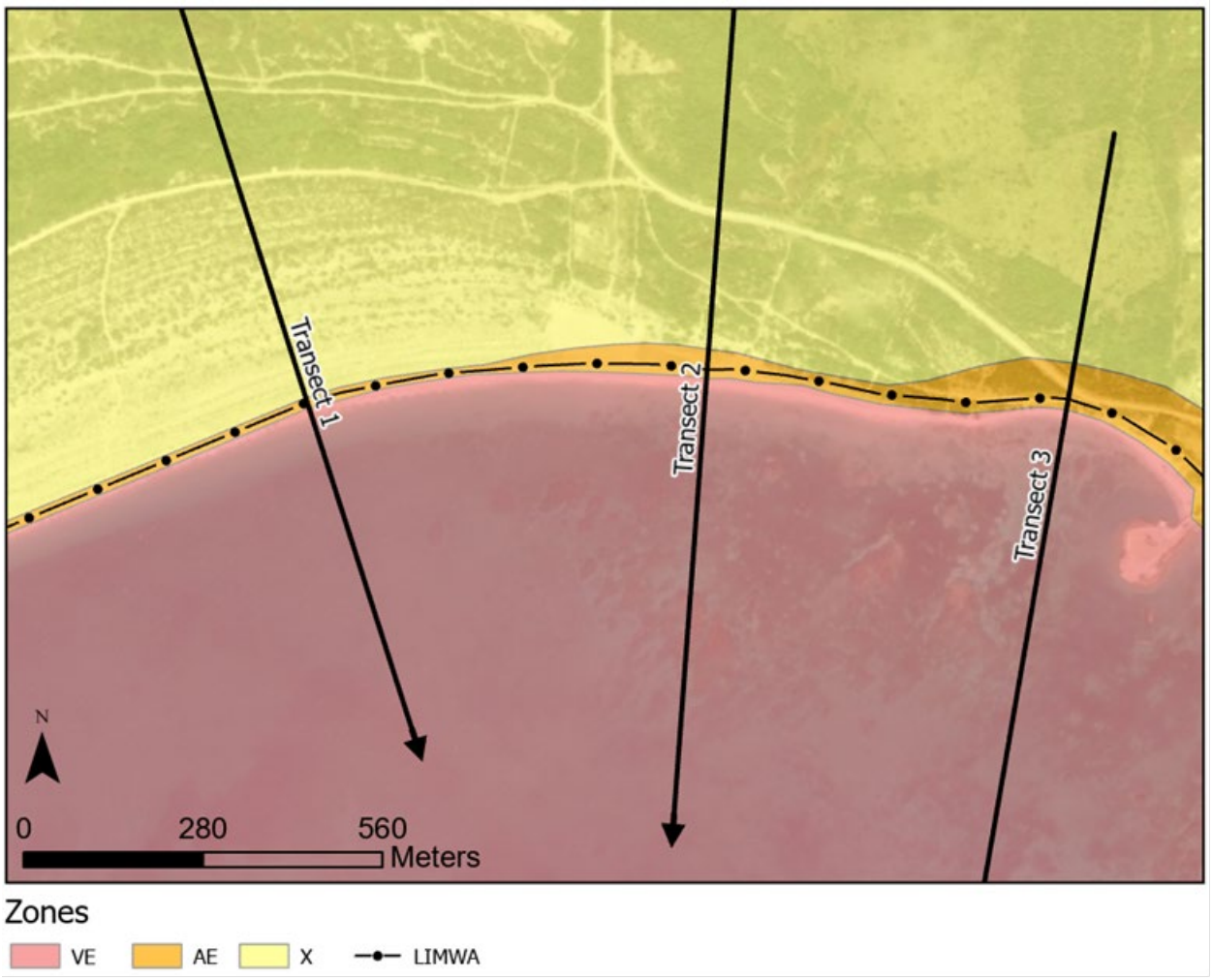

FIGURE 3.12: APPROXIMATE LOCATION OF COASTAL FLOOD ZONES THROUGHOUT THE SITE.

3.4.3. Base Flood Elevations (BFEs) and Design Flood Elevation (DFE)

FEMA primarily determines Base Flood Elevations (BFEs) and differentiates between VE Zone, AE Zone, and X Zone based on the maximum wave height. Wave height is defined as the vertical distance between the crest and trough of a wave as it moves across the water surface. In coastal areas, BFEs are typically set at the elevation of the wave crest as it moves inland.

This maximum wave height is largely influenced by the 100-year SWEL and the local ground elevation. It is important to note that in this context, ground elevation refers not to the existing ground level but to the ground level that will result from erosion expected during the base flood (as modeled and shown in the previous Section).
To determine BFEs for areas affected by coastal flooding, the design team computed the 100-year SWEL (including wave setup), and then determined the maximum 100-year wave heights.

The BFEs shown for coastal flood hazard areas on FIRMs are established not at the SWEL, but at the elevation of either the wave crest or the wave runup, whichever is greater. The greater of

the wave crest elevation or the wave runup elevation is primarily influenced by the upland topography.

Figure 3.9 through Figure 3.11 show the BFEs at different locations along the three transects considered (in light blue). BFEs throughout the site range between +3.3 to +2.4 (m. w.r.t. MSL), based on wave the results of the upland wave propagation analysis completed in Section 3.3.2.

Inadequate elevation of a building exposes its superstructure to destructive wave forces. Therefore, building designs should include freeboard, elevating the structure above the required minimum level for the lowest floor or bottom of the lowest horizontal member. FEMA considers the BFE as the elevation of the water during a 1% annual chance flood (also known as the 100-year flood), however the Design Flood Elevation (DFE) is the minimum elevation recommended to ensure that structures are built to withstand flooding risks. This elevation is calculated by considering a one- to two-feet (0.30 to 0.6 m.) freeboard between the BFE and the Bottom of Lowest Horizontal Structural Member (BLHSM), as depicted in Figure 3.13.

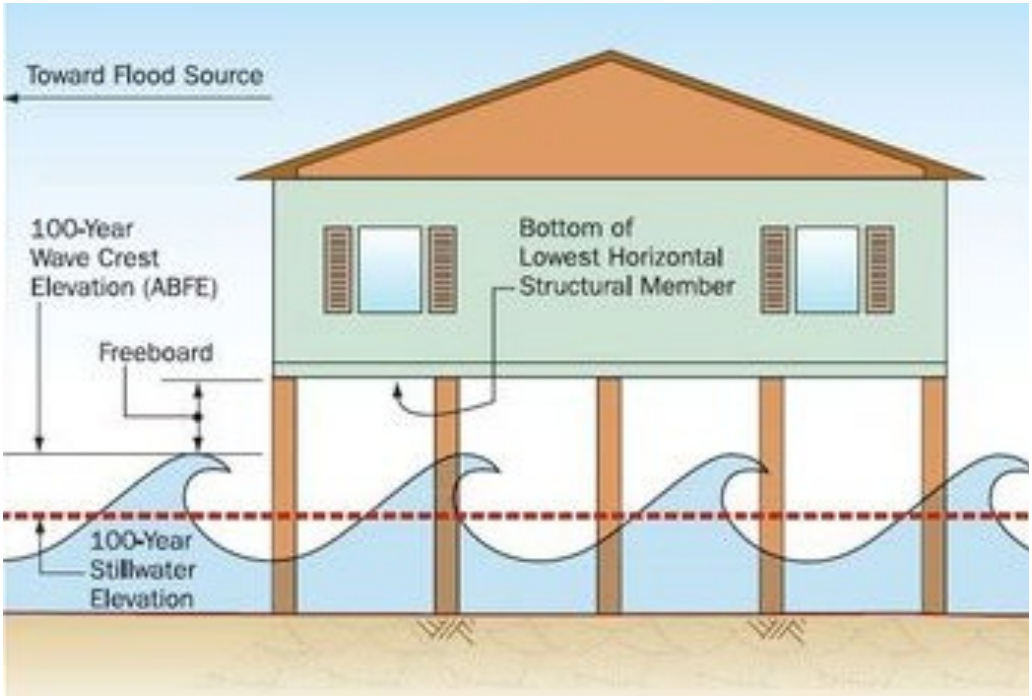

FIGURE 3.13:EXCEEDING NFIP ELEVATION REQUIREMENTS IN COASTAL A ZONES AND V ZONES (SOURCE: FEMA).

When considering the BFE results obtained for transects 1, 2 and 3, and considering a freeboard of one (1) to two (2) feet, the recommended elevation for the BLHSM would be in the order of +2.9 to +3.2 m MSL for buildings located landward of the maximum inland extent of the eroded dune.

3.4.4. Dune Erosion and Enhancements

Buildings located in areas prone to storm-induced erosion, such as low-lying regions or on the tops of erodible dunes and bluffs, are at significant risk of damage. This damage often results from the undermining of foundations and the loss of supporting soil around vertical foundation elements.

As shown by Figure 3.9 through Figure 3.11, the frontal dune would completely be eroded during the conditions expected for the design event. As a result, constructing buildings on dunes and bluffs is generally discouraged due to these risks. It is recommended limiting structures in these areas to non-habitable, ancillary and dispensable structures (boardwalks, decks, gazebos, cabanas, in-grade pools, dune crossings…). Please note that there may be restrictions on the placement of structures in this area due to zoning/setback, or other environmental requirements.

Figure 3.9 through Figure 3.11 show limited erosion to the secondary dune. However, these areas are expected to be flooded and exposed to wave action during the design event. It is not recommended to construct habitable structures in this area either, but if construction on these features is necessary, buildings must be carefully positioned away from erodible slopes and should be supported by deep, well-designed pile or column foundations to ensure stability. The structural design for these elements will need to consider local foundation scour and wave loading.

Enhancing dunes through renourishment and stabilizing them with vegetation is a highly effective method for reducing erosion and mitigating the risk of storm impacts on adjacent upland areas. These natural barriers help to absorb and deflect wave energy, preventing coastal erosion and safeguarding infrastructure, habitats, and other vital areas from storm surges and flooding. It is strongly recommended to not only enhance dunes but also to plant native dune grasses and other appropriate vegetation. These plantings help to stabilize the dunes by reinforcing the soil with their root systems, increasing the dunes' ability to resist erosion over time. In order to increase the success of dune plantings, a bio-degradable erosion control mat (made out of coconut fibers or straw) can be installed. Dune planting has also proven more successful when implementing a higher-density planting layout that incorporates various native species.

Regular and comprehensive assessments of dune health should be integrated into an ongoing beach monitoring plan, ensuring early detection of any issues such as vegetation loss, erosion, or structural weakening.

In addition, restoration and enhancement efforts should be prioritized following major storm events, as they can significantly damage or degrade dune systems. These efforts may include replanting vegetation, replenishing sand, and reinforcing the dune structure to restore its protective function and prevent further damage during future storms.

3.4.5. Foundation Design

Foundation design is a critical factor in the success and stability of coastal buildings. Foundations are divided into open or closed, and shallow or deep.

Open and closed foundations refer to the above-grade portion of the foundation. The shallow and deep descriptions refer to the below-grade portion. Foundations can be open and deep, open and shallow, or closed and shallow. Foundations can also be closed and deep, but these foundations are relatively rare and generally found only in areas where (1) soils near the surface are relatively weak (700 pounds/square foot bearing capacity or less), (2) soils near the surface contain expansive clays (also called shrink/swell soils) that shrink when dry and swell when wet, or (3) other soil conditions exist that necessitate foundations that extend into deep soil strata to provide sufficient strength to resist gravity and lateral loads.

Based on the flood zone at the location of a given building, FEMA provides guidance on the foundation style (see Table 3.4) that is recommended/not permitted. Shallow spread footings and slab foundations are not suitable for areas exposed to wave impact and erosion, as they can lead to building collapse, even during minor flooding or erosion events. Due to the potential for undermining by erosion and scour, these types of foundations may not be appropriate for coastal bluff areas outside the mapped floodplain or in certain AE Zones. In some post-hurricane assessments, foundation failure has been observed on buildings located several hundred feet from the shoreline in AE Zone, due to inadequate foundation design, highlighting the need for open foundations in AE Zones.

TABLE 3.4: FOUNDATION STYLES IN COASTAL AREAS (SOURCE: FEMA).

Foundation Style	*VE Zone*	Coastal A Zone (LiMWA)	*AE Zone*
Open/deep	Acceptable	Acceptable	Acceptable
Open/shallow	Not permitted	Acceptable*	Acceptable
Closed/shallow	Not permitted	Not recommended	Acceptable
Closed/deep	Not permitted	Not recommended	Acceptable

*Shallow foundations in Coastal A Zone are acceptable only if the maximum predicted depth of scour and erosion can be accurately predicted and foundations can be constructed to extend below that depth.

Similarly, continuous perimeter wall foundations, such as crawlspace foundations (especially when constructed with unreinforced masonry), are highly vulnerable to wave impact and erosion, which may result in severe damage, collapse, or complete loss of the building. In the case of open foundations, insufficient depth of foundation members is a common cause of failure, particularly in pile-elevated family homes.

3.4.6. Other Requirements and Recommendations for Coastal Construction

In addition to the recommendations summarized on the previous sections, additional resources and references for construction in the coastal zone are provided, such as those outlined in several of the FEMA guiding documents including:

- Coastal Construction Manual Vol. I and II (FEMA P-55).
- Home Builder's Guide to Coastal construction (FEMA P-499).
- Engineering Principles and Practices for Retrofitting Flood-Prone Residential Structures (FEMA P-259).
- Decks, Pools, and Accessory Structures (Technical Fact Sheet No. 28).
- Free-of-Obstruction Requirements (Technical Bulletin 5).
- Protecting Building Utilities from Flood Damage. (FEMA P-348).
- Foundation Requirements and Recommendations for Elevated Homes (Hurricane Sandy Recovery Fact Sheet No. 2)

Appendix A provides a high-level summary of coastal construction requirements and recommendations for coastal construction.

4. References

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7. FEMA, *Free-of-Obstruction Requirements (Technical Bulletin 5)*, 2011
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Appendix A. Summary of Coastal Construction Requirements and Recommendations

Summary of Coastal Construction Requirements and Recommendations

Purpose: *To summarize recommendations for exceeding National Flood Insurance Program (NFIP) regulatory requirements concerning coastal construction.*

Key Issues

- *New construction** in coastal flood hazard areas (V Zone and A Zone) should be designed using the engineering standards (ASCE 24 and ASCE 7) or the International Residential Code (IRC), as applicable. Best practices must exceed the minimum NFIP requirements and must meet, or exceed, all community zoning and building code requirements. *Repairs, remodeling, and additions* must always meet NFIP and building code requirements for the part of the structure impacted. Should these costs exceed 50 percent of the fair market value of the structure, the entire building must be brought to local floodplain management and building code compliance.

- Engineering standards ASCE 24-05 and ASCE 7-10 are *more stringent in V Zones than in A Zones*, to protect against the increased flood, wave, flood-borne debris, and erosion hazards typical of V Zones.

- ***For added protection, it is strongly recommended that buildings in flood zones that are subject to breaking waves between 1.5 and 3 feet as well as erosion and scour be designed and constructed to V Zone standards.*** These coastal areas, mapped as A Zones, may be subject to damaging waves and erosion and are often referred to as "Coastal A Zones." Buildings in these areas are typically constructed to the minimum NFIP A Zone requirements and have at least a 1-percent-annual-chance of sustaining major damage or being destroyed. This regulatory standard is known as the *base flood*.

- Buildings constructed to minimum NFIP A Zone standards and subject solely to shallow flooding (i.e., not subject to breaking waves greater than 1.5 feet or erosion) are still subject to flood damage and should be built with a first floor elevation above the BFE (usually at least one foot or greater), which is referred to as "freeboard."

- Following the recommendations in the following table will result in less damage to the building and may reduce flood insurance premiums (see the V Zone Risk Factor Rating Form in FEMA's *Flood Insurance Manual* (http://www.fema.gov/nfip/manual.shtm).

* For floodplain management purposes, ***new construction*** refers to structures for which construction began on or after the effective date of adoption of the community's floodplain management ordinance. Substantial improvements, repairs of substantially damaged buildings, and some enclosures must meet the same floodplain management ordinance and building code requirements as new construction where such ordinances and codes have been adopted by the community.

The following table summarizes NFIP regulatory requirements and recommendations for exceeding those requirements for both (1) new construction and (2) repairs, remodeling, and additions.

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Foundation				
Structural Fill **NFIP 60.3(e)(6)**	**Prohibited**	**Requirement:** Compaction where used; protect against scour and erosion.	**Requirement:** Compaction where used; protect against scour and erosion.	**IBC:** 1804.4, App. G 401.1, App. G 401.2 **IRC:** R322.3.2 **ASCE:** ASCE 24 Sec. 2.4 **Other:** FEMA TB #5
Solid Foundation Walls [see Fact Sheet Nos. 3.1, 3.5] **NFIP 60.3(c)(3)**	**Prohibited**	**Requirement:** Flood vents must be installed to equalize pressures (see Fact Sheets Nos. 3.5 and 8.1). **Recommendation:** An open foundation system should be used.	**Requirement:** Where used, the walls must allow floodwaters to pass between or through the walls using flood openings (see Fact Sheets Nos. 3.5 and 8.1).	**IBC:** 1612.5.1 **IRC:** R322.2.3 **ASCE:** ASCE 24 Sec. 2.5, ASCE 7 Sec. 5.4.4.2 **Other:** FEMA TB #5, FEMA 550
Open Foundation [see Fact Sheet No. 3.1] **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Recommendation:** Site new construction landward of the long-term erosion setback and landward of the area subject to erosion during the 1% coastal flood event. **Requirement:** All new construction shall be landward of the reach of the mean high tide; alteration of sand dunes and mangrove stands that increases the potential of flood damage is prohibited.	**Recommendation:** Open foundations are recommended in Coastal A Zones.	**Recommendation:** Open foundations are recommended in A Zones.	**IBC:** 1803.5.5 **IRC:** R322.3.3 **ASCE:** ASCE 7 Sec. 5.4.4.1, ASCE 24 Sec 4.5.5 **Other:** FEMA TB #5
Lowest Floor Elevation (not in a V Zone) [see Fact Sheet No. 1.5] **NFIP 60.3(c)**	**Not Applicable**	**Recommendation:** Elevate the bottom of the lowest horizontal structural member at, or above, BFE. **Requirement:** Top of floor must be at or above BFE.	**Requirement:** Top of floor must be at or above BFE.	**IBC:** 1603.1.7, 1612.5 **IRC:** R105.3.1.1, R322.2.1, R322.1.5 **ASCE:** ASCE 24 Sec. 1.5.2, ASCE 24 Sec. 2.5, ASCE 24 Ch. 5, ASCE 24 Ch. 7 **Other:** FEMA TB #5
Bottom Lowest Horizontal Structural Member [see Fact Sheet No. 1.4] **NFIP 60.3(e)(4)**	**Requirement:** Bottom of the lowest horizontal structural member of the first floor must be at, or above, the BFE (see Fact Sheet No. 1.5).	**Recommendation:** Follow the V Zone building elevation requirement.	**Recommendation:** The minimum recommendation is to follow the Coastal A Zone requirements. Users should consider following V Zone recommendations for the lowest horizontal structural member elevation to further minimize the risk of flood damage.	**IBC:** 1603.1.7, 1605.2.2, 1605.3.1.2, 1612.4, 1612.5.2 **IRC:** R322.3.2 **ASCE:** ASCE 24 Sec. 4.4, ASCE 24 Sec. 2.5, ASCE 24 Ch. 5 **Other:** FEMA 55, FEMA TB #8, FEMA TB #5

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Foundation				
Orientation of Lowest Horizontal Structural Member	**Requirement:** Elevate the bottom of the lowest horizontal structural member at, or above, BFE.	**Recommendation:** If the orientation of the lowest horizontal structural member is parallel to the expected direction of waves, elevate the bottom of the member to or above BFE; If the orientation of the lowest horizontal structural member is perpendicular to the expected direction of waves, elevate the bottom of the member to BFE plus one foot. Diagonal bracing for decks, stairways, balconies and other attached structures should also be elevated at, or above, the BFE.	**Recommendation:** Follow the Coastal A Zone recommendation.	**IBC:** see ASCE 24 **IRC:** R322.3.2 **ASCE:** ASCE 24 Sec 4.4 **Other:** FEMA TB #5
Freeboard [see Fact Sheet Nos. 1.1, 1.4]	**Requirement:** No NFIP requirement, but freeboard is required by IRC and ASCE.	**Recommendation:** Freeboard is recommended in Coastal A Zones. **Note:** Per ASCE 24-05 one foot of freeboard required for Risk Category II structures.	**Recommendation:** Freeboard is recommended in A Zones. **Note:** One foot above BFE is required per IRC R322.2.1 Item #2 for Coastal A Zones.	**IBC:** see ASCE 24 **IRC:** R322.2.1, R322.3.2 **ASCE:** ASCE 24 Sec. 2.3
Enclosures Below the BFE (not in a V Zone)	**Not Applicable**	**Recommendation:** If an enclosure is constructed, use breakaway walls, open lattice, or screening (as required in V Zones). **Requirement:** If an area is fully enclosed, the enclosure walls must be equipped with openings to equalize hydrostatic pressure; the size, location, and covering of openings governed by regulatory requirements.	**Recommendation:** If an enclosure is constructed, use breakaway walls, open lattice, or screening (as required in V Zones). **Requirement:** If an area is fully enclosed, the enclosure walls must be equipped with openings to equalize hydrostatic pressure; the size, location, and covering of openings governed by regulatory requirements.	**IBC:** 1203.3.2, 1403.5, 1612.4, 1612.5.1 **IRC:** R322.2.2, R408.7 **ASCE:** ASCE 24 Sec. 2.6, ASCE 24 Sec 4.6 **Other:** FEMA TB #1
Enclosures Below the BFE (not in V Zones) [see Fact Sheet No. 8.1] NFIP 60.3(c)(5)	**Prohibited,** except for breakaway walls, open wood lattice, and screening.	**Not Applicable**	**Not Applicable**	**IBC:** 1403.5, 1403.6, 1612.4, 1612.5.2 **IRC:** R322.3.2, R322.3.4, R322.3.5 **ASCE:** ASCE 24 Sec. 4.6, ASCE 7 Sec. C5.3.3 **Other:** FEMA 55, FEMA TB #5, FEMA TB #9

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Foundation				
Non Structural Fill	**Requirement:** Allowed for minor landscaping and site drainage as long as the fill does not interfere with free passage of flood waters and debris beneath the building, or cause changes in flow direction during coastal storms that could result in damage to buildings.	**Recommendation:** Follow the V Zone fill requirement.	**Recommendation:** Follow the V Zone fill requirement.	**IBC:** 803.11.1 **IRC:** R322.14.2, R322.3.2 **ASCE:** ASCE 24 Sec 1.5.4, 45.4 **Other:** FEMA TB #5
Use of Space Below BFE [see Fact Sheet No. 8.1]	**Requirement:** Allowed only for parking, building access, and storage	**Requirement:** Allowed only for parking, building access, and storage	**Requirement:** Allowed only for parking, building access, and storage	**IBC:** 1107.7.5, G105.7 (5), 801.5, G103.5, G103.8 **IRC:** R309.3, R322.1, R322.1.2, R322.1.3, R322.1.4, R322.1.4.1, R322.2.1, R322.2.2, R322.3.2, R322.3.5 **ASCE:** ASCE 24 1.5.2, 2.6, 2.6.1, 2.6.2.1, 2.6.2.2, 4.6, 4.6.1, 4.6.2
Utilities				
Sanitary Sewer NFIP 60.3(a)(6)(i) and 60.3(a)(6)(ii)				**IBC:** 1403.6, App. G 401.3 **IRC:** R322.1.7, R P2602.2, R P3001.3, R P3101.5 **ASCE:** ASCE 24 Sec. 7.3.4 **Other:** FEMA 348, FEMA TB #4
Utilities [see Fact Sheet No. 8.3] NFIP 60.3(a)(3)(iv)	**Requirement:** Must be designed, located, and elevated to prevent flood waters from entering and accumulating in components during flooding. Utility lines must not be installed or stubbed out in enclosures below BFE unless flood proofed to the extent practicable.	**Requirement:** Electrical, heating, ventilation, plumbing, and air-conditioning equipment and other service facilities to be designed and/or located as to prevent water from entering or accumulating within the components during periods of flooding. **Recommendation:** Follow the V Zone utility recommendation	**Requirement:** Electrical, heating, ventilation, plumbing, and air-conditioning equipment and other service facilities to be designed and/or located as to prevent water from entering or accumulating within the components during periods of flooding.	**IBC:** 1403.6, 1612.4, App. G 701 **IRC:** R322.1.6, IFGC 301.11, R G2404.7, R P2601.3, R P2602.2, R M1301.1.1, R M1401.5, R M1601.4.9, R M1701.2, R M2001.4, R M2201.6 **ASCE:** ASCE 24 Ch. 7 **Other:** FEMA 348, FEMA TB #4
Certification				
Permits NFIP 60.3(b)(1)	**Requirement:** V Zone certificate, Breakaway Wall certificate, and Elevation Certificate.	**Requirement:** Elevation Certificate.	**Requirement:** Elevation Certificate.	**IBC:** App. G 101.3, App. G 103, App. G 104 **IRC:** R104.2, R105, App. E, App. J **ASCE:** ASCE 24 Sec. 4.6, ASCE 7 Sec. C5.3.3 **Other:** FEMA EMI IS-9

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Certification				
Elevation **NFIP 60.3(b)(5)(i) and 60.3(e)(2)**	**Requirement:** The lowest horizontal structural member must be at, or above, BFE; electrical, heating, ventilation, plumbing, and air-conditioning equipment and other service facilities (including ductwork) must be designed and/or located so as to prevent water from entering or accumulating within the components during flooding (see Fact Sheet Nos. 1.4,1.5, 8.3)	**Recommendation:** Follow the V Zone building elevation requirement. **Requirement:** Top of lowest floor must be at, or above, BFE; electrical heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork) must be designed and/or located so as to prevent water from entering or accumulating within the components during flooding (see Fact Sheet Nos. 1.4 8.3)	**Recommendation:** The minimum recommendation is to follow the Coastal A Zone requirements. Users should consider following V Zone recommendations for the lowest horizontal structural member elevation to further minimize the risk of flood damage. **Requirement:** Top of the lowest floor must be at, or above, BFE; electrical heating, ventilation, plumbing, and air conditioning equipment and other service facilities (including ductwork) must be designed and/or located so as to prevent water from entering or accumulating within the components during flooding (see Fact Sheet Nos. 1.4, 8.3)	**IBC:** 110.3.3,1603.1.7, 1612.5 **IRC:** R106.1.3, R322.1.2, R322.1.5, R322.2.1 **ASCE:** ASCE 24 Sec. 1.5.1, 1.5.2, 4.4
Structure	**Requirement:** Registered engineer or architect must certify that the design and methods of construction are in accordance with an accepted standard of practice for meeting design requirements described under General Requirement (see Fact Sheet No. 1.5)	**Recommendation:** Follow the V Zone requirement.	**Recommendation:** Follow the V Zone requirement.	**IBC:** 1604.1,1604.2, 1604.3 **IRC:** R301.1, R301.1.3,R301.2 **ASCE:** ASCE 7 Sec. 1.3.1.3.3

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Certification				
Breakaway Walls [see Fact Sheet Nos. 1.5, 8.1] (also see Enclosures Below BFE) **NFIP 60.3(e)(5)**	**Requirement:** Walls must be designed to break free under larger of the following allowable stress design loads: (1) design wind load, (2) design seismic load, or (3) 10 psf, acting perpendicular to the plane of the wall; if loading intended to cause collapse exceeds 20 psf using allowable stress design, the breakaway wall design shall be certified; when certification is required, a registered engineer or architect must certify that the walls will collapse under a water load associated with the Base Flood and that the elevated portion of the building and its foundation will not be subject to collapse, displacement, or lateral movement under simultaneous wind and water loads.	**Recommendation:** Breakaway walls are recommended with an open foundation in lieu of solid walls; if breakaway walls are used and enclose an area, flood openings are required (see Fact Sheet Nos. 3.1, 3.5).		**IBC:** 1612.5 (2.3) **IRC:** R322.3.4 **ASCE:** ASCE 24 Sec. 4.6.1, 4.6.2, 2.6.1.1, ASCE 7 Sec. 5.3.3 **Other:** FEMA TB #5, FEMA TB #9
Openings in Below-BFE Walls [see Fact Sheet Nos. 3.1, 3.5] (also see Enclosures Below BFE) **NFIP 60.3(c)(5)**	**Not Applicable**	**Requirement:** Unless the number and size of the openings meet regulatory requirements, a registered engineer or architect must certify that the openings are designed to automatically equalize hydrostatic forces on the walls by allowing automatic entry and exit of flood waters.	**Requirement:** Unless the number and size of the openings meet regulatory requirements, a registered engineer or architect must certify that the openings are designed to automatically equalize hydrostatic forces on the walls by allowing automatic entry and exit of flood waters.	**IBC:** 1203.4.12, G1001.4 **IRC:** R322.2.2 **ASCE:** ASCE 24 Sec. 2.6.1, 2.6.2.1, 2.6.2.2 **Other:** FEMA TB #1
Repairs, Remodeling, and Additions [See Fact Sheet No. 9.1]				
Substantial Improvements and Repairs of Substantial Damage **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Requirement:** Must meet current NFIP requirements concerning new construction in V Zones except for siting landward of mean high tide (see Fact Sheet Nos. 1.4, 1.5, 2.2, 3.1, 3.5, 8.1, 8.3).	**Recommendation:** Follow the V Zone requirement for building elevation and open foundations. **Requirement:** Must meet current NFIP requirements concerning new construction in A Zones (see Fact Sheet Nos. 1.4, 3.1, 3.5, 8.1, 8.3).	**Recommendation:** Elevate bottom of lowest horizontal structural member to or above BFE. **Requirement:** Must meet current NFIP requirements concerning new construction in A Zones (see Fact Sheet Nos. 1.1, 3.1, 3.5, 8.1, 8.3)	**IBC:** 1612.1, 1612.2, 3403.2, 3404.2, 3405.2, 3405.3, 3405.4 **IRC:** R322.1.6, R322.3.1 **ASCE:** ASCE 24 Sec. 4.3, ASCE 7 Sec. 1.6 **Other:** FEMA P-758

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Repairs, Remodeling, and Additions [See Fact Sheet No. 9.1]				
Lateral Additions That Constitute Substantial Improvement **NFIP 60.3(e)(5)**	**Requirement:** Both the addition and the existing building must meet current NFIP requirements concerning new construction in V Zones (see Fact Sheet Nos. 1.4, 1.5, 2.2, 3.1, 3.5, 8.1, 8.3).	**Recommendation:** Follow V Zone requirement for building elevation and open foundations for the addition and the existing building. **Requirement:** Only additions must meet current NFIP requirements concerning new construction in A Zones (see Fact Sheet Nos. 1.4, 1.5, 3.1, 3.5, 8.1, 8.3), provided the existing building is not subject to any work other than cutting an entrance in a common wall and connecting the existing building to the addition; if any other work is done to the existing building it too must meet current NFIP requirements for new construction in A Zones.	**Recommendation:** Elevate bottom of lowest structural member of the addition to or above BFE (same for the existing building if it is elevated). **Requirement:** Only additions must meet current NFIP requirements concerning new construction in A Zones (see Fact Sheet Nos. 1.4, 2.2, 3.1, 3.5, 8.1, 8.3), provided the existing building is not subject to any work other than cutting an entrance in a common wall and connecting the existing building to the addition; if any other work is done to the existing building it too must meet current NFIP requirements for new construction in A Zones.	**IBC:** 3403.2, 3412.2.3, 3405.3 **IRC:** R322.3.1 **ASCE:** ASCE 7 Sec. 1.6 **Other:** FEMA TB #1, FEMA TB #5, FEMA TB #9, FEMA 550
Lateral Additions That Do Not Constitute Substantial Improvement **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Recommendation:** Make addition compliant with current NFIP requirements for V Zone construction. **Requirements:** Post-FIRM existing building – the addition must meet NFIP requirements in effect at time the building was originally constructed. Pre-FIRM existing building – NFIP requirements concerning new construction are not triggered (see Fact Sheet Nos. 1d, 1e, 2b, 3a, 3e, 8a, 8c)	**Recommendation:** Follow V Zone requirement for building elevation and open foundations for the addition and the existing building. **Requirements:** Post-FIRM existing building – the addition must meet NFIP requirements in effect at the time the building was originally constructed (see Fact Sheet Nos. 1d, 1e, 2b, 3a, 3e, 8a, 8c). Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered.	**Recommendation:** Elevate bottom of lowest horizontal structural member to or above BFE (same for existing building if it is elevated) (see Fact Sheet No. 1d) **Requirements:** Post-FIRM existing building – the addition must meet NFIP requirements in effect at the time the building was originally constructed (see Fact Sheet Nos. 1d, 1e, 2b, 3a, 3e, 8a, 8c). Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered.	**BC:** 3403.2, 3412.2.3, 3405.3 **IRC:** R322.3.1 **ASCE:** ASCE 7 Sec. 1.6 **Other:** FEMA TB #1, FEMA TB #5, FEMA TB #9, FEMA 550

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Repairs, Remodeling, and Additions [See Fact Sheet No. 9.1]				
Vertical Additions That Constitute Substantial Improvement **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Requirement:** Entire building must meet current NFIP requirements concerning new construction in V Zones (see Fact Sheet Nos. 1d, 1e, 2b, 3a, 3e, 8a, 8c).	**Recommendation:** Follow V Zone requirements for building elevation and open foundations. **Requirement:** Entire building must meet current NFIP requirements concerning new construction in A Zones (see Fact Sheet Nos. 1d, 1e, 2b, 3a, 3e, 8a, 8c).	**Recommendation:** Elevate bottom of lowest horizontal structural member to or above BFE (same for existing building if it is elevated) (see Fact Sheet No. 1d). **Requirements:** Post-FIRM existing building – the addition must meet NFIP requirements in effect at the time the building was originally constructed (see Fact Sheet Nos. 1d, 1e, 2b, 3a, 3e, 8a, 8c). Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered.	**IBC:** 3405.3.1, 3405.4, 3405.5 **IRC:** N/A **ASCE:** N/A
Vertical Additions That Do Not Constitute Substantial Improvement **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Recommendation:** Make the addition compliant with current NFIP requirements for V Zone construction. **Requirements:** Post-FIRM existing building – the addition must meet NFIP requirements in effect at the time the building was originally constructed. Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered (see Fact Sheet Nos. 1.4, 1.5, 2.2, 3.1, 3.5, 8.1, 8.3).	**Recommendation:** Follow the V Zone requirement for building elevation and open foundations for the existing building. **Requirements:** Post-FIRM existing building – the addition must meet NFIP requirements in effect at the time the building was originally constructed (see Fact Sheet Nos. 1.4, 1.5, 2.2, 3.1, 3.5, 8.1, 8.3). Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered.	**Recommendation:** Elevate bottom of lowest horizontal structural member at, or above, BFE (same for the existing building if it is elevated) (see Fact Sheet No. 1.4). **Requirements:** Post-FIRM existing building – the addition must meet NFIP requirements in effect at the time the building was originally constructed (see Fact Sheet Nos. 1.4, 1.5, 2.2, 3.1, 3.5, 8.1, 8.3). Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered.	**IBC:** 3405.3.1, 3405.4, 3405.5 **IRC:** N/A **ASCE:** N/A

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Repairs, Remodeling, and Additions [See Fact Sheet No. 9.1]				
Elevating on New Foundation **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Requirement:** New foundation must meet current NFIP requirements concerning new construction in V Zones; the building must be properly connected and anchored to the new foundation. **Note:** Repairing a foundation that does not constitute a substantial improvement does not require current compliance, but compliance to the year of construction.	**Recommendation:** Follow the V Zone requirement for building elevation and open foundations. **Requirement:** New foundation must meet current NFIP requirements concerning new construction in A Zones; the building must be properly connected and anchored to the new foundation.	**Recommendation:** Elevated bottom of lowest horizontal structural member to or above BFE (see Fact Sheet No. 1d). **Requirement:** New foundation must meet current NFIP requirements concerning new construction in A Zones; the building must be properly connected and anchored to the new foundation.	**IBC:** 1808.1, 1808.2, 1808.3, 1808.6, 1808.6.1 **IRC:** R401.1, R401.2, R401.3, R401.4, R401.4.1 **ASCE:** ASCE 24 Sec. 1.5.3, 1.5.3.1, 1.5.3.2, 1.5.3.3, ASCE 7 Sec. 1.6 **Other:** FEMA 550, FEMA TB #1, FEMA TB #5
Enclosures Below Buildings–When Enclosure Constitutes a Substantial Improvement **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Requirement:** Both the enclosure and the existing building must meet current NFIP requirements for new construction in V Zones (see Fact Sheets Nos. 1.4, 1.5, 2.2, 3.1, 8.1, 8.3).	**Recommendation:** Follow the V Zone requirement for building elevation and open foundations. **Requirement:** Both the enclosure and the existing building must meet current NFIP requirements for new construction in A Zones (see Fact Sheets Nos. 1.4, 1.5, 2.2, 3.1, 8.1, 8.3).	**Recommendation:** Elevated bottom of lowest horizontal structural member at, or above, BFE (see Fact Sheet No. 1.4). **Requirement:** Both the enclosure and the existing building must meet current NFIP requirements for new construction in A Zones (see Fact Sheets Nos. 1.4, 1.5, 2.2, 3.1, 8.1, 8.3).	**IBC:** 1612.1, 3404.2 **IRC:** R322.1, R322.1.8, R322.3.5 **ASCE:** ASCE 24 Sec. 4.6, ASCE 7 Sec. 1.6 **Other:** FEMA TB #5, FEMA TB #9
Enclosures Below Buildings–When Enclosure Does Not Constitutes a Substantial Improvement **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Recommendation:** Make the enclosure compliant with current NFIP requirements for new V Zone construction. **Requirement:** Post-FIRM existing building – the enclosure must meet NFIP requirements in effect at the time the building was originally constructed. Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered (see Fact Sheet No. 8.1).	**Recommendation:** Construct only breakaway enclosures; install flood openings in the enclosure; do not convert the enclosed space to habitable use. **Requirement:** Post-FIRM existing building -- the enclosure must meet NFIP requirements in effect at the time the building was originally constructed. Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered (see Fact Sheet Nos. 3.5, 8.1).	**Recommendation:** Install flood openings in the enclosure; do not convert the enclosed space to habitable use. **Requirement:** Post-FIRM existing building – the enclosure must meet NFIP requirements in effect at the time the building was originally constructed. Pre-FIRM existing building -- NFIP requirements concerning new construction are not triggered (see Fact Sheet Nos. 3.5, 8.1).	**IBC:** 1612.1, 3404.2 **IRC:** N/A **ASCE:** ASCE 24 Sec. 4.6 **Other:** FEMA TB #1, FEMA TB #5, FEMA TB #9

	Coastal Construction Requirements and Recommendations			
	V Zone 	Coastal A Zone 	A Zone 	Additional Resources
Repairs, Remodeling, and Additions [See Fact Sheet No. 9.1]				
Reconstruction of Destroyed or Razed Building **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Requirement:** Where the entire building is destroyed, damaged, or purposefully demolished or razed, the replacement building must meet current NFIP requirements concerning new construction in V Zones, even if it is built on the foundation from the original building (see Fact Sheet Nos. 1.4, 1.5, 9.1).	**Recommendation:** Follow the V Zone requirement for building elevation and open foundations. **Requirement:** Where the entire building is destroyed, damaged, or purposefully demolished or razed, the replacement building must meet current NFIP requirements concerning new construction in A Zones, even if it is built on the foundation from the original building (see Fact Sheet Nos. 1.4, 9.1).	**Requirement:** Where the entire building is destroyed, damaged, or purposefully demolished or razed, the replacement building must meet current NFIP requirements concerning new construction in A Zones, even if it is built on the foundation from the original building (see Fact Sheet Nos. 1.4, 9.1).	**IBC:** 1810.1.2, 105.1, K103.1 **IRC:** R105.1, AJ501.3, AJ501.4, AJ501.5.1, AJ501.5, AJ501.5.1, AJ501.5.2, AJ501.5.3, AJ501.5.3.1, AJ501.5.3.2, AJ501.5.3.3, AJ501.5.3.4 AJ501.5.3.5, AJ501.6, AJ501.7, AJ501.8, AJ501.8.1, AJ501.8.2, AJ501.8.3 **ASCE:** N/A **Other:** FEMA 550
Moving Existing Building **NFIP 60.3(e)(5) and 60.3(c)(5)**	**Requirement:** Where the existing building is moved to new location or site, the relocated building must meet current NFIP requirements concerning construction in V Zones (see Fact Sheet Nos. 1.4, 1.5, 9.1).	**Recommendation:** Follow the V Zone requirement for building elevation and open foundations. **Requirement:** Where the existing building is moved to new location or site, the relocated building must meet current NFIP requirements concerning construction in A Zones (see Fact Sheet Nos. 1.4, 9.1).	**Recommendation:** Elevate bottom of lowest horizontal structural member at, or above, BFE (see Fact Sheet No. 1.4). **Requirement:** Where the existing building is moved to new location or site, the relocated building must meet current NFIP requirements concerning construction in A Zones (see Fact Sheet Nos. 1.4, 9.1).	**IBC:** 3410.1 **IRC:** AE102.6 **ASCE:** ASCE 7 Sec. 1.6 **Other:** FEMA 550
Manufactured Housing				
General				**IRC:** R322.1.9, App. AE101 **ASCE:** Not Applicable **Other:** FEMA 85