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July 10, 2025

Ms. Rocio Medina Bolivar
Authorised Representative
Inter-American Development Bank
1300 New York Avenue, N.W,
Washington, D.C. 20577

Dear Ms. Bolivar,

Disclosable versions of the ESA/ESMP and Stakeholder Engagement Plan for the Strengthening Marine Ecosystem Resilience by Enhancing Wastewater Infrastructure in Caye Caulker (BL-L1051) Program

Environmental Solutions Ltd. (ESL) is pleased to submit the Disclosable Version of the Environmental and Social Assessment (ESA), Environmental and Social Management Plan (ESMP) and Stakeholder Engagement Plan for the captioned project.

We look forward to your review and approval.

Sincerely,

ENVIRONMENTAL SOLUTIONS LIMITED

Annmarie Goulbourne, MSc.
Manager, Environmental Management Services

ENVIRONMENTAL AND SOCIAL ASSESSMENT, ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN, AND STAKEHOLDER ENGAGEMENT PLAN

Strengthening Marine Ecosystem Resilience by Enhancing Wastewater Infrastructure in Caye Caulker (BL-L1051) Program

PREPARED BY
ENVIRONMENTAL SOLUTIONS LIMITED

PREPARED FOR
BELIZE WATER SERVICES LIMITED (BWS)

PROPRIETARY RESTRICTION NOTICE

STATEMENT OF CONFIDENTIALITY

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ACRONYMS AND ABBREVIATIONS

AMSL	Above Mean Sea Level
BAPDA	Belize Assembly for Persons with Diverse Abilities
BBNJ	Marine Biological Diversity of Areas beyond National Jurisdiction
BPD	Belize Police Department
BSWaMa	Belize Solid Waste Management Authority
BWS	Belize Water Services Limited
CCGES	Caye Caulker Group for Environmental Sustainability
CLO	Community Liaison Officer
CoC	Code of Conduct
CZMAI	Coastal Zone Management Authority and Institute
DCCRC	Disaster and Climate Change Risk Classification
DAI	Direct Area of Influence
DOE	Department of the Environment
DRM	Disaster Risk Management
EA	Executing Agency
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
ENSO	El Niño Southern Oscillation
ESA	Environmental and Social Assessment
ESPF	Environmental and Social Policy Framework
ESPS	Environmental and Social Performance Standards
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
FOG	Fat, Oil and Grease
GBV	Gender Based Violence
GCM	Global Climate Model

GHG	Greenhouse Gas
GIS	Geographic Information Systems
GRM	Grievance Redress Mechanism
IAI	Indirect Area of Influence
IDB	Inter-American Development Bank
ILO	International Labour Organization
IPCC	Intergovernmental Panel on Climate Change
KPIs	Key Performance Indicators
LiDAR	Light Detection and Ranging
MABR	Membrane Aerated Biofilm Reactor
M&E	Monitoring and Evaluation
MIS	Management Information Systems
MoECST	Ministry of Education, Science and Technology
NBSAP	National Biodiversity Strategy and Action Plan
NDCs	Nationally Determined Contributions
NEMO	National Emergency Management Organisation
NGO	Non-Government Organization
NOAA	National Oceanic and Atmospheric Administration
OSH	Occupational Safety and Health
PPE	Personal Protective Equipment
PIU	Project Implementation Unit
RCM	Regional Climate Model
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SDGs	Sustainable Development Goals
SEAH	Sexual Exploitation, Abuse, and Harassment
SGBV	Sexual and Gender-Based Violence
SEP	Stakeholder Engagement Plan

SESA	Strategic Environmental and Social Assessment
SESMP	Strategic Environmental and Social Management Plan
SIDS	Small Island Developing States
TSS	Total Suspended Solids
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNIBAM	The United Belize Advocacy Movement
WHO	World Health Organization
WWTP	Wastewater Treatment Plant

1 INTRODUCTION

1.1 Background

The proposed project, titled *"Strengthening Marine Ecosystem Resilience by Enhancing Wastewater Infrastructure in Caye Caulker"* (IDB Operation No. BL-L1051), is being implemented by Belize Water Services Limited (BWS) with financial support from the Inter-American Development Bank (IDB) under a specific investment loan totalling US$11 million. The operation is also a part of the IDB CLIMA Pilot Program, which promotes climate and nature-positive investments.

Caye Caulker, a small island off the coast of Belize, is a globally recognised marine tourism destination and a key part of the Mesoamerican Reef System, a UNESCO World Heritage Site. The island currently lacks a centralised wastewater collection and treatment system. Wastewater is managed through individual septic tanks and soak-away pit latrines, many of which are poorly designed and compromised by the island's high water table and porous substrate. This has resulted in the infiltration of untreated or partially treated sewage into coastal and marine environments, posing serious public health risks and contributing to the degradation of nearby coral reefs, seagrass beds, and mangrove ecosystems.

With tourism as the main economic driver, and the marine ecosystem central to its sustainability, the environmental vulnerabilities of Caye Caulker have reached a critical point. Furthermore, intensifying climate-related pressures including sea level rise, flooding, and coral bleaching also threaten the island's ecological integrity and community wellbeing.

To address these intersecting challenges, this project will finance the construction and phased implementation of a vacuum sewer collection network and a modular Membrane Aerated Biofilm Reactor (MABR) wastewater treatment plant. The system has been designed for climate resilience and ecological sensitivity, including elevated infrastructure and the retention of mangrove buffers. Institutional strengthening, stakeholder engagement, and environmental monitoring are also central components of the program.

1.2 Objectives

This Environmental and Social Assessment (ESA) has been prepared in accordance with the IDB's Environmental and Social Policy Framework (ESPF) and is aligned with the requirements of applicable Environmental and Social Performance Standards (ESPS). The ESA provides an integrated evaluation of the environmental and social risks and potential impacts associated with the implementation of the wastewater infrastructure project in Caye Caulker.

Specifically, the ESA aims to:

- Identify and assess the environmental and social risks and potential adverse impacts that may arise during the planning, construction, and operation of the wastewater collection and treatment system.
- Evaluate the cumulative and indirect impacts on sensitive ecosystems, including coral reefs, seagrasses, mangroves, and coastal water quality.

- Assess potential impacts to local communities, including health and safety concerns, stakeholder perceptions, land use conflicts, and socio-economic outcomes.
- Inform the development of a comprehensive Environmental and Social Management Plan (ESMP), including mitigation, monitoring, and contingency measures consistent with the mitigation hierarchy.
- Support the preparation of a fit-for-purpose Environmental and Social Management System (ESMS) for BWS, in compliance with ESPS 1.
- Promote the meaningful participation of stakeholders and establish a Stakeholder Engagement Plan (SEP) with an effective grievance redress mechanism.
- Contribute to the achievement of the IDB's goals for climate adaptation, biodiversity conservation, and green finance through the integration of climate and nature-based considerations.

In accordance with the IDB's ESPF, this project is classified as Category B, with an initial environmental and social risk rating of "Substantial", and a high Disaster and Climate Change Risk Classification (DCCRC) due to the project's exposure to sea level rise, hurricanes, and coastal flooding.

The ESA will also serve as a critical input to environmental permitting and licensing, safeguard compliance, and ongoing dialogue with the affected communities and institutional stakeholders.

2 Programme and Projects Description

2.1 Background and Justification

Caye Caulker is a limestone coral island approximately 20 miles northeast of Belize City. It is one of Belize's most popular tourism destinations, chosen by over 30% of overnight visitors prior to the COVID-19 pandemic. The island's economy is heavily dependent on its natural coastal and marine assets, including coral reefs, seagrass beds, and mangroves, which form part of the Mesoamerican Barrier Reef System, a UNESCO World Heritage Site of global ecological and economic value.

Despite its importance as a tourism hub and its environmental sensitivity, Caye Caulker currently lacks a centralised wastewater collection and treatment system. Wastewater management is dominated by individual septic tanks and soak-away pit latrines, many of which are poorly designed and maintained, and are compromised by the island's high water table and porous soils. These conditions pose significant health risks to residents and visitors and have led to the infiltration of untreated or partially treated sewage into groundwater and coastal waters. The resulting nutrient loading contributes to marine pollution, coral reef degradation, and proliferation of pathogens, threatening both public health and the tourism-dependent economy.

Belize as a whole faces significant climate change risks, being ranked among the most vulnerable Small Island Developing States (SIDS). According to the Natural Disaster Hotspot study by the World Bank, Belize is the 61st highest exposed country for relative mortality risk from multiple hazards in the world and ranked 8th out of 167 countries for climate risk. Coastal areas such as Caye Caulker are exposed to hurricanes, storm surges, sea-level rise, flooding, and erosion. The degradation of coastal ecosystems further reduces natural resilience against these hazards. Addressing wastewater management in Caye Caulker is thus essential not only for public health and economic sustainability but also for climate adaptation and biodiversity conservation goals.

The Government of Belize, through Belize Water Services Limited (BWS), has identified the urgent need to establish a centralised, resilient, and environmentally sound wastewater collection and treatment system for Caye Caulker. This need is recognised in national and sectoral planning frameworks and aligns with Belize's Nationally Determined Contributions (NDCs) under the Paris Agreement, the National Biodiversity Strategy and Action Plan (NBSAP), and other climate and environmental commitments.

The proposed programme is being financed under the IDB's "IDB CLIMA Pilot Program" as a Specific Investment Loan, totalling US$11 million. It is designed to provide significant environmental, social, and economic benefits to Caye Caulker while strengthening BWS's institutional capacity to plan and manage climate- and biodiversity-sensitive sanitation investments.

2.2 Objectives

The primary objective of this programme is to mitigate the degradation of the coral reef and associated marine ecosystems in and around Caye Caulker by improving wastewater management. More specifically, it seeks to:

- Increase access to wastewater collection and treatment services in Caye Caulker.
- Improve BWS's planning and management capacity to develop resilient, financially sustainable water and sanitation infrastructure.
- Strengthen BWS's capacity to identify, design, and implement sanitation investments with climate and biodiversity considerations, including improved monitoring, reporting, and verification of environmental impacts.

2.3 Components of the Programme

The programme is structured as a Specific Investment Loan with a total value of US$11 million and an expected disbursement period of five years. The following details the breakdown of the loan usage for the various project components:

The programme comprises four main components:

Component 1: Wastewater Collection and Treatment System for Caye Caulker

This component will finance the design and construction of the wastewater collection and treatment system for the village of Caye Caulker. The technical solution includes:

- A vacuum sewer network designed to suit the island's flat terrain and high water table, minimizing infiltration and exfiltration risks.
- A modular wastewater treatment plant using energy-efficient technology with minimal sludge production.
- Tertiary treatment through sand filtration and disinfection to reduce solids and pathogens in the effluent.
- A phased construction plan tailored to immediate and future needs, with capacity designed through 2034 projections.

This component directly addresses the health and environmental risks of existing on-site systems and is expected to benefit at least 900 connections, including the tourism sector.

Component 2: Improvement of Services by BWS

This component focuses on institutional strengthening to improve BWS's capacity to deliver sustainable sanitation services. Activities include:

- Enhancing asset management systems to optimize investment returns.
- Improving design and planning of investment plans.
- Strengthening operational and maintenance practices.
- Upgrading information management systems, including Geographic Information Systems (GIS) and Management Information Systems (MIS).
- Developing a sustainable business model for sanitation services.
- Conducting public awareness and stakeholder management activities.

COMPONENT 3: INSTITUTIONAL STRENGTHENING TO SUPPORT BWS'S ENVIRONMENTAL SUSTAINABILITY COMMITMENT

This component will support BWS in mainstreaming climate and biodiversity considerations into its planning and operations. Activities include:

- Developing a climate and nature strategy for integration into BWS's projects and decision-making.
- Building capacity to monitor, report, and verify climate and biodiversity impacts in the water and sanitation sector.
- Aligning monitoring systems with national adaptation and mitigation methodologies.

COMPONENT 4: PROJECT MANAGEMENT, AUDIT, AND EVALUATION

This component will cover the costs of project management, supervision, audits, and evaluations. It ensures transparent and accountable implementation, with resources allocated to:

- Day-to-day project management by BWS.
- External audits.
- Intermediate and final evaluations to assess progress and impact.

2.4 Implementation Arrangements

The implementation of the Caye Caulker Wastewater Collection and Treatment System Project will be led by Belize Water Services Limited (BWS), the national utility responsible for water and sanitation services across Belize. The project will be executed in close coordination with the Government of Belize, the Department of the Environment (DOE), and other regulatory agencies to ensure compliance with national legislation and safeguard requirements.

EXECUTING AGENCY:

- BWS will serve as the Executing Agency (EA) responsible for planning, procurement, construction supervision, commissioning, and operation of the wastewater system. BWS has experience in delivering donor-funded infrastructure projects, though this will be its first large-scale island wastewater system using this technology.

IMPLEMENTING STRUCTURE:

- A dedicated Project Implementation Unit (PIU) will be established within BWS to manage day-to-day project activities. The PIU will include technical, environmental, social, procurement, financial, and monitoring specialists to ensure compliance with IDB and Government of Belize standards.

- Procurement processes will follow IDB's Policies for Procurement of Works and Goods (GN-2349-15) and Policies for Selection and Contracting of Consultants (GN-2350-15).

ENVIRONMENTAL AND SOCIAL MANAGEMENT:

- BWS will adopt and operationalise the Environmental and Social Management System (ESMS) that has been developed in accordance with IDB's Environmental and Social Performance Standard 1 (ESPS 1).
- The Environmental and Social Management Plan (ESMP) will guide mitigation, monitoring, and reporting activities, including stakeholder engagement and grievance management.
- BWS will ensure compliance with Belize's Environmental Impact Assessment Regulations through coordination with the Department of Environment.

ENGINEERING AND CONSTRUCTION:

- Detailed design and construction contracts will be competitively tendered to qualified firms with proven experience in vacuum sewer and modular treatment plant technologies suitable for small islands with high water tables and wetland areas. This will also be extended to those based in Caye Caulker.
- Contractors will be required to implement mitigative measures and management plans aligned with the project's ESMP and IDB safeguards.
- Independent supervision consultants may be engaged to ensure quality, compliance, and timely delivery.

OPERATION AND MAINTENANCE:

- Upon commissioning, BWS will operate and maintain the system using its in-house staff, supported by capacity-building activities financed under the project's institutional strengthening components.
- Training will be provided in system operation, maintenance, environmental monitoring, and health and safety.

MONITORING AND EVALUATION:

- BWS will establish a monitoring and reporting framework, including Key Performance Indicators (KPIs) for environmental compliance, service coverage, effluent quality, and stakeholder engagement.
- Annual progress reports will be submitted to the IDB and relevant national authorities.
- The project includes provision for independent audits and a final evaluation to assess achievement of objectives.

2.5 Expected Benefits

The programme is expected to generate multiple environmental, social, economic, and institutional benefits for Caye Caulker and Belize more broadly.

Environmental Benefits

- Significant reduction in untreated or poorly treated wastewater discharge into coastal waters.
- Improved water quality, thereby protecting coral reefs, seagrass beds, mangroves, fisheries and associated marine biodiversity.
- Reduced nutrient loading and pathogen contamination, benefiting the Mesoamerican Barrier Reef System.
- Contribution to Belize's National Biodiversity Strategy and Action Plan and Updated Nationally Determined Contributions (NDCs).

Social and Health Benefits

- Improved sanitation services for at least 900 connections, enhancing public health outcomes.
- Reduced risk of waterborne diseases linked to contaminated groundwater or coastal waters.
- Increased resilience of the island community to sanitation system failures and contamination associated with climate-related hazards.
- Improved living conditions supporting human health and well-being.

Economic Benefits

- Protection of the tourism-dependent local economy by maintaining the island's reputation as a clean, eco-friendly destination.
- Enhanced visitor experience, supporting sustainable tourism growth and related employment.
- Reduced costs for households currently investing in maintaining insufficient/poorly constructed septic or soakaway systems.
- Local employment opportunities during the construction and operation phases.

Institutional Benefits

- Strengthened capacity within BWS to design, manage, and operate climate-resilient and environmentally sound sanitation systems.
- Adoption of modern, energy-efficient wastewater treatment technology with modular expansion potential.
- Improved planning and asset management systems, supporting sustainable service delivery.
- Better stakeholder engagement and accountability through structured public awareness and grievance redress mechanisms.

2.6 Description of the Project

The project proposes a modern, centralised wastewater collection and treatment system tailored to the island's unique environmental and socio-economic context. Its primary objective is to design, build, and commission a modern, reliable, and sustainable sewerage system that:

- Protects public health by safely collecting and treating sewage
- Prevents marine and groundwater contamination
- Enhances tourism sustainability and the island's attractiveness
- Supports Belize's commitments under the SDGs, the Convention on Biological Diversity, and climate resilience planning

The project comprises two tightly integrated infrastructure systems:

Vacuum Sewer Collection System

A vacuum sewer system was selected based on feasibility studies considering the island's flat topography, high groundwater table, narrow streets, and dense development. Vacuum systems use negative pressure to draw wastewater from households to a central collection station, overcoming challenges that make gravity sewers infeasible.

The network design is divided into three main vacuum lines to optimise flow management and phase construction. The system will consist of underground mains laid within the village's street corridors, with individual properties connected by interface valve pits via 4-inch minimum diameter pipes. It uses air-liquid ratios between 3:1 and 15:1 to ensure effective transport and employs corrosion-resistant, high-velocity vacuum mains to prevent blockages and ensure self-cleaning. Wastewater from homes and businesses will be drawn under negative pressure (-0.5 to -0.7 bar) to a central vacuum station, ensuring minimal infiltration or exfiltration even in high water table conditions. The system is designed for 2034 projected flows and will be built in phases to match growth and funding availability.

The vacuum station will house pumps, sewage pumps, control panels, and monitoring systems designed to maintain consistent vacuum pressure and transfer collected sewage to the treatment plant via force mains. This approach minimises surface disruption, manages narrow rights-of-way, and offers a highly reliable and maintainable solution for the island.

Wastewater Treatment Plant (WWTP)

The selected technology is a Membrane Aerated Biofilm Reactor (MABR) system chosen for its low energy consumption, small footprint, and ability to produce high-quality effluent suitable for sensitive marine discharge (Figure 2-1).

The treatment process will begin with pre-treatment via fine screening (1 mm) to remove solids and a FOG trap to handle oils/greases, the latter of which will be essentially to manage wastewater coming from restaurants. This process is then followed by flow equalisation tanks to manage diurnal and seasonal variations in influent. Within the biological treatment stage, the eight (8) MABR modules will cultivate biofilms that efficiently break down organic matter and

reduce nitrogen and phosphorus. Sand filtration will form a part of the final effluent disposal process and will ensure the effluent meets strict quality standards before discharge to marine waters via a diffuser. Sludge generated from the process will be dewatered using drying beds with geotubes and recirculated into the system. Considerations for the reuse of the treated effluent are a top priority for the project, particularly in construction and wetting of road networks during the dry season.

The WWTP is designed with a modular layout to enable phased implementation. The initial installed capacity will be approximately 200,000 gallons per day (GPD), sufficient to meet demand projections through the early 2030s. As population and service coverage grow, additional treatment modules can be added in future phases to expand capacity to approximately 315,000 GPD by 2050.

CONSTRUCTION PHASING

Construction will also include site works to ensure resilience against flooding, with elevated structures, improved drainage, and provision for backup power. Supporting infrastructure such as access roads, perimeter fencing, and utility connections will be developed to enable reliable operation and maintenance. Water source during the operation of the treatment system will be supplied from the Reverse Osmosis plant on the island, and electricity will be from generators with potential for connection to the energy supply coming from San Pedro.

The overall project will be implemented in phases to optimise costs and minimise disruption. The first phase will prioritise service connections in the island's most densely populated and environmentally sensitive zones (Red and Blue zones on planning maps in Figure 2-2), with further extensions planned to eventually serve the areas south of the village. In parallel, BWS will procure vacuum trucks to manage septic tank emptying in areas not immediately connected to the network, ensuring comprehensive sanitation service across the southern sections of the island. The second phase of the project will include an extension of the vacuum network to the remaining areas as needed (Green zone) and the addition of treatment modules at the WWTP as flows increase. Supporting Infrastructure and Site Works include:

- Construction of access roads, generator and office buildings, vacuum station building, security hut, and supporting electrical systems.
- Civil works for site preparation on a flood-prone, low-lying site, including fill and drainage.

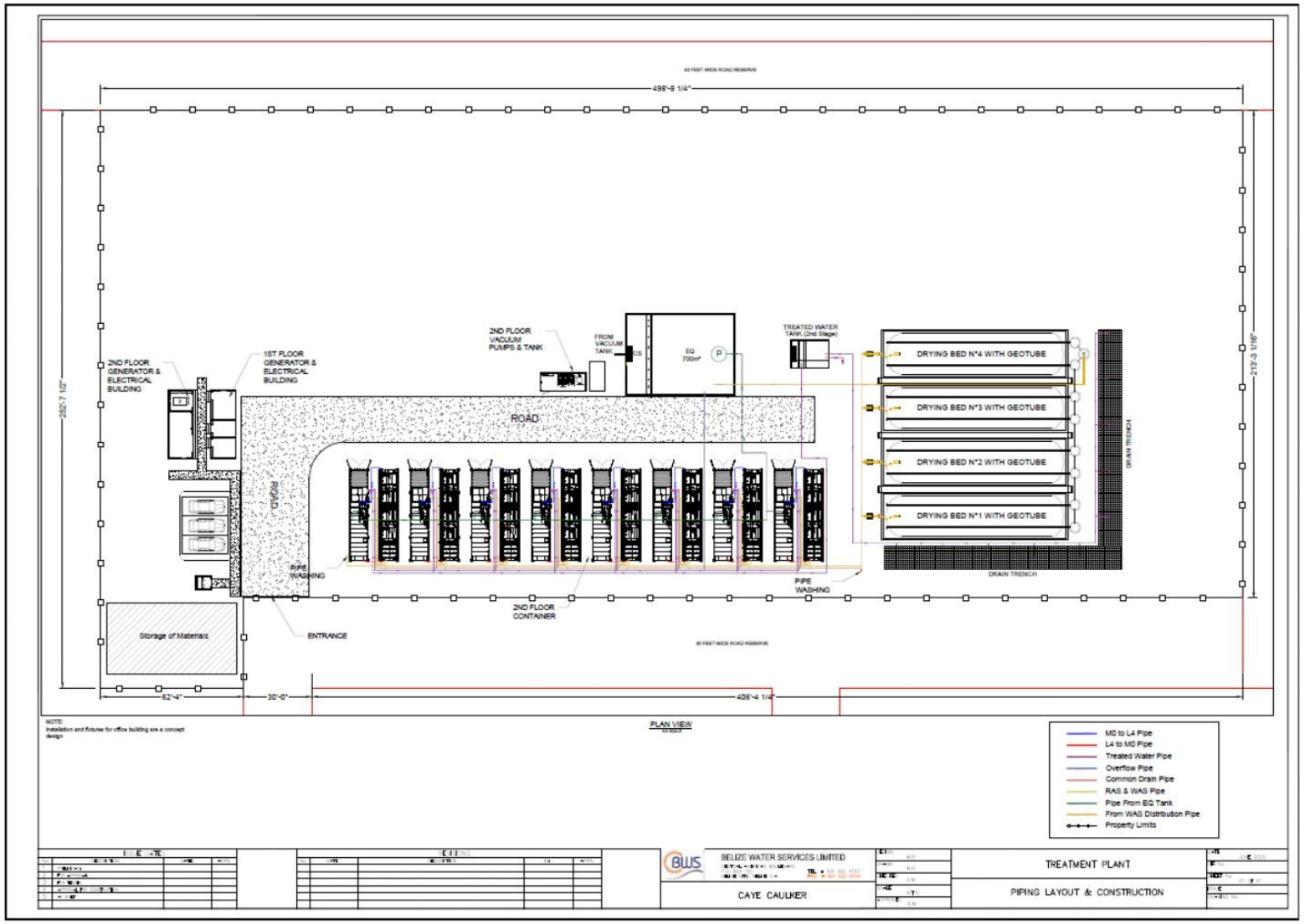


Figure 2-1: Revised Site Layout

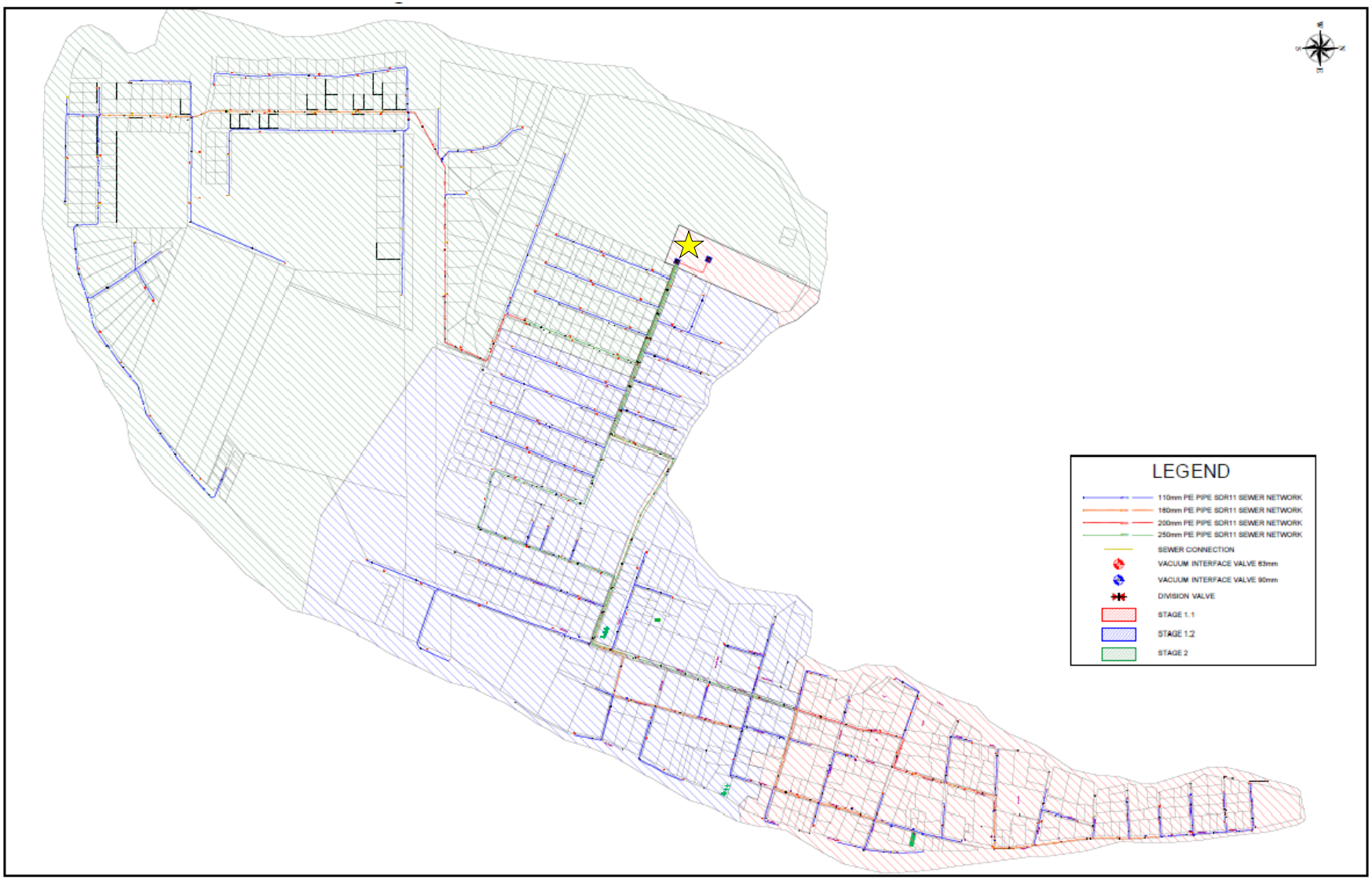


Figure 2-2: Vacuum Network Construction Stages. The star indicated the proposed location for the WWTP plant

3 Legal and Institutional Framework

3.1 National Legislative Framework

The project must comply with Belize's legal and institutional framework for environmental management, water and sanitation, coastal protection, and public health. Below is a summary of the most relevant national laws and regulations applicable to the design, construction, and operation of the wastewater collection and treatment system in Caye Caulker.

Environmental, Disaster, Solid and Hazardous Waste Management

Laws and Regulations	Relevance
Environmental Protection Act (CAP. 328 of 1992, as amended in 2009)	Principal legal framework for environmental management in Belize. Empowers the Department of the Environment (DOE) to regulate and enforce environmental protection, including EIA approvals and monitoring.
Environmental Impact Assessment Regulations (SI 107 of 1995, as amended in 2020) Revised 2023	Requires an EIA for significant projects, including sewage treatment plants. Sets out procedures for screening, TOR preparation, public consultation, review, approval, and compliance monitoring.
National Protected Areas Systems Act, 2024	This Act provides for the maintenance of coordinated management of a system of protected areas that is representative of internationally agreed categories, effectively managed, ecologically based, consistent with international law, and based on best available scientific information and the principles of sustainable development for the economic, social and environmental benefit of present and future generations of Belize.
Forest (Protection of Mangroves) Regulations (SI 52 of 2018)	Requires permits for clearing or altering mangroves, relevant if the project affects mangrove buffers during the construction of pipelines or facilities.
Coastal Zone Management Act (CAP. 329) of 2015, Revised 2020	Establishes the Coastal Zone Management Authority and Institute (CZMAI). Requires consideration of coastal management plans in project design to protect reefs, seagrass, and mangroves.
Fisheries Resources Act No.7, 2020	This act aligns with international best practices regarding the management of aquatic and fisheries resources of Belize to optimize present and future benefits through long-term conservation, management, sustainable use and development within the fisheries waters of Belize; to provide for the effective regulation of the fishing industry; to provide for the management and regulation of mariculture.
National Integrated Water Resources Act (CAP. 222:01), Revised 2020	This Act concerns the management and conservation of water resources in Belize. Conservation measures also aim at the prevention of pollution of water resources. It enforces the policy of the Government for the orderly and coordinated development and use of Belize's water resources, to conserve and protect such resources for the benefit of present and future generations of Belizeans, and to provide the Belizean public with a safe, adequate and reliable supply of water. No person shall

Laws and Regulations	Relevance
	abstract water, augment, distribute or use water resources without a licence obtained from the Authority.
Water Industry Act (Cap. 222) of 2001 (amended 2020)	Governs the establishment and regulation of water and sewerage services. Empowers BWS to develop, operate, and maintain sewerage systems and set connection and service fees. Defines the mandate of BWS, which includes the authority to construct, operate, maintain, and regulate wastewater collection and treatment infrastructure.
Pollution Regulations (SI 56 of 1996) Amended in 2009	Establishes permissible effluent discharge limits to prevent contamination of water bodies. Requires wastewater treatment facilities to meet these standards before discharge.
Solid Waste Management Authority Act (Cap. 227), 2000	Governs solid and hazardous waste management, including sludge from wastewater treatment plants. Requires proper disposal and may require coordination with licensed facilities.
Effluent Limitations Regulations, 1996 (Amended in 2009)	These Regulations prohibit the discharge of effluent from new and altered point sources and establish a licensing system for discharging effluents under specific conditions. They establish the requirement for the treatment of effluent, as well as limitations or standards for physical and chemical parameters to be monitored for various industries. In 2009, the Effluent Limitations Regulations were amended to include provisions for the categorisation of Class I and II Waters that differentiate waters with unique ecological characteristics that are sensitive to the impacts of domestic wastewater.
Hazardous Waste Regulations, 2009	These Regulations were passed in August 2009 to address the overall management of hazardous waste, including storage, transportation, treatment and prohibitions.
Public Health Act (Cap. 40) 2021	Provides for the control of conditions affecting public health. Includes powers to regulate sewage systems, disposal of excreta, and to abate nuisances threatening health.
Lands Utilisation Act (Cap. 188), Revised 2020	Governs land use planning and subdivision. It may affect siting and land tenure for treatment plants, pump stations, and outfalls.
Building Act (Cap. 131) Revised 2020 and Regulations	Establishes requirements for the design and construction of infrastructure, including standards for flood risk mitigation and resilience.
Disaster Preparedness and Response Act, 2000 (Amended in 2024)	This is the primary disaster risk management law in Belize. Coordinated by NEMO (National Emergency Management Organisation), this act provides the framework for Belize's approach to disaster prevention and mitigation as well as disaster preparedness, response and recovery.

Social, Labour and Culture

Laws and Regulations	Relevance
Labour Act, 1960, Amended 2020	This Act lays down provisions on the duties of the Labour Department; authorization of officers to perform inspection duties; duties of employers; establishment and duties of the Labour Advisory Board; principles and procedures of labour contracts; protection of wages;

Laws and Regulations	Relevance
	safety, health and housing of workers; forced labour and employment of women and children; and the establishment, powers and duties of the Labour Complaint Tribunal.
Belize Occupation Safety and Health Bill, 2025 (Pending Implementation)	The Cabinet has approved amendments to the Occupational Safety and Health (OSH) Bill, signalling a significant stride towards protecting the lives and well-being of employees across various sectors. The amended OSH Bill represents a crucial initiative aimed at establishing a robust legal framework dedicated to ensuring the safety and health of workers throughout Belize. Among its key objectives is the delineation of clear responsibilities for both workers and employers, marking a departure from outdated regulations such as the Factories Act, Chapter 296 of the Substantive Laws of Belize. Crucially, the amended OSH Bill incorporates essential protections tailored to the needs of workers, especially those in high-risk industries like construction and factories.
Freedom of Information Act, 1994 (Revised 2000)	This Act promotes the maximum disclosure of information in the public interest. It guarantees and facilitates the right of access to the information of each person.

National Development Plans And Policies

Plans and Policies	Relevance
Belize's National Biodiversity Strategy and Action Plan	Provides a framework for conserving biodiversity. Requires assessing and mitigating impacts on marine and coastal habitats during construction and operation.
Belize Updated Nationally Determined Contributions To The UNFCCC (Updated 2021)	As a signatory to the United Nations Framework Convention on Climate Change (UNFCCC), this document outlines the Government of Belize's targets to reduce GHG emissions at the expected level between 2021 and 2030 including a number of sectoral actions to build resilience and develop capacity to adapt to the impacts of climate change in key economic sectors and supporting systems Regarding mangrove forests it intends to enhance the capacity of the country's mangrove and seagrass ecosystems to act as a carbon sink by 2030, through increased protection of mangroves and by removing significant carbon dioxide from these areas between 2021 and 2030 through mangrove restoration.
Belize National Climate Change Policy, Strategy, and Action Plan	Guides national actions to address climate change risks. Emphasizes resilient infrastructure and environmental protection. Relevant to wastewater system design and siting.
Belize National REDD+ Policy 2021	The Belize National Reducing Emissions through Deforestation and Forest Degradation (REDD+) Strategy details strategies to facilitate emission reduction and carbon sequestration from REDD+ activities. The primary objective of REDD+ Strategy is to substantially lower greenhouse gas (GHG) emissions from forests, including mangrove forests, and enhance their capacity to sequester GHGs. This involves reducing emissions from deforestation, forest degradation and promoting sustainable forest management over the next decade,

Plans and Policies	Relevance
	while also facilitating carbon stock enhancement, forest conservation, and forest restoration.
BELIZE MEDIUM-TERM DEVELOPMENT STRATEGY 2022-2026	The Medium-Term Development Strategy is a national policy with a multi-sectoral approach. The timeframe of the Strategy is 5 years covering the period from 2022 to 2026. It outlines six strategic objectives: (i) poverty reduction, (ii) economic transformation and growth, (iii) trade deficit reduction, (iv) citizen security, (v) good governance and (v) protection of the environment. Blue industries will be supported to enhance productivity and competitiveness via regulatory reforms and incentives, trade policy and market support, and government investment in the enterprises. The Strategy addresses the need for excellent coordination between the health, economy, industry, and finance sectors, with a focus on innovation, employment, wages, gender equality, and knowledge dissemination.

In addition to national legislation, plans and policies, the project is informed by Belize's international environmental commitments. The table below summarises relevant international treaties, conventions, and commitments applicable to the design, construction, and operation of the wastewater collection and treatment system in Caye Caulker.

INTERNATIONAL CONVENTIONS AND COMMITMENTS

Agreements	Relevance
PARIS AGREEMENT (UNFCCC, 2015)	Belize is a Party to the Paris Agreement and has submitted updated Nationally Determined Contributions (NDCs) committing to reduce emissions and increase adaptation. Relevant for integrating climate resilience into wastewater design (elevated infrastructure, energy efficiency, flood risk reduction).
THE OCEAN BIODIVERSITY AGREEMENT, 2024	Belize was the first Caribbean nation to officially ratify the ocean biodiversity agreement under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas beyond National Jurisdiction (BBNJ Agreement), which stipulates a global commitment to safeguard 30 percent of the ocean by 2030.
CONVENTION ON BIOLOGICAL DIVERSITY	Belize's National Biodiversity Strategy and Action Plan (NBSAP) implements CBD commitments. The project must consider impacts on marine and coastal biodiversity, including coral reefs, seagrass beds, and mangroves.
CARTAGENA CONVENTION AND PROTOCOL CONCERNING POLLUTION FROM LAND-BASED SOURCES	Regional agreement under UNEP for Caribbean marine protection. Requires control of land-based sources of marine pollution, including sewage discharge. Supports project goals of reducing untreated wastewater flows.
REGIONAL AGREEMENT ON ACCESS TO INFORMATION, PUBLIC PARTICIPATION AND JUSTICE IN ENVIRONMENTAL MATTERS IN	The Escazú Agreement recognises, protects and promotes the rights of all human rights defenders of the environment by ensuring the three rights of access to information, participation, and justice in environmental matters. Belize ratified the agreement in 2023.

Agreements	Relevance
Latin America and the Caribbean (Escazú Agreement)	
Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) (ratified 1976)	Aims to ensure that international trade in wild animals and plants does not threaten their survival. Regulates trade in listed endangered species through permits and monitoring. While the wastewater project itself does not directly involve wildlife trade, Caye Caulker's marine environment (including coral reefs and seagrass beds) supports species that may be protected under CITES. Preventing untreated sewage discharges protects these habitats and reduces indirect threats to listed species.
Central American Biodiversity Convention (Central American Alliance for Sustainable Development (ALIDES) in 1994	Regional framework under the Central American Alliance for Sustainable Development (ALIDES) for conservation and sustainable use of biodiversity. Promotes coordinated environmental policies among member states. It supports Belize's obligations to maintain ecosystem integrity. The project contributes to ALIDES goals by reducing nutrient and pathogen pollution in marine ecosystems around Caye Caulker, which are biodiversity-rich and critical for regional conservation priorities.
Convention for the Conservation of Biodiversity and the Protection of Priority Areas in Central America, 1992.	Focuses on conserving biodiversity, protecting priority areas, and promoting sustainable development across Central America. Caye Caulker is adjacent to the Belize Barrier Reef Reserve System, a global priority area. The wastewater project will mitigate direct pollution threats to these sensitive marine habitats, supporting Belize's commitment to this convention.
Organisation for the Fishing and Aquaculture Sector of the Central American Isthmus (OSPESCA)	Regional body managing and promoting sustainable fisheries and aquaculture management across Central America, supporting food security and marine conservation. Caye Caulker's economy and food security depend partly on small-scale fisheries. By preventing sewage pollution and eutrophication of coastal waters, the project supports healthier fish habitats and aligns with OSPESCA's sustainability goals.
Convention on the Transboundary Movements of Hazardous Wastes (1997).	Controls and regulates the cross-border movement and disposal of hazardous wastes to prevent environmental harm. While the wastewater project focuses on domestic sanitation, sludge generated at the treatment plant is a regulated waste. Proper management and potential off-island transport for treatment or disposal must comply with national laws aligned with this convention.
The Convention on Wetlands of International Importance Especially as Waterfowl Habitats (RAMSAR) (Signed 1998).	Promotes conservation and wise use of wetlands globally, recognising their ecological and socio-economic value. Caye Caulker's mangroves and coastal lagoons are wetlands of high ecological value. Reducing untreated wastewater discharges and supporting restoration activities being proposed under this project will help to protect/conserve these habitats, supporting Belize's commitments under the Ramsar Convention to maintain wetland health and biodiversity.
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (The Cartagena Convention).	Legally binding regional agreement for the protection and sustainable management of the Caribbean Sea's marine environment. Includes protocols on pollution, biodiversity, and land-based sources. The project reduces land-based sources of marine pollution, a key target of the Cartagena Convention's Land-Based Sources Protocol.

Agreements	Relevance
	Supports regional commitments to protect coral reefs, seagrass beds, and marine water quality critical to Caye Caulker.

3.2 IDB Environmental and Social Policy Framework

This section evaluates the relevance of the project components to the Inter-American Development Bank's (IDB) Environmental and Social Performance Standards (ESPS), ensuring compliance with the IDB's Environmental and Social Policy Framework (ESPF).

3.2.1 ESPS 1 – Assessment and Management of Environmental and Social Risks and Impacts

This project requires compliance with ESPS 1, as it provides the overarching framework for identifying, assessing, and managing environmental and social risks. Given the project's potential impacts on sensitive coastal ecosystems, public health, and local livelihoods, ESPS 1 guides the preparation of a comprehensive Environmental and Social Assessment (ESA), an Environmental and Social Management Plan (ESMP), and the establishment of a fit-for-purpose Environmental and Social Management System (ESMS) within Belize Water Services (BWS). It also ensures alignment with national EIA requirements and mandates meaningful stakeholder engagement and the implementation of a grievance redress mechanism, all of which are essential for ensuring environmentally sustainable and socially inclusive project outcomes.

3.2.2 ESPS 2 - Labour and Working Conditions

The project aligns with ESPS 2, as it addresses the need to ensure fair, safe, and healthy working conditions for all project workers. During the construction phase, the project will employ direct and contracted workers through civil works contractors and subcontractors, who will need clear labour management procedures to ensure compliance with national labour laws and IDB requirements. This includes enforcing occupational health and safety (OHS) measures to protect workers from construction hazards, heat stress, equipment-related injuries, and potential exposure to untreated sewage. During operation, Belize Water Services (BWS) staff will operate and maintain the vacuum sewer network and treatment plant, requiring ongoing training and safety protocols for confined space entry, chemical handling, and equipment maintenance. ESPS 2 also requires non-discriminatory employment practices, worker grievance mechanisms, and documentation of terms and conditions of employment, all of which are essential to safeguard worker rights and well-being throughout the project lifecycle.

3.2.3 ESPS 3 - Resource Efficiency and Pollution Prevention

The project is directly relevant to ESPS 3 because its core objective of minimising resource use and preventing pollution directly aligns with the project's purpose of improving wastewater management to protect marine ecosystems. The design and operation of the new treatment plant must ensure that effluent meets national and international discharge standards to prevent nutrient loading and pathogen contamination in coastal waters, protecting coral reefs, seagrass beds, and fisheries. The system also needs to manage sludge in compliance with solid and hazardous waste regulations to avoid land or water contamination. Energy efficiency is critical,

given the island's vulnerability to climate change and high utility costs, making the selection of modular, energy-efficient treatment technology essential. Overall, ESPS 3 guides the project to integrate best practices in resource efficiency, pollution prevention, and sustainable design, reducing environmental impacts while supporting Belize's climate adaptation and biodiversity goals.

3.2.4 ESPS 4 - Community Health, Safety, and Security

The project's construction and operational activities must ensure compliance with ESPS 4, as it presents risks to community health, safety, and security that must be carefully managed. During construction, potential hazards include noise, dust, increased traffic, restricted access, and worker-community interactions that may disrupt daily life or tourism operations. Excavation and trenching for the vacuum sewer network in narrow island streets may pose safety hazards to pedestrians and local businesses. During operation, risks include accidental overflows, equipment failures, or exposure to untreated sewage that could harm residents and tourists. The project is also exposed to climate risks such as sea-level rise and flooding, which could compromise infrastructure integrity and public safety if not properly designed and maintained. ESPS 4 guides the development of measures to mitigate these risks, such as robust design standards for climate resilience, traffic and safety management plans during construction, emergency preparedness and response plans, and clear communication with the community to ensure health and safety protections are effectively implemented.

3.2.5 ESPS 6 - Biodiversity Conservation and Sustainable Management of Living Natural Resources

The project's activities align with ESPS 6, because Caye Caulker is part of the Mesoamerican Barrier Reef System, a globally significant marine ecosystem with sensitive habitats such as coral reefs, seagrass beds, and mangroves. The current lack of adequate wastewater treatment contributes to nutrient loading, pathogen contamination, and habitat degradation, threatening marine biodiversity and ecosystem services vital to tourism and fisheries. The project's construction activities will likely result in the modification of mangrove stands and the restoration of adjoining degraded mangrove systems. ESPS 6 requires the project to avoid, minimize, or mitigate adverse impacts on critical habitats through careful site selection, environmentally sensitive design, and robust effluent treatment standards that prevent marine pollution. It also supports the integration of nature-based solutions and sustainable resource management, aligning the project with Belize's commitments under the Convention on Biological Diversity and its National Biodiversity Strategy and Action Plan.

3.2.6 ESPS 9 - Gender Equality

The project strongly aligns with ESPS 9, because equitable access to improved sanitation services and participation in decision-making processes are essential to achieving inclusive development outcomes. Women in Caye Caulker, as in many communities, often have primary responsibility for household hygiene, caregiving, and managing water use, making them key stakeholders in sanitation improvements. The project must ensure that women's voices are meaningfully included in consultation, planning, and monitoring processes, and that service designs consider gender-specific needs for safety, privacy, and affordability. Additionally, employment opportunities during construction and operation phases should promote equal

access for women, with non-discriminatory recruitment and safe working conditions. By meeting ESPS 9 requirements, the project can help reduce gender inequalities, improve health outcomes, and support Belize's commitments to gender-responsive infrastructure and sustainable development.

3.2.7 ESPS 10 - Stakeholder Engagement and Information Disclosure

Compliance with ESPS 10 is essential because meaningful, transparent, and inclusive stakeholder engagement is essential for the project's success on a small island with a tourism-dependent economy and close-knit community. The project will affect residents, businesses, tourists, local government, and environmental stakeholders during construction (through noise, dust, and traffic disruptions) and operation (through service costs, maintenance, and environmental safeguards). ESPS 10 requires the development and implementation of a Stakeholder Engagement Plan (SEP) that ensures early and ongoing consultation, accessible information disclosure in appropriate formats, and culturally appropriate participation, including for vulnerable groups. It also mandates an effective Grievance Redress Mechanism (GRM) so community members can raise concerns and receive timely responses. Following ESPS 10 standards, the project can build trust, address community needs and concerns proactively and strengthen local ownership and support for improved wastewater management.

4 Environmental and Social Baseline

4.1 Introduction

This chapter describes the existing environmental and social conditions in the project area to establish a clear baseline for impact assessment and management planning. A thorough understanding of the baseline context is essential for identifying, predicting, and mitigating the potential environmental and social risks and impacts associated with the construction and operation of the proposed wastewater collection and treatment system in Caye Caulker.

4.1.1 Area of Influence

Based on the project activities associated with this operation, this assessment considers the environmental footprint that will likely be impacted during the construction and operation phases. This includes the sites of intervention (Direct Area of Influence) and their surroundings (Indirect Area of Influence). The environmental context presented below represents the baseline environmental and social conditions for the area of influence prior to commencing project activities. Much of the information presented was compiled through desktop research and review of online environmental reports, national assessments, as well as the pre-feasibility, feasibility, and supporting design studies that were conducted across the study area.

DIRECT AREA OF INFLUENCE

The Direct Area of Influence (DAI) refers to the immediate geographical and socio-economic areas directly affected by the implementation of the project activities, particularly those that involve infrastructure development, construction, and future system upgrades. These are the areas where the project's physical interventions occur, and where the most significant direct impacts are expected to affect sensitive receptors. The area of influence for this project includes:

- Direct Project Footprint: All land parcels required for the construction and operation of the vacuum sewer network, pumping stations, and the wastewater treatment plant site. This includes trenches within village streets and the final plant site and access roads.
    - *Wastewater Treatment Plant Site*: The parcel of land selected for the construction and operation of the modular wastewater treatment plant, including access roads and any supporting infrastructure (e.g., electrical connections, fencing). This site will be subject to vegetation clearing, earthworks, construction of infrastructure, and long-term operational use.
    - *Vacuum Sewer Network Routes*: The existing streets and rights-of-way within the Caye Caulker village, where vacuum sewer lines will be installed. This includes trenches and excavation zones for laying pipes, as well as restoration of road surfaces and public spaces after installation.
    - *Pumping Stations and Valve Chambers*: Specific locations along the sewer network where pumping stations and vacuum valve chambers will be constructed and maintained. These are permanent facilities that require excavation, civil works, and ongoing maintenance.

- *Construction Laydown Areas*: Temporary sites used for equipment staging, storage of materials, worker facilities, and contractor offices during construction. These may include vacant lots or cleared land secured for project use.
- *Transportation Routes on the Island*: Roads and paths used by construction vehicles and equipment, affecting traffic flow, road condition, and potentially increasing noise and dust levels in adjacent areas.

- Construction Impact Zone: Areas potentially affected by noise, dust, traffic, vibration, and temporary disruptions during the construction period. This encompasses adjacent residences, businesses, tourism facilities, and public spaces.
- Operational Influence Area: Zones potentially affected by odours, effluent discharges, maintenance activities, and any risk of accidental releases.
- Natural Environment Receptors: Coastal and marine ecosystems potentially affected by changes in water quality, including coral reefs, seagrass beds, mangroves, and associated biodiversity within the surrounding lagoon and reef system.
- Socioeconomic Context: The entire community of Caye Caulker, including its permanent residents, seasonal workers, and tourists, may be affected by improved sanitation services, service fees, public health benefits, and changes in local infrastructure.

INDIRECT AREA OF INFLUENCE

The Indirect Area of Influence (IAI) includes all areas beyond the immediate construction footprint that may experience secondary or indirect environmental and social effects resulting from the project's construction, operation, and long-term outcomes. These may include:

- Residential and Commercial Properties Adjacent to Sewer Routes: Homes, businesses, accommodations, and tourism facilities located along streets where the vacuum sewer network will be installed. These properties may experience temporary disruptions such as traffic detours, noise, dust, and access limitations during construction.
- Wider Village of Caye Caulker: Includes all island residents, businesses, and visitors who will be impacted by improvements to wastewater services and by any construction-phase nuisances (e.g., noise propagation, increased traffic, staging areas).
- Coastal Waters and Marine Ecosystems: Treated effluent discharges and reduced septic seepage will improve nearshore water quality. The IAI includes surrounding waters, seagrass beds, mangroves, and coral reef systems that benefit from improved nutrient management and reduced pathogen loading.
- Public Health Across the Island: Community health benefits extend beyond directly connected properties, as improved wastewater treatment reduces island-wide exposure to pathogens and waterborne diseases.

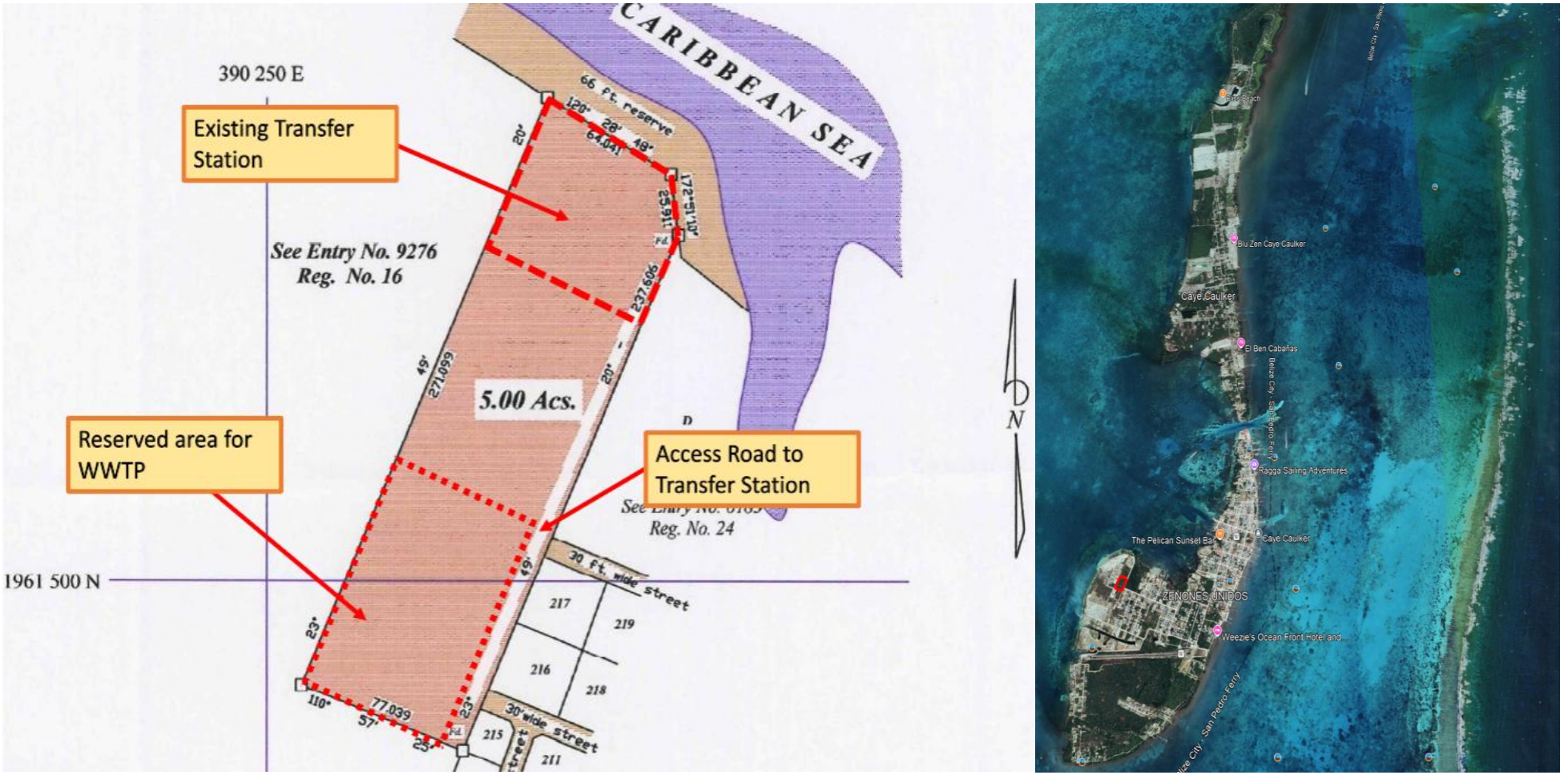


Figure 4-1: Location of the Caye Caulker Wastewater Collection and Treatment Plant (red box)

4.2 Physical Environment Baseline

4.2.1 Climate

Belize experiences a humid tropical climate, marked by distinct wet and dry seasons. Belize's climate is significantly influenced by the El Niño Southern Oscillation (ENSO). El Niño tends to bring warmer conditions between June and August, whereas La Niña leads to increased rainfall and the potential for tropical Atlantic cyclones. Similarly, Caye Caulker, located off the coast of the Belize mainland, experiences a tropical maritime climate, characterised by consistently warm temperatures, high humidity, and distinct wet and dry seasons influenced by the Caribbean Sea. The climate is typical of low-lying Caribbean cays, with minimal elevation relief and a strong moderating effect from coastal breezes.

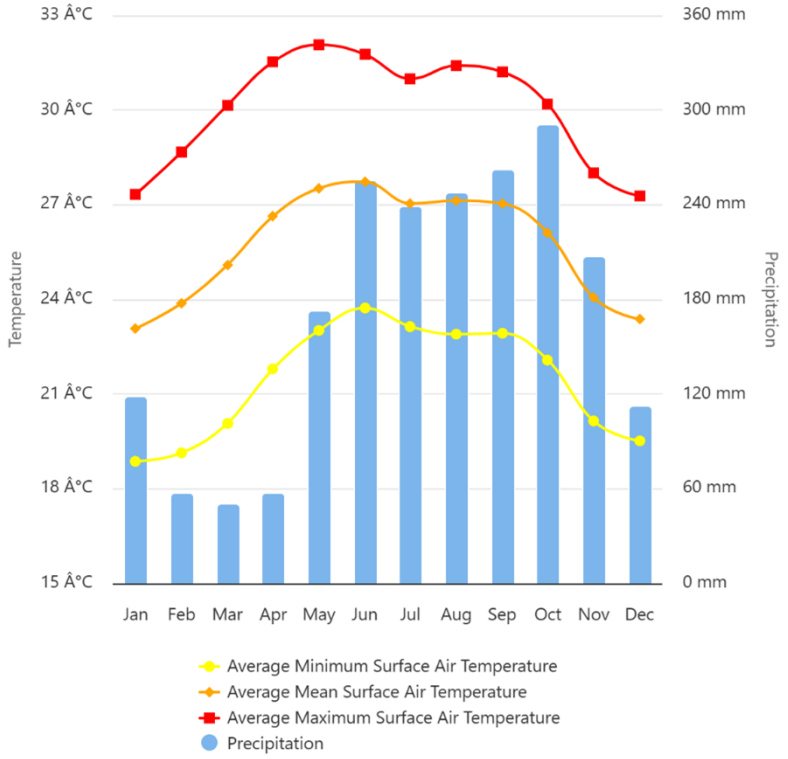


Figure 4-2: Monthly Climatology of Average Minimum, Average Mean, and Average Maximum Air Temperature along with Average Mean Precipitation 1991-2023 in Belize. Source: World Bank Group 2024[1]

TEMPERATURE

Temperatures on Caye Caulker remain warm year-round, with average monthly highs typically ranging between 28°C and 32°C (82–90°F). Nighttime lows generally fall between 22°C and 26°C (72–79°F). Seasonal variation is modest, with slightly cooler and drier conditions during the winter "nortes" (cold fronts from the north) and warmer, more humid conditions during the wet season.

[1] https://climateknowledgeportal.worldbank.org/country/bahamas/climate-data-historical

RAINFALL

Precipitation on Caye Caulker follows a distinct seasonal pattern. The wet season extends roughly from June to November, coinciding with the Atlantic hurricane season. During this period, the island experiences frequent showers and thunderstorms, often heavy but typically brief, with monthly averages exceeding 200 mm at times. The dry season, from February to May, is marked by reduced rainfall, clearer skies, and lower humidity, with monthly averages often below 50–75 mm. Annual rainfall typically averages 1,500–2,000 mm, but this can vary significantly with regional climatic patterns such as El Niño–Southern Oscillation (ENSO) phases.

HUMIDITY AND WINDS

Humidity is generally high year-round, averaging 75–85%, contributing to a warm, muggy feel, especially during the wet season. The prevailing winds around the Caye are the Easterlies, which flow between 5 to 15 knots. During the months of February to March, the wind changes to a south-easterly direction, blowing up to 20-25 knots. However, during the cooler months, winds are from the north-easterly direction. These winds are responsible for the creation of waves and wave action.

During the months of November to January, an average of three to four 'Northerlies' affect the country of Belize. These northerlies usually last between two to four days, blowing between 5 – 15 knots from the north to west. The northerlies produce choppy waves, stirring up sediments drastically, which reduces visibility. The increased wave action also speeds up erosion on exposed soil and vegetation. These winds provide important ventilation and moderating effects. They are typically stronger during the dry season, creating more comfortable conditions.

CLIMATE CHANGE PROJECTIONS

According to the IPCC 2018 Special Report, the risks from heavy precipitation events are projected to increase significantly with higher levels of global warming, under specific climatic phenomena. While annual rainfall is expected to remain relatively stable, the distribution of rainfall is likely to become more erratic. In addition, the heavy precipitation associated with tropical cyclones is expected to become more intense at 2°C of global warming compared to 1.5°C, also with medium confidence. Based on information presented on the Climate Change Knowledge Portal, Belize will experience an increase in the intensity of both droughts and heavy rainfall events, leading to a higher incidence of flooding and soil erosion. This variability poses a threat to agriculture, water supply, and infrastructure.

The country is projected to continue experiencing intense precipitation events over shorter periods. Average annual rainfall is also projected to reduce by as much as 4 mm/day by the 2030s. Reduced precipitation (with exceptions only in the early (May) and late (November) sections of the wet season) is projected for the entire country up to the 2050s. These projections are supported by the regional PRECIS-ECHAM4 – A2 & B2 and the HADCM3 - A2 & B2 models, which show the percentage change in annual rainfall for the period 2071 -2099 for the Caribbean and Central American region.

In essence, climate models project warmer average temperatures, increased variability in rainfall, and more intense extreme weather events in the Caribbean region. For Caye Caulker, this

means a higher risk of damaging hurricanes, coastal flooding, erosion, and infrastructure disruption. These vulnerabilities are particularly critical for wastewater infrastructure, which must be designed for resilience against storm surges, flooding, and sea-level rise to ensure reliable operation and to protect public health and marine ecosystems.

4.2.2 Topography

Figure 4-3: Map of Caye Caulker

The Caye Caulker Regional Planning Area is made up of two (2) cayes, Caye Caulker and Caye Chapel, comprising approximately 234.7 square kilometres of terrestrial and aquatic environment, including flats and reefs, of which 5.2 square kilometres or 2.22% is terrestrial and 37 square kilometres or 97.78 % is aquatic. Caye Caulker is a small, low-lying limestone cay situated approximately 33 km (20 miles) northeast of Belize City in the Caribbean Sea. It forms part of the Belize Barrier Platform and is roughly 8 km long (north to south) and less than 1.6 km wide at its widest point. The island has a negligible topographic relief as it is extremely flat and low-lying. Elevations across most of Caye Caulker range from approximately 0.5 to 2.5 meters above mean sea level (AMSL). The highest point on the island is the sand ridge that runs along the length of the cay, with many built areas sitting just above the high-tide line. Street-level elevation surveys conducted during design studies for the wastewater project show that road centrelines typically lie between 0.7 m and 1.3 m AMSL, with localised depressions subject to ponding and flooding during heavy rainfall.

The island is naturally divided into two contiguous sections by a narrow channel known as “The Split,” which separates the more densely inhabited southern portion from the less developed northern section. The separation of the island by the split in its early beginnings was primarily man-made, then later widened by Hurricane Hattie. Over the years, the currents flowing through the channel and the effects of subsequent storms and hurricanes like Hurricane Keith of 2000 have deepened (>6.5 m) and widened (>60 m) the split to its present dimensions, where boats can now easily navigate through. The natural erosion continues to this day and threatens the soft sand banks of the waterway, and has now become an issue of concern among residents. East of the village is a shallow lagoon between 6 inches (150mm) and 14 feet (4.3m) deep that meets the Belize Barrier Reef.

4.2.3 Geology and Soils

Caye Caulker is a coralline island that can be characterised as a sand bar over a limestone shelf with underwater caves found in the limestone. The island is underlain by porous, permeable limestone with very limited topsoil. The surface is often sandy or consists of thin organic layers over limestone fill. The Geological Map of Belize, revised edition 2005 (Figure 4-4) establishes the landform in Caye Caulker as being Quaternary period sand bars, modern reef, calcareous sand and mud from the Holocene (last 10,000 years) to present. Deposits of this age are a common occurrence close to ground level, often forming soils that cover harder and older rocks.

The Quaternary (Pleistocene) rocks and modern sediments along the coast, and underwater, are the youngest cycle of deposition in Belize, and are represented largely by shallow-water, limey sediments. Their foundation of Cretaceous and Tertiary limestone is formed from the accumulation of shells and reef debris like those being deposited today. The soils in Caye Caulker are similar to that of Ambergris Caye belonging to the Ambergris Sub-suite of the Turneffe Suite. The soils of the Turneffe Suite are primarily formed from marine deposits along old and current shorelines. This type of soil has little organic matter, and the texture is mainly calcareous and sandy (Baillie, et al. 1993). Being sandy, alkaline and poorly developed, they have high infiltration rates with very limited potential for agricultural use and their potential use is mainly associated with tourism and recreational development.

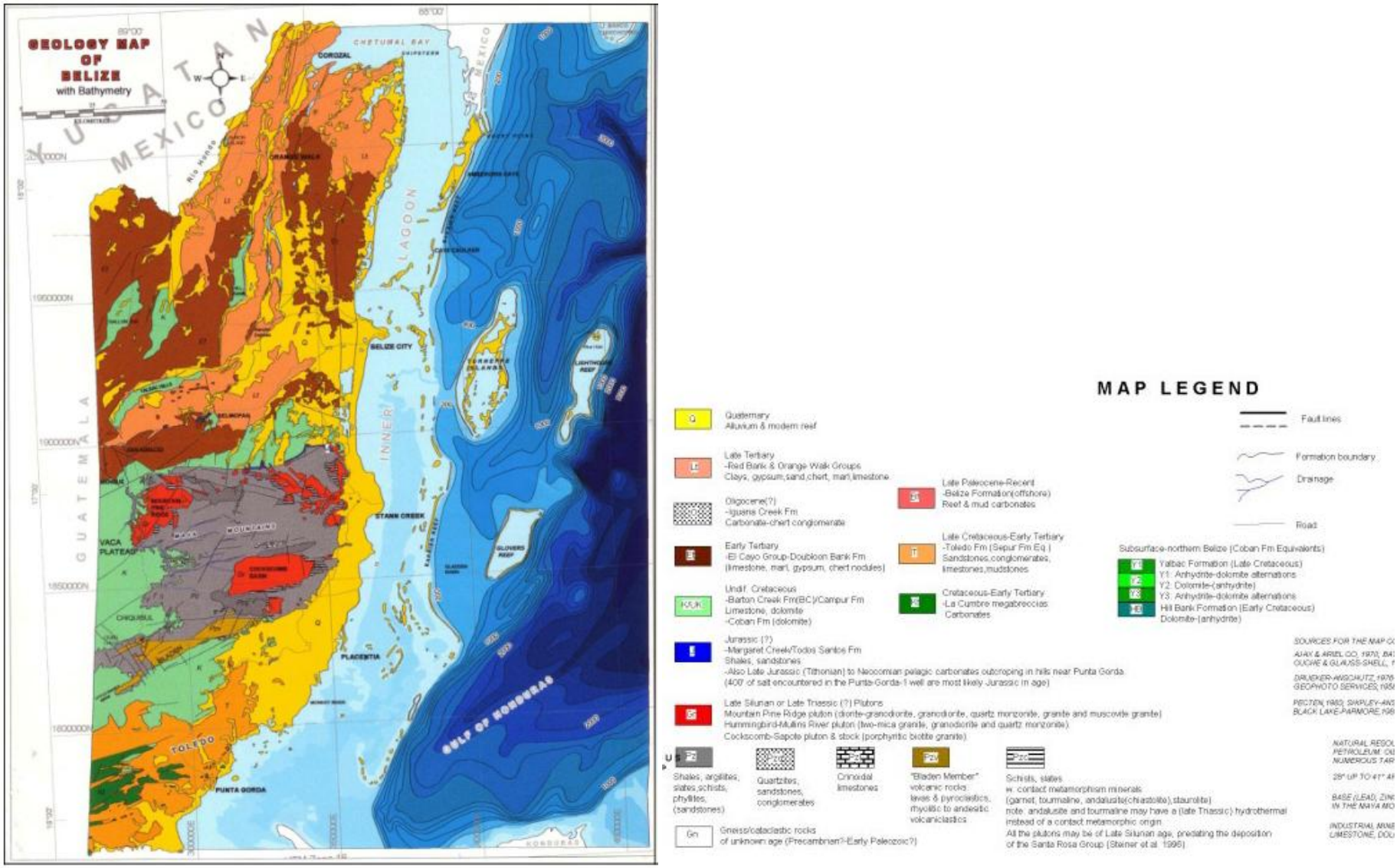


Figure 4-4: Geological Map of Belize. The area in which Caye Caulker is located consists of Quaternary Alluvium and Modern Reef

4.2.4 Hydrology

Due to its low relief and proximity to sea level, Caye Caulker is highly susceptible to tidal inundation, storm surge, and flooding during heavy rains. Water tends to pond in low-lying depressions, and drainage is poor because of the minimal elevation gradient.

Typical of coral islands, the occurrence of groundwater in Caye Caulker is characterised by a very thin lens-shaped body of fresh water floating on seawater. Groundwater flow is connected to the seawater and observations of rising groundwater levels in wells during high tide indicate a direct connection to the sea.

The depth and volume of a freshwater lens are heavily influenced by the width of the island and the elevation of land above the sea. After rainfall has recharged the lens, the amount of time it takes for that recharged water to reach the sea via vertical and horizontal percolation depends on the permeability of the soil. The narrowness and low elevation of the island, combined with the very high permeability of its soil, result in a relatively thin freshwater lens that will lose water rapidly to the sea and thus have a relatively small safe yield, particularly during dry periods.

Flood mapping prepared for climate vulnerability assessments indicates that much of the village area can experience coastal flooding from storm surge of 0.5–1.5 meters, particularly during hurricanes or extreme high tides.

4.2.5 Water Quality

Caye Caulker's environmental water quality reflects the complex interactions between its fragile island hydrogeology, dense human settlement, limited wastewater infrastructure, and surrounding marine ecosystems. Between 2010 and 2011, the Department of Environment designed and implemented a comprehensive Water Quality Monitoring Programme, collecting and analysing both ground and coastal waters in and around Caye Caulker to determine the extent of contamination resulting from the current sewage and wastewater management practices. The results and interpretation of data from this monitoring exercise represent the main source of information available on water quality in Caye Caulker. It reveals significant insights into contamination and environmental stress across the island.

This monitoring exercise assessed water quality in eight strategically located wells across the island, capturing conditions in residential zones, commercial areas, undeveloped sites, and near the island's landfill. Elevated salinity was a consistent challenge, especially in outlying and low-lying areas (e.g., wells located at the undeveloped northern and southernmost tips of the island, near the proposed project site and the landfill). Some wells were classified as highly brackish or saline, likely due to their location along the narrow edges of the lens, which is more vulnerable to saltwater intrusion. Seasonal variations were also observed with salinity levels tending to spike during the dry season. This pattern is likely from abstraction rates temporarily exceeding natural recharge, underscoring the lens's limited resilience to overuse and sea-level rise. Additionally, Biochemical Oxygen Demand (BOD) was generally high, particularly in densely populated areas. Wells near the solid waste disposal site and residential areas showed elevated BOD levels, consistent with contamination from wastewater discharge and leaching of organic materials.

This was indicative of untreated or poorly treated sewage, as well as organic waste from the landfill, percolating into the groundwater system. Coliform bacteria, including faecal coliforms, were detected in all sampled wells, demonstrating widespread contamination from failing or poorly maintained septic systems, and that greywater discharged into soakaways and leach fields is directly infiltrating the island's groundwater. Given the shallow water table and highly porous soils, there is effectively no natural filtration, leading to almost immediate contamination of the freshwater lens.

Elevated levels of nitrates and phosphates were also recorded. These nutrients are typically associated with domestic wastewater, particularly from the use of phosphate-laden detergents. Their presence in the freshwater lens indicates diffuse pollution sources and raises the risk of nutrient enrichment in connected coastal waters. The smell of hydrogen sulphide, characterised by a "rotten egg" odour during monitoring, was noted in several wells, especially during the dry season. This odour suggests anaerobic decomposition of organic matter, further evidence of high organic loading and insufficient natural treatment capacity.

Based on these monitoring results, the groundwater in Caye Caulker is not suitable for drinking, bathing, or washing without significant treatment such as chlorination. Local stakeholders report that these water quality problems have worsened in more recent years, likely due to increasing development pressures and near-universal use of septic tanks (about 98% of properties) that often see little or no maintenance over the years.

Monitoring of marine water quality around Caye Caulker similarly highlighted both natural variability and the influence of human activities. The following represents the general characteristics of the marine water immediately surrounding Caye Caulker.

- Temperature: Varied seasonally from 24.5 °C to 29.9 °C, averaging 27.6 °C, consistent with the tropical marine environment.
- pH: Ranged from 7.24 to 8.35, indicating generally alkaline conditions typical of seawater.
- Salinity: Averaged around the normal seawater benchmark of 35 parts per thousand (ppt), with variations driven by rainfall dilution (as low as 28.4 ppt) and slight concentration increases (up to 36.8 ppt) at the onset of the rainy season.

Measured DO readings were indicative of acceptable water quality necessary to sustain marine life. However, localised reductions in DO may signal pockets of organic loading and decomposition, particularly in sheltered lagoon areas.

Nitrate concentrations recorded the highest readings during the rainy season at sites likely influenced by surface runoff and groundwater discharge. Phosphate concentrations varied from 0.1 to 1.5 ppm, which is significant in the context of typically oligotrophic (nutrient-poor) tropical marine systems, as changes in ambient levels greater than 1 ppm can drive eutrophication, promoting algal growth that smothers coral reefs and seagrass beds. All monitored marine sites showed the presence of total and faecal coliform bacteria. Although levels were within WHO-recommended standards for recreational waters, their consistent detection indicates contamination from human sewage. This contamination is almost certainly linked to failing on-site wastewater systems on land, greywater discharge, and inadequate solid waste management.

4.2.6 Currents and Tides

Water circulation in Belizean waters and the Cayes area at the macro level is dominated by surface currents and cyclonic, counterclockwise rotating circulating gyres. The main flow of currents is directed northward up along the Mexican coast, flowing past Cuba and out into the Gulf of Mexico. These gyres are generated south of the Caribbean current as it flows from east to west and crosses the shallow banks between Honduras and Jamaica.

These cyclonic gyres, characterised by a central water level depression of 20 - 30 cm, progress westward along the coast of Honduras towards the Belize Barrier Reef. The gyre is generated every few months and requires 2-3 months to reach the Barrier Reef (Heyman and Kjerfve, 2001). These cyclonic eddies are confined to an area south of latitude 18.5° N.

Although tide heights are minimal (15 centimetres), the currents generated by them through reef cuts and faros play a significant role in the spatial dispersion of sediment, nutrients, and larvae along the shallow reef flats (Heyman & Kjerfve 2001). Incoming currents greatly exceed ebb currents. This indicates a slow, continual infilling of the lagoon with fresh oceanic waters. Local currents within the lagoon and platforms are mainly wind-driven while those that occur near cuts are strongly influenced by the tides (Rath, 1996). King tides are experienced periodically across Caye Caulker, the most recent of which caused flooding in and around the project area.

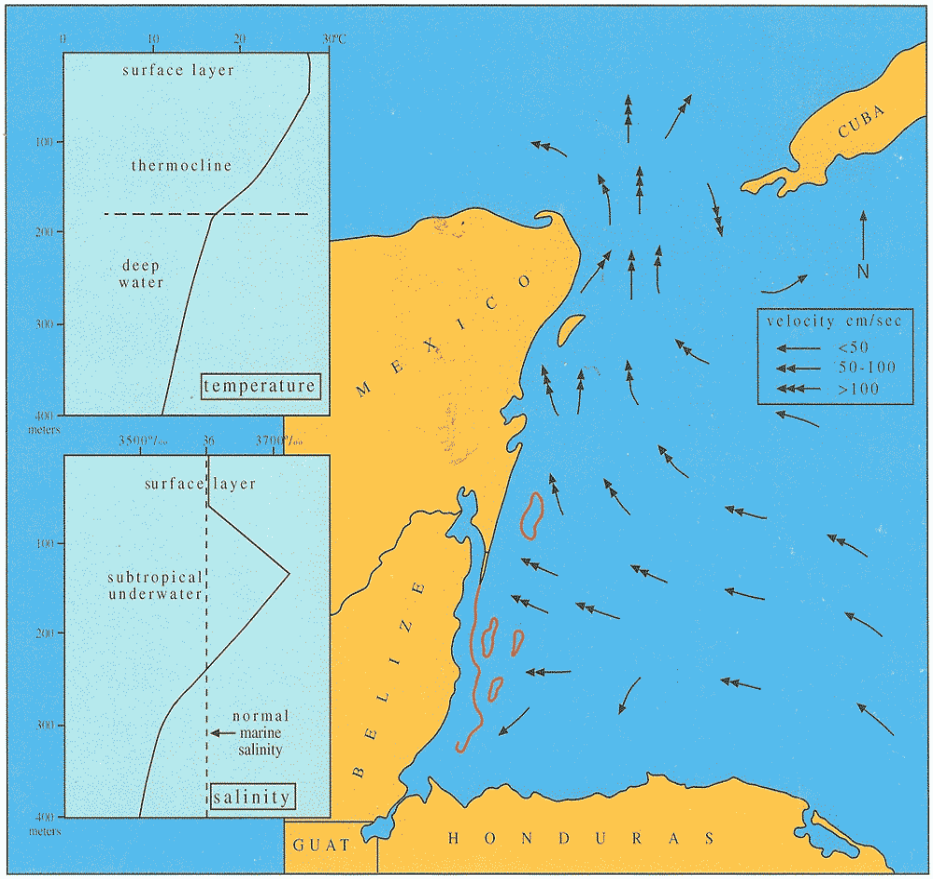


Figure 4-5: Map of the Surface Currents Affecting Belize

4.2.7 Disaster Risk

The following analysis is guided by the IDB's Disaster and Climate Change Risk Assessment Methodology with particular focus on wastewater systems. It includes the identification and assessment of criticality and vulnerability within the context of the proposed project and Caye Caulker (i.e., the potential physical negative effects on the structure, population and services that a failure of the operation could cause due to natural hazards). This process will help to classify the level of disaster risk anticipated. A supporting Disaster Risk Management Plan is provided in Section 6.5.5 to guide the application of mitigative measures for the project.

4.2.7.1 Step 1: Hazard Exposure

Caye Caulker, like much of Belize's coastal zone, is highly vulnerable to a range of natural hazards, reflecting its geographic position in the western Caribbean, its low-lying coastal topography, and its reliance on fragile ecosystems for natural protection. Disaster risk in Caye Caulker is shaped by the interplay of extreme weather events, sea-level rise, storm surge, flooding, and climate change impacts. As such, IDB specialists provided a preliminary classification of disaster risk as 'High'. The hazards identified are detailed below.

TROPICAL CYCLONES AND HURRICANES

Caye Caulker lies squarely within the Atlantic hurricane belt and is routinely exposed to the impacts of tropical cyclones during the hurricane season (June–November). According to the NOAA Hurricane Statistics for Belize, there have been 10 hurricanes since 1945 which have passed within 60 nautical miles of Caye Caulker (Figure 4-6), with several of them severely impacting the country's buildings, infrastructure, development, and economy. Hurricanes bring high winds, torrential rainfall, storm surge, and wave action that can devastate infrastructure, cause flooding, erode coastlines, and damage ecosystems.

The impacts of hurricanes and tropical storms on the island coastline are issues of major concern. Caye Caulker was directly affected by Hurricane Hattie in 1961. The storm surge from this hurricane contributed significantly to the widening of an existing hand-dug channel created by local fishermen to navigate between both sides of the island. This resulted in 'The Split' that now divides Caye Caulker. Hurricane Mitch in 1998 caused severe erosion and shoreline destruction, destroying most of the piers on the Caye, although it did not hit Belize directly. In 2000, Hurricane Keith lingered offshore Ambergris Caye before moving across the Chetumal Bay as a category four hurricane and caused severe damage to the western coast of Caye Caulker. It also destroyed much of the fringing mangroves, which have since recovered, and even the highest points inland across the village were flooded. Tropical Storm Chantal 2001 produced wind gusts of about 71 mph, once more damaging sea walls and piers across Caye Caulker, resulting in coastline erosion. More recently, Hurricane Earl (2016) caused severe damage on the island, including widespread flooding, destruction of buildings, loss of tourism revenues, and threats to life and health. Projections indicate the potential for increasing storm intensity under climate change scenarios, even if overall storm frequency remains constant or declines.

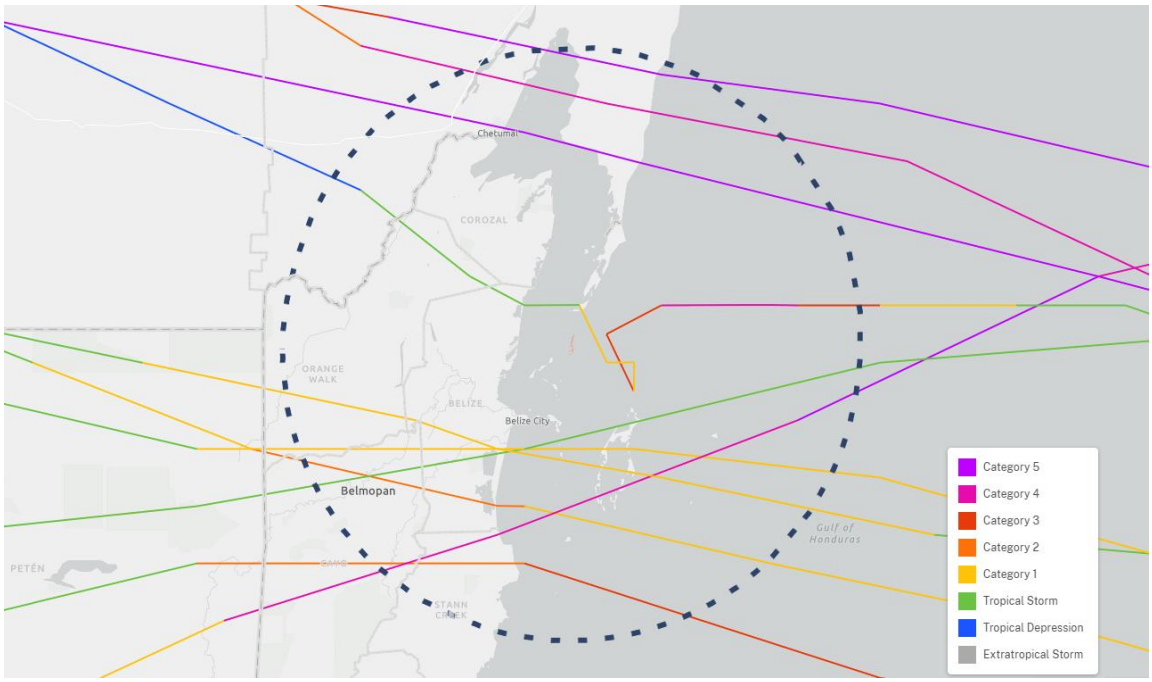


Figure 4-6: History of hurricanes making landfall or passing in close proximity to Caye Caulker since the 1940s. Source: NOAA Historical Tracker Tool

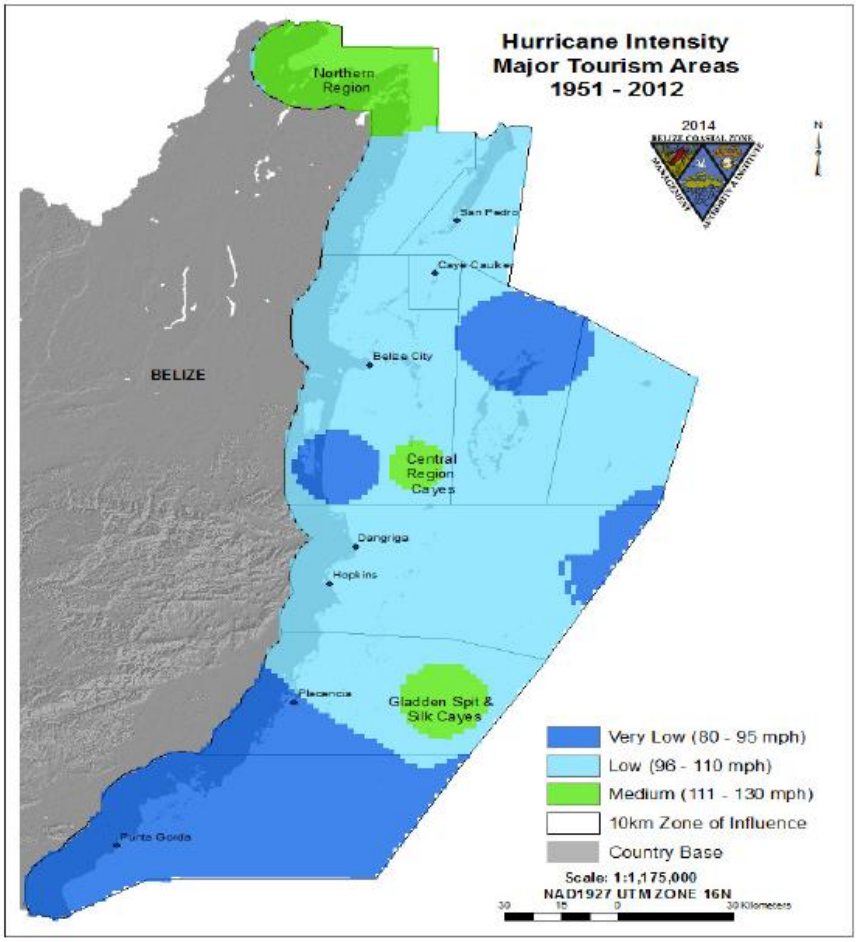


Figure 4-7: Hurricane wind speed average from 1951-2012 (Source: Belize CZMAI, 2014)

Storm Surge and Coastal Flooding

One of the most severe hazards for Caye Caulker is storm surge. The low elevation of Caye Caulker (generally 0.5–1.5 meters above sea level) makes it highly susceptible to storm surge, where hurricane-driven sea levels can rise by over 1–2 meters. Surge events inundate homes, roads, and critical infrastructure, including sanitation systems. Floodwaters can carry debris, sewage, and contaminants, creating major health hazards and disrupting services.

Sea Level Rise (SLR)

Sea-level rise is a chronic hazard that compounds the risk from storm surges and tidal flooding. Climate change projections indicate that sea levels in the Caribbean are rising at approximately 3 mm/year, with acceleration expected under high-emission scenarios. Even modest sea-level rise significantly increases baseline flooding risk in Caye Caulker, making regular tides, seasonal highs, and storm surge events more destructive over time. Inundation threatens the long-term viability of built infrastructure, freshwater lenses, and tourism assets. Based on studies led by CARIBSAVE in 2011, a total of 36,065.03 m^2 of land is projected to be lost due to SLR, with total beach losses of 4,327.43 m^2. This is expected to impact several tourism properties, including Caye Reef Beachfront Luxury, Ocean Pearl Royale Hotel, Costa Maya Beach Cabanas and Sea Dreams Hotel (Figure 4-8).

Figure 4-8: Total Land and Beach Loss based on the projected effects of 100cm sea-level rise in Caye Caulker Village

Table 4-1: Beach Area Lost from Sea Level Rise (SLR) in Caye Caulker

SLR Scenario	Land Area Lost to SLR (m^2)	Beach Area Lost (%)
0.5 m	723	17
1.0 m	3424	96
2.0 m	180	100

Extreme Heat and Drought

Though less dramatic than hurricanes, increasing temperatures and shifting rainfall patterns can stress water supplies, increase energy demands, and exacerbate health risks. Droughts can reduce freshwater availability and impair the functioning of sanitation systems that depend on water flow. Extreme heat can also result in increased sea surface temperatures that can result in bleaching and stress to corals and other marine organisms. Figure 4-9 shows the thermal stress levels recorded across the Belize Cayes between 2006 and 2010.

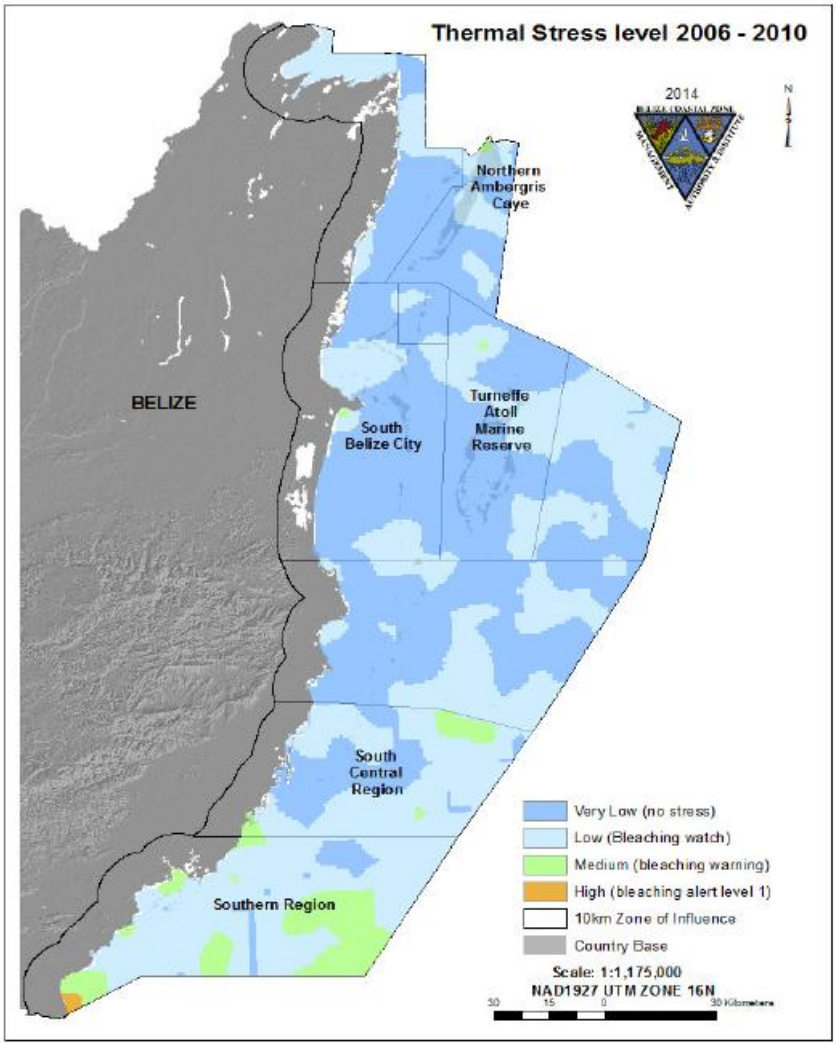


Figure 4-9: Summary analysis of exposure to thermal stress from elevated sea surface temperature on coral reefs across Belize, including Caye Caulker[2]

[2] Map sourced from: Analyzing Vulnerability of the Belize Coastal Tourism Sector (2014)

Extreme Rainfall and Flooding

Heavy rainfall events, whether associated with cyclones or seasonal thunderstorms, can lead to surface flooding and ponding due to the island's flat topography and poor drainage capacity. The porous limestone substrate offers limited attenuation during extreme rainfall, and areas of the village can experience prolonged waterlogging, disrupting transport, damaging property, and increasing mosquito breeding.

Erosion and Coastal Degradation

Storm events, wave action, and rising seas can erode beaches and shoreline vegetation, including critical mangroves that buffer the island against waves and surge. Loss of these natural barriers reduces the island's resilience to future hazards. In addition, land clearance and unplanned development can exacerbate erosion and sedimentation.

Regional climate models for the Caribbean project higher average temperatures, more intense rainfall events, greater variability in seasonal precipitation, and increased frequency of intense hurricanes (See Box 1 for more details on Belize). These trends imply a growing risk of combined hazards, including stronger storms producing higher surge atop elevated sea levels, with cascading impacts on infrastructure, ecosystems, and community health. Climate change is expected to worsen most of these hazards.

Box 1: Climate Modelling Projections for Belize

Temperature: Regional Climate Model (RCM) projections indicate increases between 3.5˚C and 3.6˚C in mean annual temperatures by the 2080s, in the higher emissions scenario.

Precipitation: Global Climate Model (GCM) projections of rainfall span both overall increases and decreases, ranging from -34 to +13 mm per month by 2080 under a higher emissions scenario. Most projections tend toward decreases. The RCM projections, driven by HadCM3 boundary conditions, indicate large decreases in all seasons (-26%) and decreases of (-32%) with ECHAM4.

Sea Surface Temperatures (SST): GCM projections indicate increases in SST throughout the year. Projected increases range from +0.8˚C and +2.7˚C by the 2080s across all three emissions scenarios.

Tropical Storms and Hurricanes: North Atlantic hurricanes and tropical storms appear to have increased in intensity over the last 30 years. Observed and projected increases in SSTs indicate potential for continuing increases in hurricane activity and model projections indicate that this may occur through increases in intensity of events but not necessarily though increases in frequency of storms.

For small, low-lying islands like Caye Caulker, even incremental sea-level rise can translate into large increases in the area exposed to flooding and storm damage. This disaster risk context is highly relevant for the planned wastewater collection and treatment system and based on the known conditions, the following has been taken into consideration in the design of the system:

- Infrastructure designed to withstand storm surges, flooding, and hurricane-force winds.
- Facilities are elevated and flood-proofed to avoid service disruption and environmental contamination.

- Emergency preparedness and backup power systems have been considered to improve resilience.
- Long-term planning has accounted for sea-level rise over the system's design life.

The following table provides a summary of key disaster events that have impacted Caye Caulker over the last 30 years. Information was compiled based on reports and historical records.

Year	Event Type	Description	Impacts
2000	Hurricane	Hurricane Keith Category 4 (sustained winds ~140 mph)	Severe flooding; extensive damage to buildings and docks; island cut off for days; major infrastructure loss
2007	Hurricane (Offshore)	Hurricane Dean Category 5 (landfall in Yucatán, Mexico)	Minor structural damage; beach erosion; precautionary evacuations; disruption of tourism
2010	Hurricane	Hurricane Richard Category 2 (landfall near Belize City)	Moderate rainfall and wind damage; some power outages and localised flooding
2016	Tropical Storm – Cat 1	Tropical Storm Earl Peak winds ~80 mph	Extensive flooding; damage to piers, homes, and power lines; loss of income from disrupted tourism
2020	Hurricane	Hurricane Nana Category 1 (landfall south of Belize City)	High winds and heavy rain; minor flooding; precautionary evacuations
2022	Hurricane	Hurricane Lisa Category 1 (landfall near Belize City)	Storm surge and heavy rainfall; flooding in low-lying areas; damage to coastal structures and vegetation
Recurring	Heavy Rainfall	Seasonal Flooding Variable (especially June–Nov)	Ponding in village streets; impacts on unpaved roads; overwhelmed soakaways; sanitation and vector risks

EXPOSURE

The interaction between elements at risk (e.g., roads, system infrastructure, etc.) and the potential hazards directly defines the level of exposure. For the WWTP project, the exposure inventory considers the following types of infrastructure and environment:

- Project infrastructure
- Supporting infrastructure (road network etc.)
- Residential properties connected to the system
- Commercial properties connected to the system (including hotels and other types of accommodations)
- Extent of coral reefs and other sensitive marine ecosystems

- Extent of mangrove ecosystems
- Health of coastal and marine habitats (coral, mangroves etc.)
- Tourism attractions.

SENSITIVITY

Caye Caulker's sensitivity to the above hazards reflects its physical characteristics, socio-economic context, and environmental conditions:

- Extremely flat terrain, which offers no natural elevation refuge from flooding or storm surge.
- High water table and porous substrate, which facilitates rapid infiltration and exfiltration, making septic systems prone to leakage and flooding.
- Dense village settlement, especially in the northern and central sections of South Caye Caulker, where homes and businesses are clustered on narrow streets with limited space for resilient infrastructure upgrades.
- The island's economy depends heavily on maintaining a safe, clean, attractive environment for visitors. Flooding, sewage failures, or beach erosion can cause severe economic harm.
- Mangroves, seagrass beds, and coral reefs provide essential protection against storm surge and wave energy but are themselves threatened by pollution, overuse, and climate impacts (e.g., coral bleaching).
- Limited resources for adaptation, given the nature of this small island community. Caye Caulker faces constraints in funding, technical capacity, and land availability to implement large-scale adaptation measures.

4.2.7.2 Step 2: Criticality and Vulnerability

VULNERABILITY

According to the vulnerability assessment done across the Belize cayes in 2014[3], Caye Caulker has a high vulnerability rank, particularly towards its tourism assets (Figure 4-10). These assets are considered to be at risk of hurricanes, storm surges and sea level rise which will significantly impact the local economy.

The planned wastewater system for Caye Caulker is both highly exposed to natural hazards and critically important for reducing the island's vulnerability to those same risks. The infrastructure components, such as pump stations, sewer lines, and the wastewater treatment plant, are directly at risk of damage from storm surge, coastal flooding, and hurricane-force winds. Without deliberate flood-resilient design, these facilities could fail at precisely the moments they are needed most, exacerbating public health and environmental hazards during emergencies.

[3] Analyzing Vulnerability of the Belize Coastal Tourism Sector (2014)

In terms of health protection, the new system addresses the long-standing issue of failing or flooded septic tanks that have led to contamination of both groundwater and surrounding coastal waters. To be effective, the infrastructure must be watertight, elevated, and engineered for resilience, ensuring continued function even under extreme weather conditions.

Beyond human health, the project also plays a critical environmental role by reducing the discharge of untreated wastewater into sensitive marine ecosystems. By improving wastewater treatment and containment, the system helps protect mangroves, seagrass beds, and coral reefs, i.e., natural features that provide vital ecosystem services such as shoreline stabilisation and buffering against storm surge.

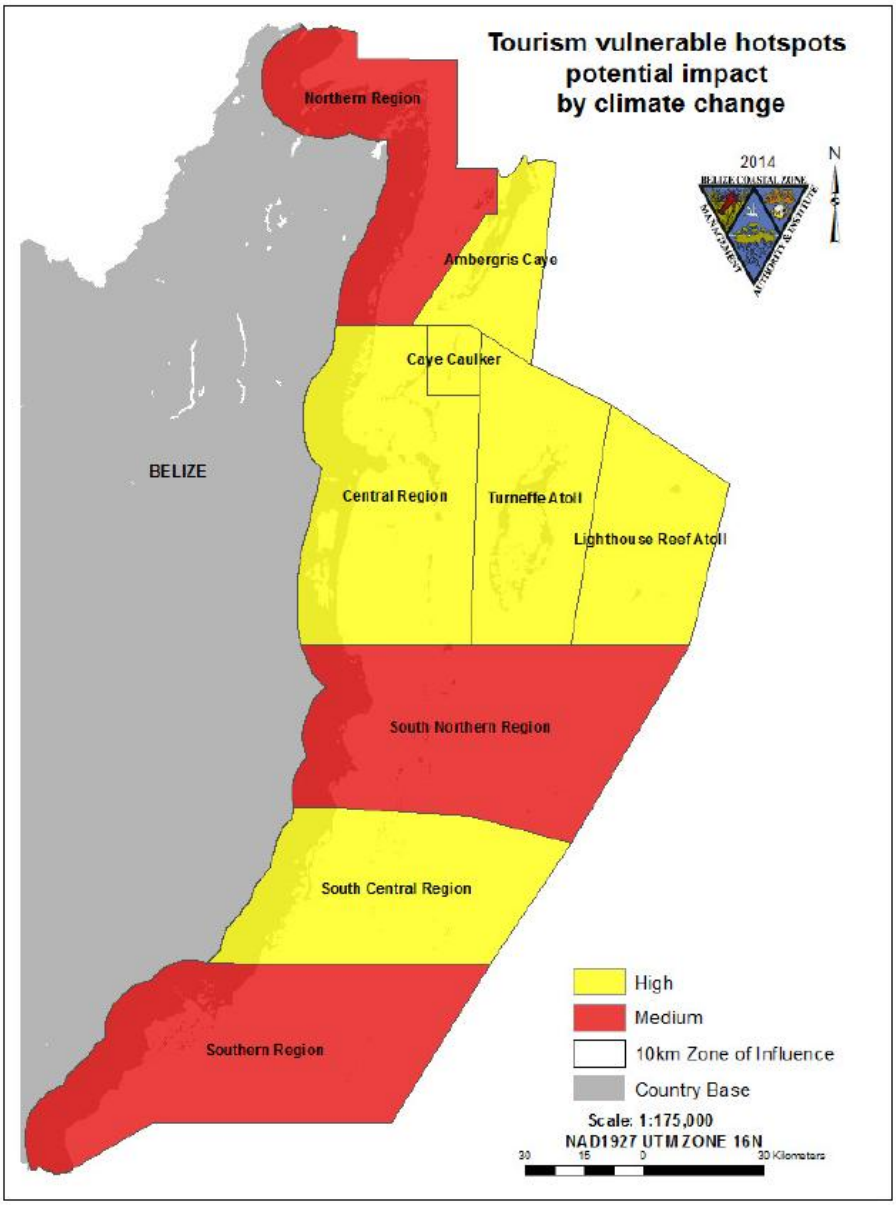


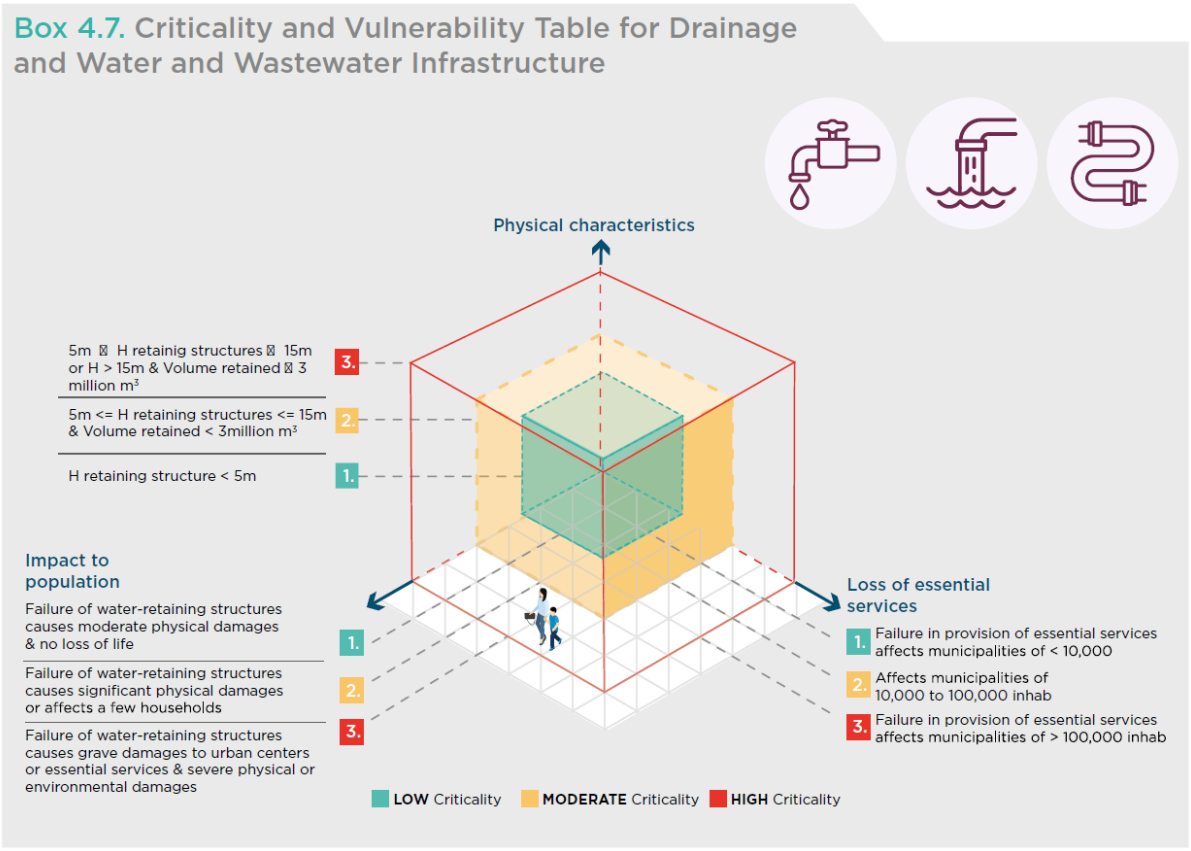
Figure 4-10: Relative Vulnerability of Belize Cayes[4]

[4] Map sourced from: Analyzing Vulnerability of the Belize Coastal Tourism Sector (2014)

Maintaining continuity of service is also essential. Hurricanes and other hazard events frequently disrupt electricity and damage surface infrastructure. The wastewater system must therefore include robust backup power systems, emergency operation protocols, and trained personnel to ensure uninterrupted service during and after such events.

Importantly, the project also represents a strategic opportunity to align with the Inter-American Development Bank's recommendations for climate-resilient infrastructure development in Belize. This includes incorporating elevated, modular, and adaptable treatment systems and ensuring that community engagement activities promote long-term environmental stewardship and disaster risk awareness.

Box 4.7. Criticality and Vulnerability Table for Drainage and Water and Wastewater Infrastructure



Criticality and vulnerability of the wastewater system in Caye Caulker (assuming that all current and future BWS customers connect to the system)

KEY COMPONENT	LOW	MODERATE	HIGH
DIMENSION 1: LOSS OF ESSENTIAL SERVICES			
IMPACTS ON SERVICE FUNCTIONALITY			Failure in the provision of wastewater management services, affecting a municipality with fewer than 10,000

KEY COMPONENT	LOW	MODERATE	HIGH
			Inhabitants [although the n*umber of inhabitants expected to be impacted in Caye Caulker by 2034 is approximately 5,133 residents and tourists, this represents 80-90% of the population*]
DIMENSION 2: IMPACT ON POPULATION			
IMPACTS ON POPULATION		The failure of the wastewater structure causes important physical damage to other assets and/or the environment, or affects a small number of households [*pipeline network is located a few centimetres below the surface and if damaged can overflow roads and nearby properties*]	
DIMENSION 3: PHYSICAL CHARACTERISTICS			
PHYSICAL CHARACTERISTICS OF WASTEWATER MANAGEMENT SYSTEMS	The existence of wastewater management structures with a height of less than 5 meters [*containers less than 5m in height and tank storage capacity of 700m^3*]		
DISASTER AND CLIMATE CHANGE RISK CLASSIFICATION (DCCRC) FOR THE OPERATION: HIGH			

4.2.7.3 Step 3: Diagnostic Narrative

The proposed Caye Caulker Wastewater Collection and Treatment System Project represents an essential investment in public health, environmental sustainability, and climate resilience for this vulnerable island community. Applying the IDB Disaster and Climate Change Risk Assessment Methodology, the project's overall risk profile emerges as high, with important considerations of hazard exposure, criticality, and vulnerability that inform both design and long-term management.

As detailed above, Caye Caulker's geographic and environmental context leaves it highly exposed to a range of climate and disaster hazards. The island's low elevation, porous limestone foundation, and proximity to the Caribbean Sea mean it faces significant threats from hurricanes, tropical storms, storm surge inundation, sea-level rise, and intense rainfall events that can overwhelm drainage and flood low-lying areas. These events are projected to increase in frequency and intensity due to climate change, making exposure to natural hazards a persistent, systemic risk for all built infrastructure on the island, including the planned wastewater collection network, pumping stations, and modular treatment plant.

The criticality of this wastewater system is classified as high. Although the island's permanent and transient population (expected to reach approximately 5,133 residents and tourists by 2034) is below the 10,000 mark outlined in the cube, the system will serve 80–90% of the total community. This high service coverage underscores the essential role of the system in maintaining public health, preventing groundwater contamination, and protecting marine ecosystems that are critical to both biodiversity and the tourism-driven local economy. Service failure during disaster events could undermine sanitation island-wide, create serious public health risks, and compromise Belize's commitments to environmental protection in a globally significant World Heritage Site.

Additionally, the project's physical infrastructure will be installed in a challenging environment. Given the nature of the high water table, the vacuum collection pipeline network is planned just a few centimetres below the surface, making it vulnerable to damage from flooding, erosion, and physical disturbance, which could lead to sewage overflows onto roads and adjacent properties. While such overflows might be localised, directly affecting a smaller number of individual properties (suggesting a low to moderate direct population impact), the environmental consequences are more significant. Untreated wastewater discharge can quickly contaminate soil and water, cause odours, and put individuals at risk of infection. The treatment system's physical scale is also an essential factor. While the container treatment system has a relatively low vertical profile and low storage capacity (less than 5 meters in height, with ≤700 m^3 of storage capacity in each tank), which reduces wind damage risk, these components still require robust floodproofing and corrosion protection given the island's exposure to saltwater, wind-driven rain, and possible wave overwash during hurricanes.

Based on the IDB methodology and the detailed impact assessment results, the project is assessed as having high criticality and vulnerability. As such, a Disaster Risk Management Plan has been developed (see Section 6.5.5), however, further detailed assessments must be undertaken to fully determine the appropriate resilience measures to be integrated that can minimise risks and complement those that have already been considered.

Disaster Risks in Project Components

Applicable Disaster Risk and Mitigation Measures
Component 1: Wastewater Collection and Treatment System (Main Infrastructure Works)

- **Risks:**
  - *Storm Surge and Coastal Flooding* – The entire system, including buried vacuum sewer lines, pumping stations, and the treatment plant, is at risk of flooding from storm surge during hurricanes or extreme tides. Flooding could damage equipment, contaminate groundwater with untreated sewage, or disrupt service.
  - *Sea-Level Rise* – Long-term sea-level rise will increase baseline water levels, exacerbating flood exposure and reducing drainage capacity.
  - *Hurricanes and High Winds* – Can cause structural damage to treatment plant buildings, power supply, and control systems.
  - *Heavy Rainfall Flooding* – Overwhelms drainage at plant sites and in streets, leading to inflow/infiltration into sewers, overloading the system.
  - *Power Outages During Storms* – Disrupt pumping and treatment processes.
  - *Coastal Erosion* – Threatens plant sites or access roads over time if not properly sited and protected.
- **Mitigation Measures:**
  - *Flood-Resilient Siting* – Locate the WWTP and pumping stations on elevated platforms above known storm surge levels, with freeboard for climate projections.
  - *Flood-Proof Design* – Use watertight, corrosion-resistant materials; seal critical access points in sewer lines; elevate electrical systems.
  - *Stormwater Management* – Incorporate site drainage and grading to divert water away from facilities.
  - *Backup Power Systems* – Install standby generators with fuel storage to maintain operation during outages.
  - *Hurricane-Resistant Structures* – Design buildings to withstand Category 4 hurricane wind loads per Belize building codes.
  - *Emergency Response Planning* – Include shut-down and start-up procedures, staffing protocols, and coordination with NEMO and emergency responders on the island.
  - *Monitoring for Sea-Level Rise* – Plan for future adjustments, such as higher fill or additional berms, as sea level increases.

Applicable Disaster Risk and Mitigation Measures

COMPONENT 2: IMPROVEMENT OF SERVICES BY BWS

- **Risks:**
  - *Disruption to Business Continuity* – Hurricanes or floods could damage BWS offices, IT systems (including GIS/MIS), or records.
  - *Staff Capacity Gaps* – Inadequate training in emergency preparedness and disaster-resilient planning could result in poor response.
- **Mitigation Measures:**
  - *Disaster-Resilient Information Systems* – Ensure off-site backups of GIS/MIS data; secure cloud storage solutions.
  - *Business Continuity Planning* – Include disaster scenarios in operational manuals; plan for alternative work locations or remote management.
  - *Cybersecurity Improvements* – Conduct diagnostics and implement recommendations, including disaster-response cybersecurity protocols.
  - *Staff Training* – Integrate disaster preparedness and climate adaptation into capacity-building activities; conduct regular drills.
  - *Asset Management Integration* – Include vulnerability and risk data in BWS asset management systems to prioritise investments in resilient infrastructure.

COMPONENT 3: INSTITUTIONAL STRENGTHENING TO SUPPORT BWS'S ENVIRONMENTAL SUSTAINABILITY COMMITMENT

- **Risks:**
  - *Failure to Account for Climate Change in Planning* – Without strong integration of climate and biodiversity considerations, future investments could increase vulnerability (e.g., siting infrastructure in flood-prone zones).
  - *Limited Capacity to Monitor Impacts* – Without robust systems, BWS may not detect or respond to environmental degradation that increases disaster risk (e.g., mangrove loss reducing storm surge protection).
  - *Lack of Alignment with National Strategies* – Missing opportunities for co-financing or policy support if monitoring systems and planning do not align with national adaptation frameworks.
- **Mitigation Measures:**
  - *Climate and Nature Strategy* - Explicitly incorporate hazard mapping, sea-level rise projections, and ecosystem services (e.g., mangrove buffers) into planning guidelines.
  - *Monitoring and Verification Systems* - Build capacity to track flooding, storm damage, and biodiversity health in service areas.

Applicable Disaster Risk and Mitigation Measures

- *Staff Training* – Include climate risk assessment methods and nature-based solutions in BWS training programs.

- *Coordination with National Agencies* – Align data systems and planning methods with national adaptation plans and disaster risk management authorities.

COMPONENT 4: PROJECT MANAGEMENT, AUDIT, AND EVALUATION

- **Risks:**
  - *Disruption to Project Management* – Extreme weather events could delay implementation, damage contractor facilities, or reduce staff availability.
  - *Weak Oversight of Safeguards* – Without robust supervision, disaster-resilient design measures could be neglected or under-resourced during construction.
  - *Evaluation Blind Spots* – Risk that mid-term or final evaluations fail to adequately assess disaster risk management and climate resilience outcomes.
- **Mitigation Measures:**
  - *Incorporate Disaster Risk into Management Plans* – Include climate and disaster risk screening in procurement, construction supervision, and contractor performance evaluations.
  - *Flexible Implementation Planning* – Build contingency time and budgets for storm-related delays.
  - *Strengthen Audit Terms of Reference* – Require explicit assessment of environmental and social safeguards, including disaster preparedness and climate adaptation measures.
  - *Include Disaster Risk Indicators in M&E* – Monitor resilience outcomes such as flood-proofing completion, emergency plan readiness, and staff training coverage.

4.3 Biological Environment Baseline

4.3.1 Terrestrial Ecosystems

Littoral Forests

Based on ecological studies conducted across the island between 2005 and 2009[5], approximately 270 species of plants are present across the Caye. Most of these plants were found to be native to Belize or the Americas, but many were also non-native species that were introduced from Asia, Africa or Australia. The ecology of the island is determined by the island's geology and soil type. Although the island was once covered with a littoral forest, this is sustained by a very thin layer of topsoil that builds up on the sand from the breakdown of organic matter.

The littoral forest once covered the entire dry sand ridge of Caye Caulker. This ridge runs from the southern end of the island to the northern tip of the island. Being situated on higher sandy ground and less waterlogged than mangrove forests, littoral forests are the most susceptible ecosystem to coastal development, especially in areas where there is limited land. This ecosystem is rapidly disappearing, and about a third of the littoral forest on the North of the island has already been planned and subdivided into housing lots to accommodate present demands. Trees of particular interest include gumbolimbo (*Bursera simaruba*), cocoplum (*Chrysobalanus icaco*), sea grape (*Coccoloba uvifera*), zericote (*Cordia sebestena*), fig (*Ficus crassinervia*), black poison wood (Metopium brownei), xo-coi (*Pithecellobium keyense*), and saltwater palmetto (*Thrinax radiata*). This vegetation cover provides habitat for a variety of birds, including migratory birds. There have been over a hundred species of birds sighted and recorded across the Caye. These include several species of conservation significance such as the black catbird, white-crowned pigeon and rufus-necked rail.

4.3.2 Coastal Ecosystems

Mangrove Forests

The mangrove forest of the island is also typical of what is found in the larger, higher coralline islands, indicative of mangrove colonisation and succession patterns. In the shallow water, they are rich in animal life and a breeding ground for fish and other sea animals.

The northern and southern ends of the island and most of its western coastline are fringed with red mangroves (*Rhizophora mangle*), typical of most of the other islands of the area. Taller black mangroves (*Avicennia germinans*) are intermixed with red mangroves and are more inland in areas periodically inundated by the tides. In and around the project area (north of the airstrip to the west of Bahia Puesto del Sol) a wetland area remains where the dominant tree is the black mangrove, however, these are partially degraded from a combination of hydrological changes, nearby dumping and the impact of hurricanes, e.g., Hurricane Keith in 2000. Community-led replanting activities in Caye Caulker have achieved positive results using new techniques such as the Riley-encasement methodology (CARIBSAVE, 2014). The white mangroves (*Laguncularia racemosa*) intermixed with buttonwood (*Conocarpus erecta*) are found on the higher and drier

[5] Assessments were conducted by Dr. Jacob Rietsema, Dorothy Beveridge, and Judy Lumb to establish a plant inventory

elevations atop the sand ridge located in the centre of the widest part of the Caye. In 2016, there was approximately 2 km^2 of mangrove cover across the Caye Caulker Planning Region, most of which was located at the northern and southern ends of the island. Mapping of mangrove habitat risk assessment scores indicates that human activities have a medium impact on those located on Caye Caulker, primarily linked to development.

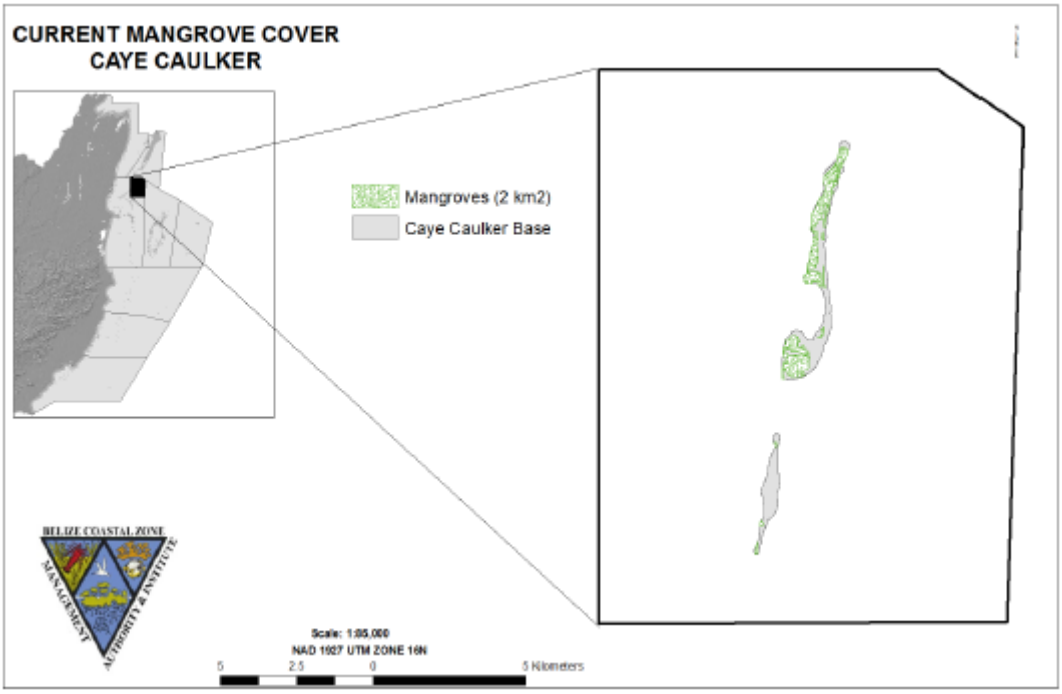


Figure 4-11: Mangrove Cover across the Caye Caulker Planning Region

4.3.3 Marine Ecosystems

SEAGRASS BEDS

There are extensive seagrass beds on the eastern coast of the island, which contribute to the total biomass of Caye Caulker. Daily dead leaves of Manatee grass (*Syringodium filiforme*) and Turtle grass (*Thalassia testudinum*) are washed ashore along the beach of the village and have to be removed regularly. As the common names imply, manatees, turtles and other sea animals feed on these grasses. Seagrass beds also support large populations of manatees, which are an important eco-tourism attraction around Caye Caulker. In 2016, the total seagrass cover for the Caye Caulker region was approximately 152 km^2. Mapping of seagrass habitat risk assessment scores indicates that human activities are having a high impact on the seagrass immediately surrounding the Caye, with medium impacts on areas located further away.

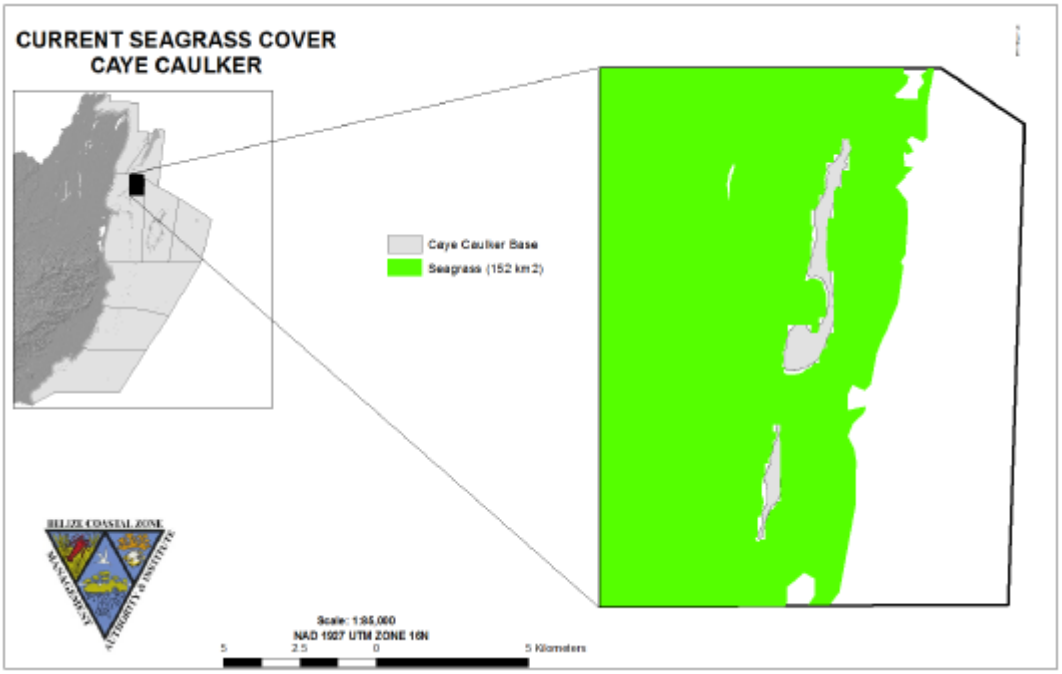


Figure 4-12: Seagrass Cover across the Caye Caulker Planning Region

Coral Reefs

There are two principal types of reef systems surrounding Caye Caulker. These include a barrier reef system, popularly known as the Belize Barrier Reef Reserve System, which is characterised by a prominent reef crest. The second type of reef system is referred to as a patch reef system. The patch reefs are generally found on gently raised sub-tidal promontories in the immediate area of the back-reef, as well as the shallower areas of the barrier lagoon, including the nearshore areas surrounding various cayes. The reef crest is characterised by semi-emergent coral forms. The deeper fore reef areas are dominated by branching, boulder-type and plate-like corals. The reef crest and back-reef areas are characterised by palmate and boulder-type coral forms. In 2016, the total coral cover in this region was approximately 9 km^2. Mapping of coral habitat risk assessment scores indicates that human activities are having a medium impact on the Belize Barrier Reef System, with higher impacts on coral patches located closer to Caye Caulker.

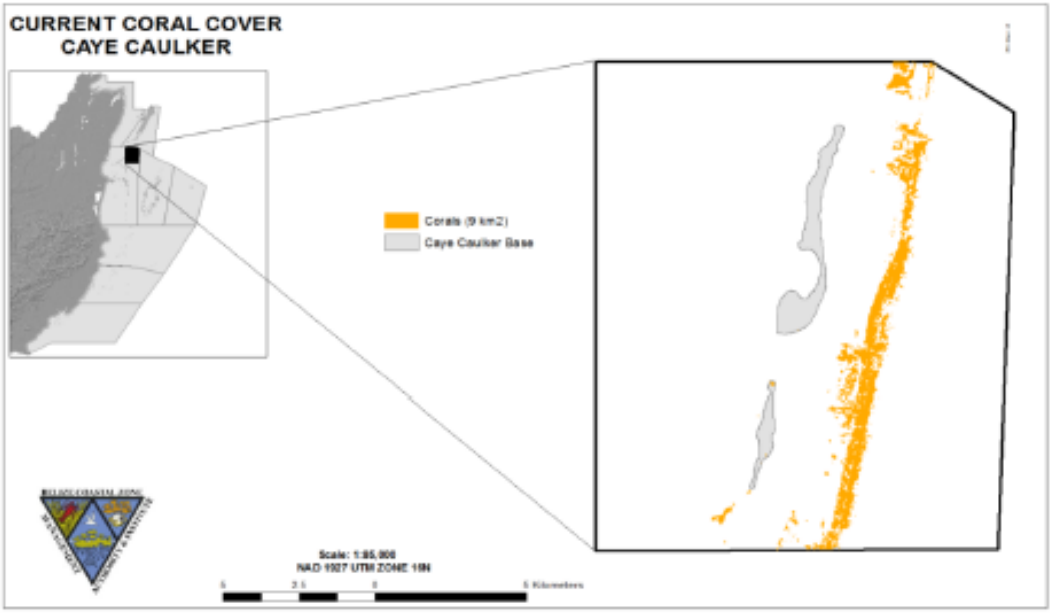


Figure 4-13: Coral Cover across the Caye Caulker Planning Region

4.3.4 Protected Areas

Approximately 100 acres of the northern tip of the island were declared a Forest Reserve in 1998 as a complement to the Caye Caulker Marine Reserve, which was also declared under the Fisheries Act of that same year (Figure 4-14). The red mangroves remain the predominant vegetation in the northern and southern fringes of the island. These areas were given protected status to protect a representative sample of the island's ecosystems. Commercial, recreational, and scientific uses are managed by establishing zones and enforcing the regulations for each zone. The forest and marine reserves encompass an area of 0.5 square kilometers and 40 square kilometers, respectively[6]. The Hol Chan Marine Reserve is located north of Caye Caulker surrounding the south-eastern tip of San Pedro, Ambergris Caye.

[6] Coastal Zone Management Authority and Institute (2016) Caye Caulker Coastal Zone Management Guidelines: Belize Integrated Coastal Zone Management Plan

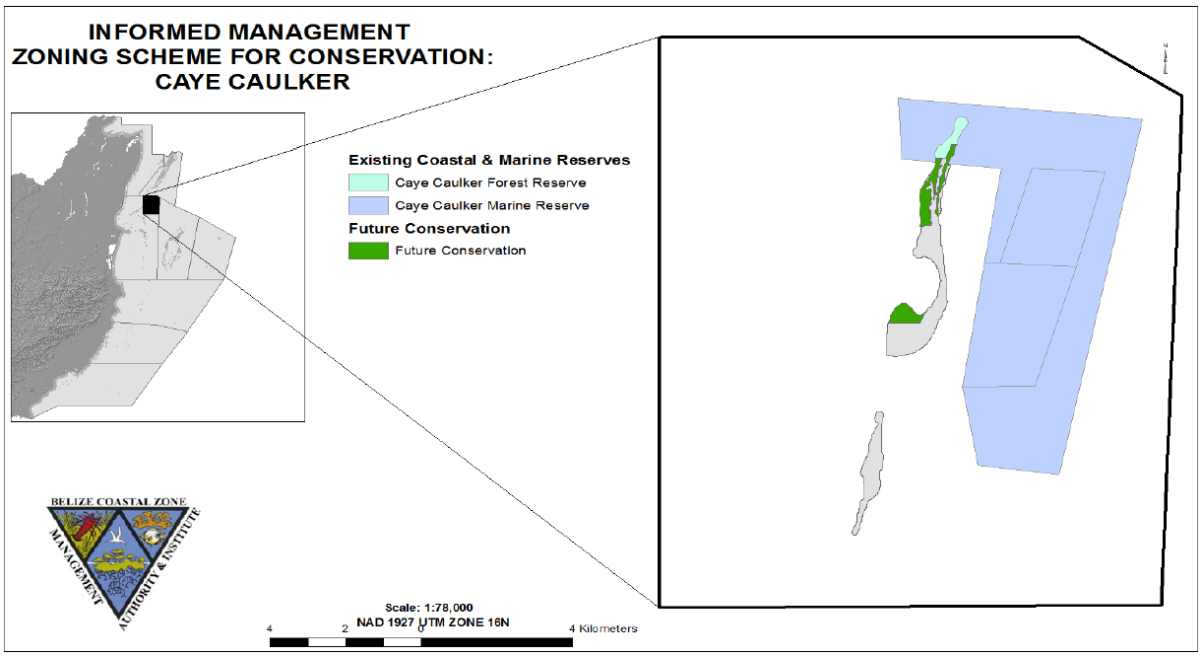


Figure 4-14: Conservation areas surrounding Caye Caulker

4.4 Socioeconomic Environment Baseline

4.4.1 Demographics and Settlement Patterns

The island is physically divided by a narrow channel known as 'The Split' into North and South Caye Caulker. The vast majority of the permanent population lives on South Caye Caulker, where the main village and most of the island's businesses and services are concentrated.

Population estimates for the island vary slightly by source. The 2022 Census reports a total of 2,729 residents, with a gender distribution of approximately 54% male (1,469) and 46% female (1,259). Other sources suggest it may approach 3,500 when accounting for seasonal and informal residency patterns. Between 2010 and 2022, Caye Caulker's population grew by 64%, reflecting sustained in-migration linked largely to the island's tourism economy and the seasonality of employment opportunities throughout the year.

During the peak tourism season, which typically runs from late November through April, the island hosts significantly higher numbers of people. Many seasonal workers arrive to take up short-term jobs in the tourism sector, while expatriates and visitors occupy vacation rentals. Projections from an IDB 2022 report estimate that by 2025, the total island population will reach approximately 3,661 people, comprising around 2,761 permanent residents and 899 tourists.

The majority of the island's permanent population resides on South Caye Caulker. The local population, known as *Hicaqueños*, live year-round on the island and are of mixed ethnic heritage. According to the 2022 Population and Housing Census published by the Statistical Institute of Belize, approximately 51% of residents identify as Mestizo, Latino, or Hispanic, with the remainder comprising East Indian and other groups.

4.4.2 Land Use, Housing and Tenure

South Caye Caulker's settlement pattern is dense, with narrow sand streets and informal grid layouts. Buildings are typically low-rise, constructed on pilings or filled ground to reduce flooding risk. Housing quality varies, with a mix of modern guesthouses, older wooden homes, and small cement block houses.

Pressure on land and housing has grown with the tourism boom. Rental prices rise significantly during peak season, making housing affordability a challenge for lower-income workers and seasonal migrants. Informal subdivision and unplanned development also contribute to challenges in managing drainage, sanitation, and coastal erosion.

The Statistical Institute of Belize's 2022 Population and Housing Census Report indicated that there are 967 households in Caye Caulker. There has been a significant increase (57%) in the number of households from 555 in 2010 to 967 in 2022. Household size has also increased during the intercensal period by 25% from 3.6 persons in 2010 to 4 in 2022. The Belize Water Services (BWS) has estimated that they are connected to an estimated 900 of these households.

Regarding home ownership in Caye Caulker, sixty percent (60%) of the permanent population own their properties; however, there is a significant segment of the population (34%) that rents.

The northern portion contains the only available National Lands and has recently been targeted for development in the form of both private and governmental residential subdivisions.

Figure 4-15: Sample of the housing stock in Caye Caulker

4.4.3 Education

Based on information gathered from key local stakeholders engaged and the site visit, the school-going population of South Caye Caulker is served locally by the Caye Caulker Roman Catholic School and Ocean Academy High School. Students also attend La Isla Cariñosa, which strictly offers virtual learning. Additionally, approximately twenty students from Caye Caulker attend school in Belize City, commuting daily by water ferry. These students are often described as *legacy students*, continuing a tradition in which their parents and family members also attended these mainland schools.

Figure 4-16: Caye Caulker Roman Catholic School

For most residents of Caye Caulker, secondary education represents the highest level of educational attainment. However, students interested in pursuing tertiary education are required to prepare for the standardized examinations administered by the Association of Tertiary Level Institutions of Belize (ATLIB). This requirement is established by the Ministry of Education, Science and Technology, which describes ATLIB's role as promoting, advocating for, and actively participating in the continuous development of a relevant, sustainable, and high-quality education system aimed at improving the quality of life of all Belizeans.

Passing the ATLIB examination enables Belizean students to qualify for entry into various tertiary institutions across the country, including the University of Belize in Belmopan and the University of the West Indies Open Campus in Belize City. The University of Belize maintains several campuses nationwide and offers a variety of training programs that can be completed in a hybrid setting, depending on course requirements. However, for degree programs that involve laboratory work, experimentation, or guided practical training, such as those in the applied sciences or medicine, students are required to attend in-person classes to meet curriculum requirements.

Additionally, recognizing the importance of tourism to the local economy, the Belize Tourism Board offers a two-month training course for individuals seeking certification as tour guides on the island, helping to strengthen local capacity for tourism services and employment.

4.4.4 Economics

Caye Caulker's economic landscape has evolved rapidly over the past two decades, transitioning from a traditional fishing village into a vibrant tourism destination. This shift has significantly influenced livelihoods, land use, and social dynamics on the island, particularly in the main settlement of Caye Caulker Village on South Caye Caulker.

Historically, fishing was the primary economic activity for the island's residents. The harvesting of lobster, conch, and finfish not only supported livelihoods but also shaped the island's social fabric, architecture, and coastal settlement patterns. Despite a gradual decline in productivity, reflected in reduced catch sizes and fisher-reported declines in conch, lobster, and finfish, fishing remains culturally significant and continues to support a portion of the population, contributing an estimated 25% to the island's economy. During the COVID-19 pandemic, when tourism came to a halt, the community relied heavily on fishing as a fallback livelihood, underscoring its enduring relevance.

To promote sustainability, local fishers are governed by national fisheries regulations, including seasonal closures and designated marine reserve zones. Continued protection of the reef, seagrass beds, and mangrove ecosystems is essential to maintaining this heritage industry, as these ecosystems support both biodiversity and the fishery itself.

Today, tourism is the primary economic engine of Caye Caulker, directly and indirectly supporting most commercial activity on the island. Caye Caulker's laid-back, eco-friendly character, close proximity to the Belize Barrier Reef (just 1.2 to 1.5 nautical miles offshore), and opportunities for marine recreation have made it a magnet for backpackers, snorkelers, divers, and adventure tourists. The tourism sector offers a wide array of services, including accommodations, SCUBA

and snorkelling tours, sport fishing, nature excursions, and water sports. These are complemented by growing support industries such as restaurants, gift shops, water taxis, artisanal craft vendors, and golf cart/bicycle rentals.

The island is home to approximately 65 licensed tour guides and operators, most of whom depend entirely on tourism for their livelihood. Interestingly, many of these guides are former or part-time fishers, highlighting the sectoral linkages between fishing and tourism. Stakeholders engaged expressed that this career progression is often gendered, as boat ownership and fishing licenses, typically held by men, have historically facilitated access to more lucrative tourism leadership roles.

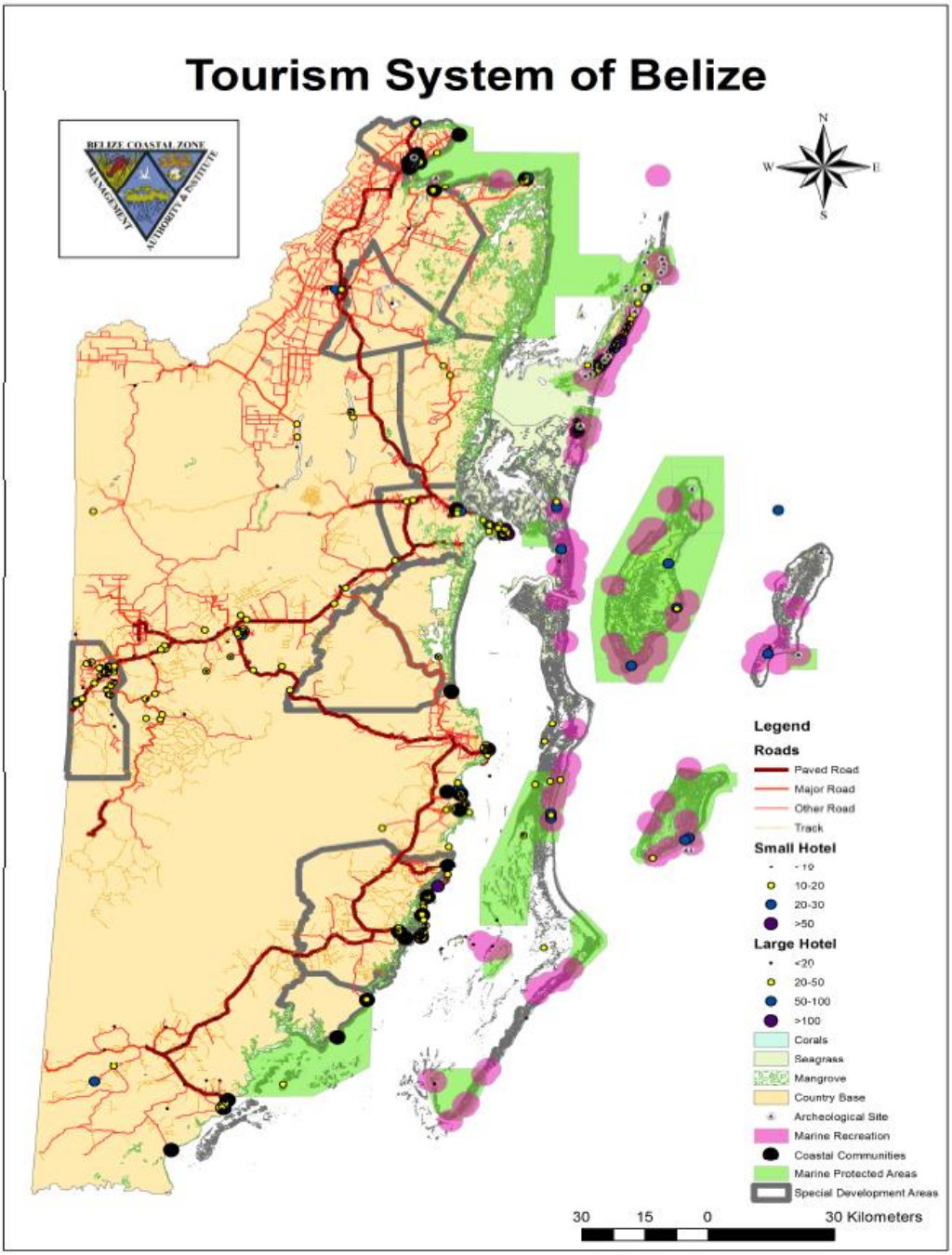


Figure 4-17: Tourism system of Belize

Women, in contrast, are more commonly employed in lower-paying service roles such as housekeeping, line cooking, bartending, and waitressing, though some also occupy managerial roles, particularly in construction and hospitality.

Tourism activity is highly seasonal, peaking between late November and April. During this period, the island's population swells with expatriates, short-term migrant workers, and vacationers. This seasonal influx creates high demand for temporary labour, housing, and services, but also places pressure on infrastructure and natural resources.

Parallel to the tourism boom has been a surge in construction activity, particularly the development of short-term rental properties and boutique hotels aimed at foreign investors and seasonal residents. This has provided additional employment opportunities, including for women in managerial positions within construction firms. However, unregulated and haphazard development has raised concerns among residents about environmental degradation, garbage accumulation, loss of vegetation, and the long-term sustainability of growth on the island.

Figure 4-18: Example of construction taking place on the island

Most workers on Caye Caulker earn an hourly minimum wage of five Belizean dollars (BZD $5). While this provides a basic income, the cost of living on the island is relatively high due to its isolation and reliance on imported goods and services. According to the local stakeholders engaged, this economic pressure underscores the need for affordable and equitable access to essential services, such as the proposed wastewater treatment system, which must be designed in a way that ensures accessibility for all residents, particularly lower-income households.

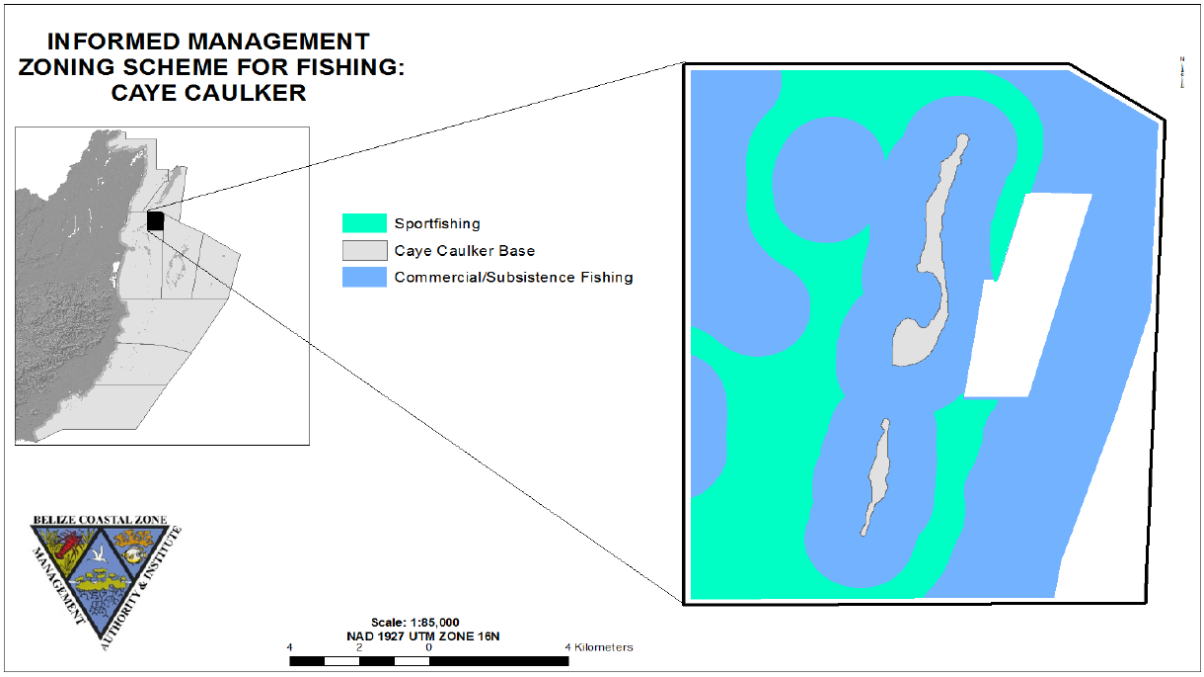


Figure 4-19: Informed Management Zoning Scheme for Fishing in the Caye Caulker Region

4.4.5 Social Services and Infrastructure

Caye Caulker offers its residents and visitors a range of essential public services, although the island's rapid growth and tourism-driven economy have put significant pressure on its infrastructure capacity.

Basic services on the island include a health clinic, police and fire services, and municipal administration. The main settlement on South Caye Caulker is served by Dr. D's Clinic, a private primary healthcare facility located in the Bahia area. The clinic provides basic health services including COVID-19 testing, medical checkups, neonatal care, and treatment for minor injuries. For cases beyond its capacity, established protocols guide patient transfers to the mainland. Arrangements with boat operators and an airlift service enable patients needing urgent care (such as those with spinal injuries or first-time mothers in labour) to be transported safely to the Karl Heusner Memorial Hospital in Belize City.

Electricity on the island is supplied via an undersea cable from the mainland, but some homes and businesses rely on backup generators to address periodic outages and support continuity during storms or maintenance events.

Water supply is a critical service managed primarily by Belize Water Services Ltd. (BWS). Historically, Caye Caulker relied on shallow wells and rainwater collection, sources that are both limited and vulnerable to contamination from inadequate sewage systems, particularly in a flood-prone, high-water-table environment. Today, freshwater for most residents is produced locally through reverse osmosis (RO) technology, which converts saline water to potable water. This

system was developed largely to meet the island's growing demand from its expanding tourism sector.

Despite these improvements, water shortages can still occur, particularly during peak tourism season, when demand surges. Residents in the northern part of the island also report low water pressure at night, a problem believed to be linked to increased demand from ongoing development on the neighbouring Caye Chapel. Water tariff rates (as of BWS 2009 data) reflect the cost of production and delivery, starting at BZ$23.00 (US$11.58) for up to 1,000 gallons per month and increasing incrementally with higher usage tiers.

Sanitation infrastructure has historically depended on septic tanks, pit latrines, and soakaways, many of which are poorly designed or maintained. Flooding during storms often leads to septic system overflows and contamination of the island's shallow freshwater lens, posing serious public health risks. This legacy of inadequate wastewater management is a major driver behind the current project, which aims to establish a centralised, climate-resilient wastewater collection and treatment system to improve health outcomes, and protect the island's sensitive environment.

4.4.6 Solid Waste Management

Solid waste management on Caye Caulker is a vital public service that faces persistent challenges due to geography, population growth, and limited infrastructure capacity. There is no engineered landfill on the island. Instead, solid waste generated must be collected, stored, and transported to the Belize mainland for final disposal. The settlement pattern on South Caye Caulker is dense, with narrow sand streets and limited vehicle access, which complicates collection logistics.

Solid waste collection on the island is coordinated by the Caye Caulker Village Council, which contracts local service providers or uses municipal equipment to conduct scheduled curbside pickups. Households, guesthouses, and businesses generally deposit bagged waste along designated collection routes for pickup by small garbage collection trucks or carts.

Waste volumes can be highly seasonal, and the seasonal surge strains local collection capacity, often leading to overflowing bins or uncollected waste in busy periods. Collected waste is delivered to a transfer site located at the south end of the island (Figure 4-20). This facility serves as a temporary holding area where waste is stockpiled before it is loaded onto barges or boats for transport to the mainland. Waste is then hauled to the Mile 24 Regional Sanitary Landfill on the George Price Highway, which is the principal engineered landfill serving the Belize District.

While this off-island disposal approach prevents permanent local dumping, it relies heavily on coordination and transport schedules. Any disruptions, such as bad weather, mechanical issues, or funding shortfalls, can lead to waste stockpiling at the transfer station, creating odour, vermin, and aesthetic problems. Despite formal collection systems, some residents and businesses still engage in informal waste disposal practices. These include unauthorized burning of garbage in yards or vacant lots, particularly for yard waste or small quantities of plastics. Burning contributes to local air pollution and health risks, releasing fine particulates and potentially toxic

compounds. Occasional illegal dumping in mangroves or coastal areas has also been observed and reported (Figure 4-21). Much of these consist of pieces of wood and organic waste (e.g., coconuts) that are not accepted at the transfer station.

Figure 4-20: Transfer Station located in souther Caye Caulker next to the proposed project site

Figure 4-21: Illegal dumping in mangroves

Recycling infrastructure is limited on Caye Caulker. There is no formal, island-wide recycling program for plastics, metals, glass, or paper. While some individual businesses and community groups promote waste separation and recycling education, consistent collection and processing of recyclables are constrained by costs and logistical barriers to off-island shipping. Beverage containers are sometimes shipped back to the mainland for reuse or recycling through voluntary systems, but participation is not universal. Composting initiatives are limited, though there is potential to reduce organic waste volumes through small-scale composting, especially given the

island's reliance on food imports and the generation of kitchen waste from hotels and restaurants.

4.4.7 Wastewater Management

Despite its economic importance and ecological sensitivity, the island lacks a centralized wastewater management system. The current system presents increasing environmental and public health challenges, particularly as development density rises and climate change exacerbates risks such as flooding, saltwater intrusion, and waterborne disease outbreaks. These issues are especially concerning in light of the island's shallow freshwater lens, porous geology, and proximity to sensitive marine ecosystems.

As mentioned throughout the document, wastewater on Caye Caulker is currently managed almost entirely through on-site systems. Most households, businesses, and accommodations on Caye Caulker rely on septic tanks discharging to soakaways or drain fields, often located very close to the water table and adjacent to buildings. Others have pit latrines, especially in lower-income or older housing areas. In some cases, greywater (from showers, sinks, and kitchens) is discharged untreated to the ground surface or shallow soak pits.

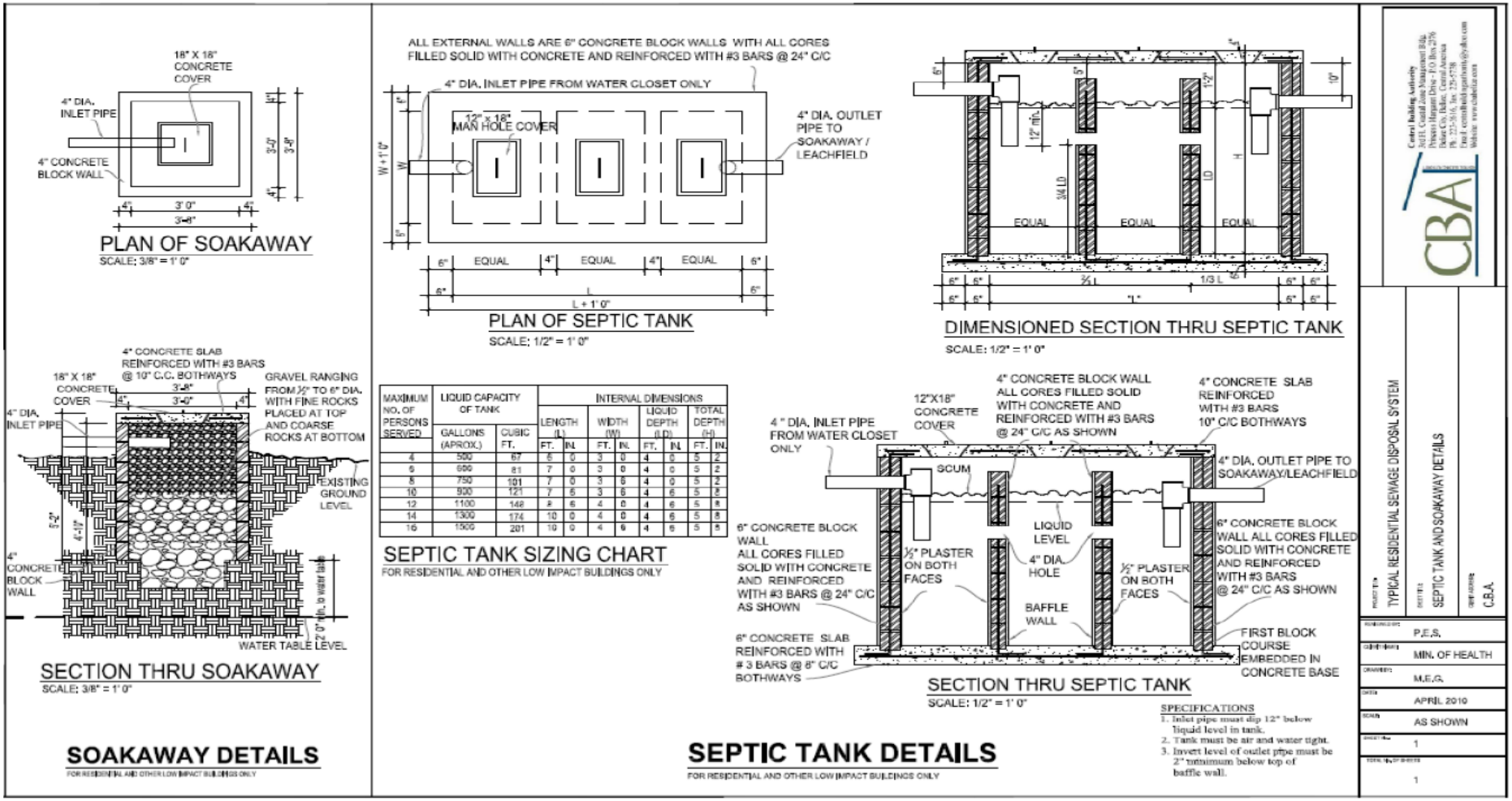
Although there are guidelines provided within the Caye Caulker Coastal Zone Management Plan based on designs from the Central Building Authority (Figure 4-22), many of these systems do not comply with modern health or environmental standards. Due to high groundwater levels and poor drainage, sewage effluent often infiltrates the surrounding soil with limited treatment, eventually reaching the island's aquifer and nearshore waters.

Additionally, there is no formal faecal sludge management system. When septic tanks or latrines fill up, residents or businesses may either hire vacuum trucks to manually pump out contents (limited availability), allow tanks to overflow or discharge untreated effluent into the ground, or in extreme cases, dig new soakaways or relocate existing tanks. This ad hoc sludge management results in indiscriminate discharges and cumulative contamination, especially after heavy rainfall or storm surge events.

The current state of wastewater management contributes to contamination of groundwater, which is still used by some residents for non-potable uses, elevated bacterial levels in marine waters used for recreation and fishing, increased risk of gastrointestinal illness, skin infections, and vector-borne diseases, and the degradation of critical ecosystems which protects the island.

There is currently no regulatory enforcement mechanism for ensuring proper siting, construction, or maintenance of on-site systems on the island, although the guidelines have been provided. This results in non-compliance with effluent standards, insufficient sludge management, and poor public awareness about wastewater risks.

To address these concerns, the proposed project introduces a centralized, climate-resilient wastewater collection and treatment system (see Section 2 for details). This will represent the first formal wastewater infrastructure of its kind for Caye Caulker and a significant step forward for environmental protection, climate adaptation, and public health improvement.



MAXIMUM NO. OF PERSONS SERVED	LIQUID CAPACITY OF TANK		INTERNAL DIMENSIONS							
			LENGTH (L)		WIDTH (W)		LIQUID DEPTH (LD)		TOTAL DEPTH (H)	
	GALLONS (APROX.)	CUBIC FT.	FT.	IN.	FT.	IN.	FT.	IN.	FT.	IN.
4	500	67	6	0	3	0	4	0	5	2
6	650	81	7	0	3	0	4	0	5	2
8	750	101	7	0	3	6	4	0	5	2
10	900	121	7	6	3	6	4	6	5	8
12	1100	148	8	6	4	0	4	6	5	8
14	1300	174	10	0	4	0	4	6	5	8
16	1500	201	10	0	4	6	4	6	5	8

Figure 4-22: Septic Tank and Soakaway Details for Residential and Low-Impact Buildings provided by the Central Building Authority in Belize

Public consultations and preliminary surveys indicate that community leaders, political representatives, residents and businesses acknowledge the current system's weaknesses and will support interventions that improve water quality, reduce odours, and preserve the marine environment. However, they are concerned about the costs of connection and service tariffs.

4.4.8 Transportation

Caye Caulker's transportation system is distinctive, reflecting the island's small size, narrow land area, limited road network, and deliberate cultivation of a laid-back, pedestrian-friendly character that appeals to residents and tourists alike. This compactness fundamentally shapes transportation choices. The main avenues for transport are as follows:

Motorised transport on the island is deliberately limited. The primary modes of local movement include:

- **Walking**: The most common and encouraged mode, with residents and visitors traversing the sandy streets and footpaths on foot. The village layout is walkable, with short distances between homes, shops, restaurants, docks, and beaches.
- **Bicycles**: Widely used by residents and tourists, bicycles are the island's hallmark form of personal transport. They are affordable, practical on narrow streets. Rental shops offer bikes to visitors, supporting local micro-enterprises.
- **Golf Carts**: The main form of motorised personal and commercial transport. Golf carts are used for passenger movement, deliveries, waste collection, and municipal services. Private rentals cater to tourists seeking convenient mobility, while businesses often maintain carts for supply runs.
- **Motorcycles and Small Utility Vehicles**: Limited in number, these are generally used by service providers, emergency responders, and some construction or delivery companies.
- **Electric Vehicles**: Some residents and businesses have begun introducing small electric golf carts as an environmentally friendly alternative.

Roads on Caye Caulker are unpaved sand or compacted marl tracks, reflecting both the island's aesthetic and practical adaptation to its low-lying, flood-prone environment. Streets are narrow and informal in layout, particularly in the historic village core, with occasional bottlenecks during busy tourism seasons. Drainage can be poor, with ponding after heavy rains, complicating movement by golf cart or bike.

Since Caye Caulker is an offshore island, access to the mainland and inter-island travel depends entirely on marine transport, including:

- **Water Taxis**: These are the primary link to Belize City, San Pedro, and neighboring cays. Regular scheduled services carry residents, workers, schoolchildren, tourists, and goods. The village's main water taxi pier is a hub of local economic and social activity. The

San Pedro Belize Express Water Taxi Company is the main entity used for public transport to Caye Caulker.

- **Freight Barges and Boats**: Essential for importing food, building materials, fuel, consumer goods, and waste removal. All solid waste collected on Caye Caulker is transported by barge to the mainland for disposal. Construction booms have increased barge traffic, which can create temporary congestion at docks and storage areas.
- **Private Boats and Tours**: The tourism economy relies on a robust fleet of small boats for snorkelling, diving, fishing, and wildlife tours. These services connect Caye Caulker to the Belize Barrier Reef, Hol Chan Marine Reserve, and neighbouring islands.

Caye Caulker also has a small airstrip on South Caye Caulker operated by Tropic Air and Maya Island Air. These short-hop domestic flights link the island to Belize City and San Pedro, offering faster transport for tourists, business owners, and residents in emergencies. While not the primary mode for freight, air transport is critical for certain perishable goods and urgent medical evacuations.

4.4.9 Disaster Management

Disaster management in Belize is led by the National Emergency Management Organisation (NEMO), located in Belmopan. NEMO is comprised of the Cabinet, with the Prime Minister as chairperson and Chief Executive Officers who chair the 10 operational committees. Further to these national-level committees, there are 9 District Emergency Committees (chaired by the senior Minister in each District) representing several areas, including Caye Caulker. There are activities within each district geared at all phases of the disaster management cycle, from conducting preparedness work through public education and training to participation in response activities[7].

4.4.10 Gender Considerations in Sanitation

In the context of this wastewater infrastructure improvement project and in alignment with IDB Environmental and Social Performance Standard (ESPS) 9, which emphasises gender equality and social inclusion, it is essential to consider the needs of socially vulnerable groups. Enabling environments that promote equitable access to safe drinking water and efficient wastewater treatment technologies can deliver significant, society-wide benefits.

These vulnerable groups include:

WOMEN AND GIRLS

Women and, often, young girls bear disproportionate responsibility for hygiene and sanitation management within the household. This includes caregiving for children, the elderly, and other relatives, as well as tasks such as fetching water, cooking, cleaning, and flushing toilets. Fetching

[7] NEMO. (2011). Belize National Emergency Management Organization. Retrieved 11/14/2011, from http://www.nemo.org.bz/

water can involve long distances, is physically demanding and time-consuming, and can reduce opportunities for income-generating activities.

For example, a single mother may need to do laundry outside of typical work hours or prepare meals for dependents early in the morning or late at night, depending on her employment schedule. These time-consuming responsibilities can limit her ability to participate fully in decision-making processes and professional roles related to water, sanitation, and hygiene (WASH).

YOUTH

Youth are also disproportionately affected when access to safe drinking water and adequate wastewater treatment is limited, as these constraints can hinder both educational attainment and employment opportunities, particularly in low-income or underserved areas. Targeted initiatives, such as skills training or internships focused on climate-resilient wastewater improvement technologies, including wastewater reuse, can help unlock employment opportunities and foster innovation. Youth engagement in community outreach and environmental stewardship should also be encouraged to build local ownership and capacity.

THE ELDERLY

Older adults rely heavily on access to safe and clean water and proper sanitation for maintaining good health. They are particularly vulnerable to waterborne diseases, making them more susceptible to health risks associated with water shortages or inadequate wastewater treatment systems. Ensuring consistent, safe, and affordable access is therefore critical to protecting this demographic.

Improving access to safe drinking water and efficient wastewater infrastructure in Caye Caulker stands to enhance health outcomes across the entire community. To maximise these benefits, equity should be embedded in all climate-resilient wastewater interventions. This means integrating social, gendered, and intergenerational analyses, incentivising community-focused solutions, and ensuring that vulnerable groups are prioritised in access to improved wastewater management and associated investments.

Inclusive design and active participation are key principles for developing sustainable, equitable wastewater treatment solutions. Meaningful stakeholder engagement must ensure that the voices of women, youth, the elderly, and other marginalised groups are heard and incorporated into project planning, decision-making, and long-term management.

4.4.11 Poverty and Access to Sanitation

While Caye Caulker is a well-known tourism destination generating significant economic activity, its prosperity is unevenly distributed, and pockets of poverty and social vulnerability remain, with direct implications for equitable access to sanitation services.

The island's economy is highly dependent on tourism, which is both seasonal and susceptible to external shocks such as hurricanes, global economic downturns, and pandemics. During peak tourism months (November to April), demand for labour surges, drawing in seasonal workers from other parts of Belize. These workers often live in informal or overcrowded rental units with limited services, highlighting socio-economic inequalities in housing quality and access to infrastructure.

Local employment is heavily concentrated in low-wage service jobs such as housekeeping, restaurant work, and construction labour. As of recent national policies, Belize's minimum wage stands at BZ$5 (US$2.50) per hour, a level that may cover basic costs but leaves many families with little margin to absorb higher utility bills or invest in private sanitation upgrades. Households with limited or unstable incomes may struggle to pay connection fees or monthly service tariffs for new wastewater systems, unless these are designed with inclusive and affordable pricing structures. Historically, sanitation on Caye Caulker has relied on septic tanks, pit latrines, and soakaways, many of which are ageing, undersized, or poorly maintained. These residents often lack the resources to repair or upgrade on-site systems or to relocate away from vulnerable areas.

Women-headed households and single mothers, who may have less access to secure employment or credit, can be particularly affected by the burden of securing safe sanitation for their families. Similarly, elderly residents or those with disabilities may face physical challenges in maintaining or using inadequate facilities.

Improving equitable access to sanitation is not only a public health imperative but also a social equity challenge. Investing in centralised, climate-resilient wastewater systems offers an opportunity to reduce the disproportionate burden of inadequate sanitation on poorer households. However, to be effective and fair, project planning must explicitly address affordability, connection support, and outreach to marginalised groups. By prioritising inclusive design, pro-poor pricing mechanisms, and active community engagement, the wastewater project can help break cycles of poverty linked to poor sanitation, improve health outcomes, and support sustainable, equitable development for all residents of Caye Caulker.

5 Environmental and Social Impacts and Risks

5.1 Assessment of Impacts and Risks

The main goal of the Impacts and Risk Assessment is to identify the environmental and social impacts associated with the Project at and around the sites of interest, focusing on both positive and negative impacts and risks as well as bio-physical, chemical, social, economic and cultural components of the environment including, but not limited to:

- Effects on wildlife, terrestrial and marine biodiversity;
- Effects on existing or proposed protected areas or other sites of conservation or special management interest;
- Effects on surrounding communities (residential and commercial activities); and
- Effects on livelihoods.

Table 5-1: Defining the nature of the potential impacts

Term	Definition
Positive Impact (Benefit)	An impact that is considered to represent an improvement on the baseline or introduces a positive change.
Negative Impact	An impact that is considered to represent an adverse change from the baseline or introduces a new undesirable factor.
Direct Impact	Impacts that result from a direct interaction between a planned project activity and the receiving environment/receptors (*e.g.* between occupation of a site and serviced communities).
Indirect Impact	Impacts that result from other activities that are encouraged to happen as a consequence of the Project (*e.g.* in-migration for employment placing a demand on resources).
Cumulative Impact	Impacts that act together with other impacts (including those from concurrent or planned future third-party activities) to affect the same resources and/or receptors as the Project.

Table 5-2: Impact Rating Table

Criteria Used for Impact Rating	
Extent	• On-site – Limited to within the site boundaries • Local – impacts that affect an area in a radius of 2km around the sites; • Regional – impacts that affect regionally important resources or are experienced at traditional authority or district scale; • National – impacts that affect nationally important resources or affect an area that is nationally important/ or have macro-economic consequences; • Transboundary/International – impacts that extend beyond country borders or affect internationally important resources.

Criteria Used for Impact Rating	
Duration	• Temporary – impacts are predicted to be of short duration and intermittent/occasional; • Short-term – impacts that are predicted to last only for the duration of the construction period; • Long-term – impacts that will continue for the life of the Project, but ceases when the Project stops operating; • Permanent – impacts that cause a permanent change in the affected receptor or resource (*e.g.* removal or destruction of ecological habitat) that endures substantially beyond the Project lifetime.
Likelihood	• Unlikely – The impact is unlikely to occur. • Likely – The impact is likely to occur under most conditions. • Definite – The impact will occur.
Magnitude	• Magnitude can be considered in terms of the sensitivity of the receptor: o Negligible – the impact is not detectable; o Low – the impact affects the environment in such a way that natural functions and processes are not affected; o Moderate – where the affected environment is altered but natural functions and processes continue, albeit in a modified way; o High – where natural functions or processes are altered to the extent that it will temporarily or permanently cease.

Table 5-3: Impact Significance or Severity Criteria

Significance Criteria	
Negligible Significance	An impact of negligible significance is where a resource or receptor will not be affected in any way by a particular activity, or the predicted effect is deemed to be imperceptible or indistinguishable from natural background levels.
Low Significance	An impact of low significance is one where an effect will be experienced, but the impact magnitude is sufficiently small and well within accepted standards, and/or the receptor is of low sensitivity/value.
Moderate Significance	An impact of moderate significance is one within accepted limits and standards. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that "moderate" impacts have to be reduced to "minor" impacts, but that moderate impacts are being managed effectively and efficiently.
High Significance	An impact of high significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. A goal of the ESIA process is to get to a position where the Project does not have any major residual negative impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). An example might be the visual impact of a development. It is then the function of regulators and stakeholders to weigh such negative factors against the positive factors, such as employment, in coming to a decision on the Project.

This chapter presents an assessment of the potential environmental and social impacts for the Caye Caulker wastewater collection and treatment plant during the construction and operational stages. While mitigation measures are presented in this chapter, the Environmental and Social Management Plan (see Chapter 6) developed includes more detailed mitigation measures and management measures. The Impacts Assessment considers the physical, ecological and socio-economic impacts of the proposed works, assesses the probability and magnitude of the impacts from project activities on the receiving physical environment, ecological resources and social environment. The various activities within the project are then analysed and impacts evaluated based on their probability, magnitude, duration, reversibility and net positive or negative impact.

5.1.1 The Construction Phase

While construction activities often raise concerns about temporary disturbances, the implementation of this wastewater project will also bring important positive impacts to the local economy and community in Caye Caulker. This section describes some of the positive benefits anticipated during the construction phase, with the details of negative impacts outlined in Table 5-4 below.

The project is expected to generate short-term employment opportunities for local workers. Construction of the sewer network, pumping stations, and treatment plant will require skilled and unskilled labour, providing income and experience to residents of the island and nearby communities. Contractors will also engage local suppliers for materials, equipment, possibly accommodation, and transport services, creating indirect economic benefits across the island's small-business sector. The project will also offer opportunities for local capacity building and training. Workers hired for construction will receive instruction in safety procedures, environmental protection measures, and construction best practices, leaving a valuable skills legacy that can be applied in future projects.

The construction phase can potentially involve improvements to local infrastructure beyond the wastewater system itself. Trenches dug for the vacuum sewer network typically require restoration or upgrading of road surfaces, if properly managed, benefiting vehicle and pedestrian access. Planning for site drainage, temporary roads, and laydown areas can also result in better-defined transport routes and drainage improvements. The project will also promote community engagement and awareness about the importance of safe sanitation, environmental protection, and public health. Through stakeholder consultations, disclosure meetings, and communication campaigns during construction, residents will gain a better understanding of the system's goals and benefits, laying the groundwork for long-term support and responsible use of the new infrastructure. Below are negative impacts identified that could potentially impact the project and the surrounding environment during the construction phase.

Table 5-4: Impacts, Proposed Mitigation Measures, Management Plans and Responsible Party for the Construction Phase of the project

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
PHYSICAL								
Noise and vibration	High	Disturbance to residents, tourism businesses, and wildlife; industrial vehicles cause buildings to shake while driving along the street	Negative	Moderate	Short-term	- Limit work hours; - maintain equipment; - install noise barriers if needed; - notify the community in advance.	Noise and Vibration Management Plan	Contractor / BWS
Dust and air emissions	High	Air quality impacts; nuisance to nearby businesses and homes	Negative	Low–Moderate	Short-term	- Regular wetting of work areas; - Maintain dust barriers - Covering trucks during transport of material; - Minimising stockpile heights; - Monitoring complaints.	Air Quality Management Plan	Contractor / BWS
Emissions from equipment and generators	High	Localized air pollution (particulate matter, exhaust fumes)	Negative	Low–Moderate	Short-term	- Use well-maintained equipment; - limit idling; - position generators away from sensitive receptors.	Air Quality Management Plan	Contractor / BWS
Traffic disruption and safety hazards	High	Restricted access; accidents involving pedestrians and vehicles; delays; large vehicles have difficulty navigating narrow streets	Negative	Moderate	Short-term	- signage and detours; - worker flaggers; - clear pedestrian pathways - Use smaller trucks.	Traffic Management Plan	Contractor / BWS
Soil and groundwater contamination	Medium	Fuel, oil, or chemical spills during equipment refuelling or maintenance can seep into the limestone substrate	Negative	Low–Moderate	Short-term	- Spill prevention procedures; - secondary containment; - training for workers; - Have emergency spill kits on site.	Spill Prevention and Response Plan	Contractor / BWS

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
Erosion and sedimentation	Medium	Runoff to nearby water bodies or mangrove systems during trenching, affecting sensitive marine and coastal species. The cumulative impact, considering the similar effect that current and ongoing developments in the area may also be having on the environment.	Negative	Moderate	Short-term	- Install silt fences and sediment barriers, as needed; - stage work to minimize exposed soil; - rapid site stabilization.	Erosion and Sediment Control Plan	Contractor / BWS
Waste generation	High	Improper disposal of construction waste and hazardous materials, combined with an already existing solid waste issue	Negative	Low–Moderate	Short-term	- Segregate waste; - contract licensed waste haulers; - ensure secure storage for hazardous materials; - maintain records.	Waste Management Plan	Contractor / BWS
Flooding of work areas during storms	Medium–High	Work delays; environmental contamination from flooded materials	Negative	Moderate	Short-term	- Site drainage management; - store materials on raised platforms; - Weather monitoring and contingency planning.	Stormwater Management Plan	Contractor / BWS
Working in wetland environment	Medium–High	Structural failure or instability of foundations; cost overruns from repairs or redesign; damage to nearby ecosystems due to foundation disturbance	Negative	Moderate–High	Long-term	- Conduct geotechnical surveys prior to final design - Use deep foundations (e.g., friction piles) where required - Employ ground stabilization techniques - Avoid construction during peak wet season to reduce compaction and disturbance - Monitor settlement during and post-construction	-	Contractor (Engineering and Works) / BWS (Supervision) / Geotechnical Engineer

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
ECOLOGICAL								
Impact on mangroves or coastal vegetation	Medium	Damage to mangroves from trenching or equipment access as well as the construction/installation of infrastructure	Negative	Moderate	Long-term if unmanaged	- Avoidance through design; clear marking of no-go zones; minimal clearing; restoration or replanting where impacts are unavoidable.	Mangrove Management / Restoration Plan	BWS; Forestry Dept
Impact on the marine environment	High	Sedimentation, turbidity, or pollution of adjacent marine habitats; damage to seagrass beds, coral, and fish nurseries; biodiversity loss	Negative	High	Short - Medium	- Schedule work during calm weather conditions - Train workers in marine-sensitive practices - Monitor water quality and visible turbidity plumes - Avoid unnecessary clearing of coastal vegetation and mangroves	Coastal Water Quality Management Plan	Contractor (Construction); BWS (Environmental Supervision); DOE (Oversight)
SOCIAL								
Public health and safety risks	High	Injuries to workers or community members; exposure to open excavations	Negative	Moderate–High	Short-term	- Worker health and safety plan; - fencing around open trenches; - clear signage; - community education.	Worker Health and Safety Plan	Contractor / BWS
Community disruption (livelihood and economic sectors)	Medium–High	Reduced tourism revenue due to construction noise, dust, access issues	Negative	Moderate	Short-term	- Advance notification; - maintain clear business access; - stage works to minimize peak tourism impacts; - stakeholder engagement.	Stakeholder Engagement Plan	Contractor / BWS

5.1.2 The Operations Phase

The most significant and lasting positive impacts of the project will occur during its operational phase, transforming sanitation management and environmental health on Caye Caulker. Foremost among these benefits is the protection of public health. By replacing failing septic tanks and pit latrines with a centralised, reliable sewerage system, the project will sharply reduce the uncontrolled release of untreated wastewater into the environment as long as there is a high connection uptake. This will help prevent pathogen contamination of groundwater needed to supply wells used by households and businesses, lowering the risks of gastrointestinal and waterborne diseases. Safer sanitation services will support overall well-being, particularly for children and vulnerable populations.

Environmental benefits should be notable as the new system aims to reduce nutrient and pathogen discharges into coastal waters, helping to protect the Belize Barrier Reef Reserve System. Healthier reef systems support biodiversity, fisheries, and ecosystem services such as shoreline protection. Reductions in nutrient loading can also help prevent algal blooms and degradation of seagrass beds and mangroves, which are vital habitats and carbon sinks.

Socio-economically, the new wastewater system will strengthen Caye Caulker's position as a premier tourism destination. Visitors increasingly expect clean, safe, and environmentally responsible destinations. By addressing a longstanding sanitation gap, the project will enhance the island's image, support tourism revenue, and safeguard jobs that depend on sustainable tourism growth. Improved environmental conditions will also benefit property values and encourage responsible development.

Institutionally, the project will build the capacity of Belize Water Services (BWS) to manage advanced wastewater systems on islands and in coastal settings. Through training, systems development, and asset management improvements, BWS will gain lasting expertise in climate-resilient service delivery. This capacity can be leveraged for future investments in Belize's water and sanitation sector.

The project will demonstrate Belize's commitment to sustainable development and environmental stewardship, supporting national policies on biodiversity conservation, climate change adaptation, and public health. These represent some of the key positive impacts anticipated by the project. However, Table 5-5 below details the risks identified that could result in negative impacts by the project, to the project and to the surrounding communities and environment during the operation of the plant.

Table 5-5: Impacts, Proposed Mitigation Measures, Management Plans and Responsible Party for the Operations Phase of the Project

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
INFRASTRUCTURE AND PHYSICAL								
System failure or overflow	Medium	Raw sewage discharge, public health hazard, environmental contamination	Negative	High	Short to medium	- Routine inspection and maintenance; - backup systems; - trained O&M staff; - emergency response plan; - periodic audits	Operations and Maintenance Plan; Emergency Response Plan	BWS
Odour nuisance	Medium–High	Community complaints, reduced quality of life, negative impact on tourism	Negative	Moderate	Continuous / episodic	- Odour control units at the treatment plant; - sealed systems; - routine maintenance of vacuum lines and sludge handling systems; - prompt repair of leaks	O&M Plan; Grievance Mechanism	BWS
Noise from pumps or generators	Low–Medium	Disturbance to residents and tourists near WWTP and vacuum stations especially since the proposed area is quiet	Negative	Low–Moderate	Continuous / episodic	- Install acoustic insulation for equipment; - maintain quiet zones around plant; - schedule noisy maintenance activities during daytime	Noise Management Plan	BWS
Sludge mismanagement	Medium	Health risks, odour, groundwater contamination if poorly handled	Negative	Moderate	Long-term	- On-site drying in enclosed geotubes or drying beds is a part of the design; - periodic removal by licensed contractor as needed; - secure, elevated sludge storage is considered in design	Sludge Management Plan	BWS; Solid Waste Authority
Groundwater contamination	Low–Medium	From exfiltration in damaged lines or poor sludge storage	Negative	Moderate	Long-term	- Leak detection systems; - routine line inspections; - watertight infrastructure; - safe sludge storage above water table	Water Quality Management Plan	BWS; Department of Environment

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
Service interruption during storms	Medium	Sanitation disruptions affecting households and tourism operations	Negative	High	Episodic	- Storm resilience plan; - backup generator systems; - pre-storm system checklists and shut-down/start-up protocols	O&M Plan; Disaster Management Plan	BWS; NEMO
Increased energy consumption	Medium	Higher carbon footprint and O&M costs	Negative	Low–Moderate	Continuous	- Use of energy-efficient MABR technology is designed; - performance monitoring; - solar options are being explored	O & M Plan	BWS
Shallow sewage collection pipes vulnerable to damage	Medium–High	Damage from flooding, erosion, traffic, excavation, road and drainage maintenance works; Pipe rupture or displacement leading to sewage overflows onto roads and adjacent properties; environmental contamination of soil and groundwater; public health risks from pathogen exposure	Negative	Moderate–High	Long-term	- Design improvements (e.g., anchoring, protective casing, elevation where feasible) - Careful planning of pipe routes to avoid high-risk areas - Regular inspections and maintenance to detect early damage - Rapid repair protocols for leaks/ruptures - Public awareness/sensitisation to avoid damage during construction or maintenance works	Emergency Response Plan; O & M Plan	Belize Water Services (BWS); Contractor; Local Government (Village Council); Department of the Environment
ECOLOGICAL								
Effluent discharge to the environment	Medium	Nutrient loading in groundwater and marine environment leading to degradation if treatment is inadequate	Negative	Moderate–High	Long-term	- Strict compliance with discharge quality standards; - regular water quality testing; - emergency bypass protocols; - well-maintained MABR units	Effluent Monitoring Plan; Marine Water Quality Plan	BWS; Department of Environment
SOCIAL								
Vector breeding near WWTP	Low–Medium	Mosquito proliferation due to stagnant water, especially in rainy season	Negative	Low–Moderate	Seasonal	- Ensure site grading and drainage; regular clearing of vegetation and puddles; apply	Occupational and Community Health and Safety Plans	BWS; Ministry of Health

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
						vector control measures if needed		
Occupational health and safety risks	Medium	Worker injuries during maintenance or sludge handling	Negative	Moderate	Episodic / recurring	- Provide PPE, safety protocols, confined space entry training, emergency drills, and access control	Occupational Health and Safety Plan (OHSP)	BWS
Unequal access to connection/services	Low–Medium	Marginalised households excluded from system access	Negative	Moderate	Long-term	- Outreach to underserved households; social inclusion mechanisms; transparent service policies	Stakeholder Engagement Plan	BWS; Village Council
High cost to use the wastewater service being provided (e.g., tariffs, connection fees)	Medium-High	Households unable or unwilling to connect; Inequitable access (vulnerable groups excluded); Reduced public health benefits if coverage is low; Community dissatisfaction or resistance	Negative	Moderate-High	Long-term	- Conduct analysis on willingness-to-pay and determine affordability - Design pro-poor, equitable tariff structures with cross-subsidies or tiered pricing - Consider connection fee financing or subsidies for low-income households - Transparent tariff-setting during public consultation - Ongoing community education on benefits and payment options	Stakeholder Engagement Plan	Belize Water Services (BWS); Public Utilities Commission (PUC); Village Council
Community dissatisfaction / grievances	Medium	Complaints about odour, service reliability, and cost	Negative	Low–Moderate	Continuous / episodic	- Functional grievance redress mechanism (GRM); community liaison officer; communication on tariffs, outages, and system benefits	Grievance Redress Mechanism; Stakeholder Engagement Plan	BWS

6 Environmental and Social Management Plan (ESMP)

6.1 Introduction to the ESMP

The Environmental and Social Management Plan (ESMP) outlined in this chapter presents the key guidelines necessary to direct the environmental and social management and occupational health and safety of the Project. This chapter outlines in detail:

- the various environmental and social plans or programs that will comply with the environmental, social and health and safety requirements that are necessary to carry out the activities of the project works, complying with the policies and regulations of both the IDB and the national government,
- institutional obligations and responsibilities for the elaboration and implementation of the required measures,
- a description of the environmental and social monitoring plan in the construction and operation stages of the project, identifying the expected results, the parameters to be measured, the places of measurement, the methods and tools to be used and the periods/frequency in which the measurements will be made, along with the responsible institutions,
- an implementation schedule of each of the proposed measures and defined responsibilities.

6.2 Objectives of the ESMP

The plan's overall goals are to:

- Describe the measures required to implement management and mitigation commitments made in relation to the potential construction and operational impacts identified in the Environmental and Social Assessment (ESA)
- Specify the additional steps necessary to achieve good practice and approval conditions set forth by the IDB and the main department with responsibility for environmental health and safety, in the case of Belize, the Department of Environment (DOE)
- Define the duties and responsibilities of the Project's environmental and social management organisation.

The executing agency, Belize Water Services Limited (BWS), along with all contractors and subcontractors, shall comply with the provisions of the ESMP, as applicable, to the tasks they are employed to undertake.

6.3 Scope of the ESMP

The ESMP consists of environmental and social management tools that satisfy the criteria outlined in the IDB's Environmental and Social Safeguards, as well as specific management plans that outline the systems and procedures that will be put in place over time by the project team to ensure compliance with local and international standards.

6.4 Key Environmental and Social Impacts and Mitigation

6.4.1 Construction Phase

The mitigation measures proposed for the Construction Phase primarily surround the following risks:

- Noise Pollution
- Coastal Water Pollution
- Groundwater Pollution
- Air Quality Pollution
- Waste Management (Hazardous Waste, Sewage Waste, Construction Waste, Trade Effluent)
- Disruption of Biological Communities (terrestrial, coastal and marine habitats)
- Erosion and Sedimentation
- Social Conflict
- Occupational Accidents and Natural Hazard Risks
- Health and Safety of Workers and Community
- Emergency and Contingency Management for the WWTP
- Community Road Safety

The ESMP for the construction phase includes the following plans to guide compliance with the IDB's environmental and social policy framework. They give special consideration to environmental and ecological protection, worker health and safety regulations, community health and safety regulations, resource use efficiency, emergency response, and pollution prevention and control. It comprises all the necessary requirements to track the efficiency of the mitigating actions taken to lessen the negative effects of the activities carried out during the construction phase.

- Noise Management Plan – This plan is intended to manage the levels of noise and vibrations generated during Project activities.

- Coastal Water Quality Management Plan – This plan is intended to reduce the pollution of waters in areas where work will be concentrated along or near the coast.

- Air Quality Management Plan – This plan is intended to reduce the dust pollution that can take place during excavation and construction activities in the immediate project area.

- Waste Management Plan – This plan is intended to manage how both solid and liquid waste generated by construction activities is handled, stored and disposed of. The types of waste

covered under this plan include construction waste, hazardous waste, sewage waste, organic waste and trade effluent.

- Erosion Control Plan – This plan is intended to manage the effects of erosion and sedimentation on the environment. Possible effects include soil disturbance, degradation, and erosion.

- Mangrove Management Plan – This plan is intended to prevent the unnecessary removal of mangrove trees during Project activities and to offset the likely effects of unavoidable mangrove removal. It also covers the management and handling of mangrove trees, the need for pruning and the use of pesticides.

- Traffic Management – This plan is intended to manage traffic disruptions during construction activities.

- Worker Health and Safety Management Plan – This plan is intended to manage the threats to the health and safety of workers during Project activities.

- Community Health and Safety Management Plan – This plan is intended to manage the threats to the health and safety of local communities during Project activities.

- Security Management Plan – This plan is intended to manage security during construction and operation.

- Contractor Management Plan – This plan is intended to guide how contracts are administered and managed.

- Labour Management Plan – This plan is intended to provide support for the hiring and management of labourers that is responsive to the local community and vulnerable groups.

- Disaster Risk Management Plan – This plan is intended to ensure that effective safety measures are implemented to minimize the impacts of emergency events. It encourages the training of workers and the maintenance of emergency response equipment.

- Stakeholder Engagement Plan (SEP) - This plan is intended to govern the measures with which the Project team will adhere in establishing communication channels with key stakeholders identified. The SEP presents measures to be used for community engagement, dissemination of project information and grievance management, and will be utilised as a key element in all the proposed management, monitoring and mitigation measures.

6.4.2 Operational Phase

The nature of the Project activities dictates that there will be minimal, if any, negative impacts during the operational phase. However, careful consideration of potential impacts in this phase remains an important requirement for compliance with the IDB's environmental and social safeguards framework. The ESMP, therefore, is developed to include management plans containing

recommended management and mitigation measures that will remain pertinent during the Project's operational phase. The following management plans relate to environmental, worker and community health and safety, as well as utility service provisions, and as such are the management plans most pertinent to the Project's operational phase:

- Waste Management Plan
- Mangrove Management Plan
- Worker Health and Safety Management Plan
- Community Health and Safety Management Plan
- Operations and Maintenance Plan
- Sludge Management Plan
- Disaster Risk Management Plan
- Labour Management Plan
- Stakeholder Engagement Plan

As well, the Stakeholder Engagement Plan consists of a Consultation and Participatory Strategy as well as a Grievance Redress Mechanism that must be implemented throughout the Project's complete life cycle.

The following plans have been prepared for the identified environmental aspects and risks to the project:

Table 6-1:List of Management Plans Developed in the ESMP

Management Plan	Construction Phase	Operational Phase
Noise Management Plan	✓	
Coastal Water Quality Management Plan	✓	
Air Quality Management Plan	✓	
Waste Management Plan	✓	✓
Erosion Control Management Plan	✓	
Mangrove Management Plan	✓	✓
Traffic Management Plan	✓	
Worker Health and Safety Management Plan	✓	✓
Community Health and Safety Management Plan	✓	✓
Disaster Risk Management Plan	✓	✓
Operations and Maintenance Plan		✓
Sludge Management Plan		✓
Security Management Plan	✓	✓
Contractor Management Plan	✓	
Labour Management Plan	✓	✓
Stakeholder Engagement Plan	✓	✓

6.5 Management Plans

6.5.1 Noise Management Plan

6.5.1.1 Monitoring and Compliance

The DOE does not have ambient noise standards for Belize, and as such, it is recommended that the Community Noise Guidelines of the World Health Organisation be adopted as guidelines governing noise generation for this Project. The Guidelines list the decibel levels at which people would be only minimally affected by noise. Table 6-2 below illustrates some of these recommended values.

Table 6-2: Noise Standards Extracted from the WHO Guidelines on Environmental Noise

SPECIFIC ENVIRONMENT	**NOISE LIMIT/L_{EQ} dBA**	
Residential	Daytime: 55	Nighttime: 45
Commercial	24 hours: 70	
Industrial	24 hours: 70	

Noise levels should be measured using a calibrated sound level meter. Before each survey, the meter should be calibrated, and the equipment's model should be made explicit. The monitors should be placed 1.5 meters above the ground and no closer than 3 meters away from any reflective surface (such as a wall). The background or ambient noise levels that would exist in the absence of construction activities and other related sources of noise serve as a broad representation of the noise level limit. Additionally, a calibrator that has been factory calibrated will be used to examine the instrument both before and after the survey. For two to three minutes, noise level readings will be obtained, and the average (geometric mean) noise level will be recorded in decibels (dBA).

6.5.1.2 Management Measures

In addition to the monitoring procedures, the Contractor will ensure the following noise reduction options are implemented where necessary:

- Provide workers with the necessary PPE (e.g., noise-cancelling headphones) and ensure that they are worn. Specialised hearing protection tailored to filter high-frequency sounds typical of electrical systems is also recommended.
- Consult with and sensitise residents in the area to the types of activities that will take place ahead of the works and assign a liaison person (recommend that a Community Liaison Officer be hired) with whom the residents can relate.
- Maintain all equipment in proper working order to avoid excessive noise generation and the simultaneous use of multiple noisy machines in proximity to each other.
- If noise complaints are received from residents, consider installing partial screening around the noisiest activities and/or mufflers on noisy equipment. In case of complaints, they should be recorded, and appropriate action should be taken via the Grievance Redress Mechanism.

- Limit the implementation of noisy work simultaneously. As well, limit noisy activities to daytime hours, adhering to local noise ordinances.
- Implement a rotating roster of personnel who are employed for noisy work – rotate workers involved in noisy activities to minimise fatigue-related errors and prolonged exposure.
- Work around key events, peak usage times, or high-traffic periods (e.g., avoid work during school hours in educational buildings or peak visiting hours in public offices and health centres). Prioritise performing the noisiest tasks during times when targeted public buildings are unoccupied, such as evenings, weekends, or holidays.
- Train workers on the importance of minimising noise during construction. This includes proper equipment use, the scheduling of noisy activities, and following best practices for equipment maintenance.

6.5.1.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the noise monitoring system.

Table 6-3: Key Performance Indicators for Noise Management

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSBILITY
Notice given to stakeholders in advance of scheduled works	Review and inspection of documentation	Twice per month or as stipulated by the DOE	BWS and/or Contractor; Results to be presented by the EHS Officer to the BWS Technical Leads for the Project and the DOE
Noise parameters within DOE standards	Results Certificate provided by DOE and the staff member responsible for EHS		
Log of complaints	Review and inspection of documentation		
Use of personal protective equipment gear (specialised hearing protection included)	Review and inspection of documentation		

6.5.1.4 Roles and Responsibilities

It is the responsibility of the BWS and all contractors and subcontractors to ensure that all mitigation measures are carried out and that monitoring reports are prepared. The Contractor should ensure that an Environmental Health and Safety (EHS) Officer is employed to oversee the specific requirements of this plan.

BWS is responsible for ensuring the contractor understands the importance of monitoring and will support them in undertaking this task as often as is required and for implementing the mitigation measures necessary. The site and the surrounding environment will be monitored, and negative

impacts caused by the construction works will be recorded. This should be included in the contract arrangements.

The sampled noise data will be compared to the WHO's standard for noise as well as the baseline data, and the analysis will be included in the environmental monitoring report prepared and submitted to the DOE. If there are any exceedances, this will be reported immediately to the EHS Officer to allow for the implementation of corrective measures or adjustments in management strategies based on the results and, where practicable, to the operations.

6.5.2 Coastal Water Quality Management

6.5.2.1 Monitoring and Compliance

The BWS and its contractors will adhere to the stipulations outlined by the national regulations for coastal water quality standards. Whilst there are no local ambient water quality standards. There are trade effluent standards as portrayed in the Environmental Protection Act, Chapter 328 (Amendment 2009) that would need to be adhered to (Table 6-4).

Table 6-4: Third Schedule: Discharges from Wastewater Treatment Systems (Sewage Water and Greywater into Class 1 Waters)

Parameter	Effluent Limit
Total Suspended Solids	30 mg/L*
Biochemical Oxygen Demand (BOD_5)	30 mg/L
pH	5-10 pH units
Fats, Oil and Grease	15 mg/L
Faecal Coliform	Faecal Coliform: 200
(E. coli (freshwater) and Enterococci (saline water))	Mpn/100 ml; or (a) E. coli: 126 organisms/100ml; (b) Enterococci: 35 organisms/100ml
Floatables	Not visible

*Does not include algae from treatment ponds

Monitoring should be conducted according to the recommendations provided by the Department of Environment. It is recommended, however, that monitoring be done from source areas twice per month and should also be taken in offshore zones during primary construction and operation activities. The results at the end of the sampling period will be compared to the stipulated standards.

During construction, monitoring will be carried out randomly twice per month during the first month or as stipulated, only in areas where construction activities are being undertaken at a given time. After the first month, monitoring may be conducted once per month until the end of construction or maintenance activities. Also, be guided by the stipulations provided by the DOE.

6.5.2.2 Management Measures

In addition to the monitoring procedures, the Contractor will ensure that these measures are followed:

- Keep machinery and equipment away from coastal waters as much as possible.
- Prevent the disposal of on-site human waste into coastal environments – develop functional on-site restroom facilities to prevent human waste from being introduced into coastal environments. Portable toilets can be temporarily utilised during the construction period.
- Establish no-work buffer zones around sensitive habitats identified, like coral reefs, mangroves, or wetlands.
- No form of waste generated during the construction phase, solid or liquid, may be incinerated, buried, or discharged into or close to coastal waters. Strict adherence to these prohibitions is mandatory. Promptly collect and dispose of waste materials, including concrete debris, old poles, and packaging, at designated storage sites and disposal facilities. Waste disposal contractors, if used, must be authorised. Partnership with the nearby transfer station is highly recommended.
- Enforce the proper disposal of solid waste, hazardous materials and otherwise recyclable materials. See Section 6.5.3.

6.5.2.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of coastal water quality monitoring systems.

Table 6-5: Key Performance Indicators for Water Quality Management

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Equipment maintenance log and schedule	Review and inspection of documentation	Twice per month or as stipulated by the DOE	BWS and/or Contractor; Results to be presented by the EHS Officer to the BWS Technical Leads for the Project
Notice to stakeholders	Review and inspection of documentation		
Receiving Water Quality parameters within stipulated standards	Review and inspection of documentation		

6.5.2.4 Roles and Responsibilities

It is the responsibility of the BWS and all contractors and subcontractors to ensure that all mitigation measures are carried out and that monitoring reports are prepared. The Contractor should ensure that an Environmental Health and Safety (EHS) Officer is employed to oversee the specific requirements of this plan.

The surrounding marine environment will be monitored by the BWS and the Contractor for negative impacts caused by the construction works.

The sampled coastal water quality data will be compared to the national standard for coastal water quality and included in the environmental monitoring report prepared and submitted to the DOE. If there are any exceedances, this will be reported immediately to the EHS Officer to allow for the implementation of corrective measures or adjustments in management strategies based on the results and, where practicable, to the operations.

6.5.3 Waste Management Plan

6.5.3.1 Monitoring and Compliance

Waste management includes operations such as waste disposal, storage, collection, transportation, sorting, and treatment, as well as monitoring and planning. In anticipation that waste will be disposed of on a weekly basis, the monitoring of waste should be done weekly to ensure that all measures are being implemented and followed. The site is located next to the solid waste transfer station on the island, and therefore, intentional steps will be taken to maximise this opportunity for responsible and sustainable waste management. Solid waste collected on the island is periodically barged from the transfer station to the mainland for further processing.

Metal, wood, old oil, lubricants and other oil derivatives, plastic, paper, concrete, cardboard, glass, and organic waste are examples of the types of solid waste that are expected to be generated during construction activities. The BWS, contractors and all subcontractors must also monitor the management of hazardous waste generated during construction.

6.5.3.2 Management Measures

While the Contractor will ensure that every effort is made to abide by the following mitigation measures during construction or operations to lessen the potential negative effects of inappropriate waste disposal and management, it is important that all waste streams are identified by the contractor to guarantee the correct implementation of waste management measures.

GENERAL SOLID WASTE MANAGEMENT

- Contain garbage and construction debris onsite until relocated to the transfer station. A comprehensive record of the waste generated at the construction site must be diligently maintained, documenting the type, volume, and detailed characterisation of the waste produced.
- Prohibit the burning of solid waste on project sites.
- Update and implement the waste management plan during the construction phase based on the general waste that construction activities under the Project are found to generate and any challenges in waste storage, handling and disposal.

- Avoid solid waste from becoming habitats for disease vectors.
- Create a viable waste management system, and conduct worker training on storage, handling and disposal of waste.
- Consult local environmental and waste management authorities on applicable waste management practices and establish a partnership with the operators of the transfer station to align strategies for proper disposal of waste.
- Create a specific, clearly identifiable waste collection area wherever works take place. Collection areas can be temporary, but must allow for easy storage of waste for future disposal.
- Assign personnel to oversee appropriate waste management practices. The EHS Officer can also act in this role.

Spill Prevention and Hazardous Waste Management

- Environmental conditions must be included in any construction contracts, thereby making contractors accountable for preventing accidental spillages.
- Conduct preventive maintenance for vehicles and machinery to ensure integrity and reliability and reduce/avoid leaks.
- Conduct any on-site repairs of machinery and equipment on impervious surfaces.
- Ensure proper handling, use and storage of all chemical and hazardous waste according to best practices:
    - Provide spill containment and cleanup equipment on site.
    - Personnel handling chemicals and hazardous substances must be trained in the use of spill prevention measures.
    - Personnel handling chemicals and hazardous substances must be trained in the correct use of the appropriate Personal Protective Equipment (PPE).
    - Utilise the proper dispensing equipment.
    - Storage areas must be well marked with appropriate signage.
    - Fuel and lubrication of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spills and evaporation. There shall be no storage of fuel on the project sites. Fuel must be brought to the project site each day that work is being performed.
    - Clean up any spills (including existing spills) immediately, through containment and removal of product and appropriate rehabilitation or disposal of contaminated soils.
    - All hazardous waste must be disposed of at a registered hazardous waste disposal facility, which is under the Ministry with responsibility for public health or stored in designated, lined and bunded areas as approved by the DOE.

- Handling and disposal of hazardous waste will only be conducted by trained personnel wearing the correct PPE.
- Any spill incidents will be reported as soon as possible.

6.5.3.3 Indicators

The following Key Performance Indicators (KPIs) have been selected to evaluate the effectiveness of waste management systems implemented.

Table 6-6: Key Performance Indicators for Waste Management

KEY PERFORMANCE INDICATOR	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Inventory of Waste Generated at Sites	Review of Documentation	Daily	BWS and/or Contractor; Results to be presented by the EHS Officer to the BWS Technical Leads for the Project
No construction waste deposited in the environment	Site Inspection	Twice per month	
No leakages or spills	Inspection of the site by the Contractor		
Recycling Rates	Inspection of recycling records	Annual	

6.5.3.4 Roles and Responsibilities

It is the responsibility of the BWS and all contractors to ensure that all mitigation measures are carried out and that monitoring reports are prepared. The Contractor should ensure that an Environmental Health and Safety (EHS) Officer is employed to oversee the specific requirements of this plan.

BWS is responsible for assigning contractors as the responsible parties for undertaking the monitoring required and for implementing the mitigation measures necessary. The Site and surrounding environment will be monitored by the BWS and contractors for negative impacts caused by the construction works.

6.5.4 Stormwater and Erosion Control Plan

6.5.4.1 Monitoring and Compliance

Daily inspections of the work site will be conducted by the BWS and contractors. Sediment controls will be assessed during site inspections and following significant rainfall events (defined as more than 10mm of rainfall within 24 hours, leading to site runoff), or as stipulated by the DOE. The assessment will also encompass the removal of any accumulated sediments as needed. This is

especially important, given the nature of the limestone substrate within the project area and the extensive impact this can have on nearby coastal and marine environments.

6.5.4.2 Management Measures

The Contractor will ensure that these measures are followed:

- Minimise the Project activities' disturbance area. Demarcate the boundaries within which Project activities will occur. All activities will strictly occur within the designated work zone, ensuring that the work scope is confined to this specific area.
- Restrict vehicular movements to designated roads and trails to reduce the possibility of off-road incidents with residents, golf carts or bicycles.
- Constant monitoring and inspection of sites is necessary to assess the effectiveness of sediment control mechanisms implemented.
- Minimise vegetation removal to reduce disturbance to the soil (and sensitive wetland/mangrove environment) and maintain natural water infiltration rates. Maintain buffer strips of native vegetation along drainage channels to filter runoff and stabilise soil.
- Keep construction activities and equipment away from water channels and flow paths. If impossible, create temporary channels to redirect water around the zone of works while maintaining the natural flow direction.
- Limit the area of exposed soil by working on small sections at a time, allowing for immediate stabilisation post-completion.
- Avoid the excessive compaction of soil, which can reduce permeability and alter runoff patterns. Soil compaction is contributed to by construction activities that include:
    - The repeated trips of construction equipment over the soil
    - Soil excavation
    - Soil mixing
    - The use of heavy machinery on wet soil

6.5.4.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the erosion control management systems.

Table 6-7: Key Performance Indicators for Erosion Control Management

KEY PERFORMANCE INDICATOR	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Absence of Substantial Sediment Deposition in waterways and marine environment	Site Inspection	Daily	BWS and/or Contractor; Results to be presented to the DOE

6.5.4.4 Roles and Responsibilities

It is the responsibility of the Contractor to ensure that all mitigation measures are carried out and that monitoring reports are prepared. The Contractor should ensure that an Environmental Health and Safety (EHS) Officer is employed to oversee the specific requirements of this plan.

BWS is responsible for assigning the contractor as the responsible party for undertaking the monitoring required and for implementing the mitigation measures necessary. The site and surrounding environment will be monitored by the contractor for negative impacts caused by the construction Works.

If there are any violations, this will be reported immediately to the BWS's and/or the Contractor's EHS Officer to allow for management strategies to be changed according to the results.

6.5.5 Disaster Risk Management (DRM) Plan

6.5.5.1 Monitoring and Compliance

The works will be monitored daily by the BWS based on adherence to the national guidelines with compliance met through the enforcement of contractual obligations for flood-resilient design and construction, whilst meeting Belize's building codes and disaster preparedness regulations. Other monitoring requirements include routine inspections of infrastructure for flood-proofing integrity, settlement, infiltration/exfiltration, and damage after storm events; regular testing of backup power systems and emergency equipment; tracking the availability and adequacy of fuel supplies for generators; reviewing drainage system performance during heavy rainfall; and assessing staff readiness through training records, emergency drills, and tabletop exercises. Thus far, the WWTP has been designed with disaster resilience in mind. The risk level has been classified as high.

6.5.5.2 Management Measures

The Contractor will ensure that the following measures are put in place for effective emergency response (including having identified first responders for incidents and emergency numbers clearly visible on the site):

- Elevate key structures above projected 1-in-100-year storm surge levels plus freeboard for sea-level rise.

- Design buildings for Category 4 hurricane wind loads per Belize Building Code.
- Flood-proof key components with watertight doors/hatches, elevated electrical panels, and sealed tanks.
- Use corrosion-resistant materials in marine/saline environments.
- Use fill, pilings, and engineered foundations to reduce settlement risk on limestone substrate.
- Include site grading and drainage channels to divert runoff from critical areas.
- Pre-wire for future integration of renewable energy systems if feasible.
- Install stormwater management features to reduce on-site flooding during heavy rains.
- Liaise with emergency response teams on the island who can quickly respond to incidents, whether they are natural disasters or accidents related to the project. These teams should have a clear chain of command, responsibilities, and communication channels, as well as appropriate equipment for handling various types of emergencies (e.g., fire extinguishers, first-aid kits, rescue equipment).
- Provide regular training on disaster preparedness and response to all project staff, contractors, and local communities. Trainings should include:
    - basic first aid,
    - fire safety,
    - evacuation procedures,
    - emergency communications,
    - hazardous material handling, and
    - marine environment risks.
- Include standard operating procedures for:
    - Pre-storm shutdown or protective measures
    - Backup generator operation and fuel management
    - Post-storm inspection and restart procedures
- Conduct community outreach to raise awareness about the potential risks associated with the project, as well as the safety measures in place to protect public health and safety. Provide training or information sessions to local communities on how to respond to emergencies.
- Promote regular emergency simulation exercises and drills with both the project team, local communities and targeted public infrastructure to test emergency response plans, improve coordination, and identify potential gaps in disaster preparedness.
- Adhere to hazard-specific plans, the management measures of which are outlined below:

Hurricanes

- Design plant infrastructure to withstand high winds, storm surges, and heavy rainfall. This may include using friction pylons and deep foundations that can withstand hurricane winds.
- Stay informed about hurricane forecasts and warnings.
- Store loose materials, equipment, and debris in a secure location or tie them down.
- Develop and communicate a hurricane emergency plan for all workers.
- Ensure there are first aid supplies, communication equipment, and emergency power sources available on-site.
- Have a clear plan for the cessation of Project activities in advance of a hurricane's arrival; ensure workers are informed of the plan and evacuation routes.
- Have a plan for interim treatment and/or removal should operations be impacted for more than 24 hours.
- Develop a protocol for rapid damage assessment after a hurricane to evaluate the impact on all associated critical infrastructure related to the system.
- Establish a priority restoration plan to quickly restore plant operations and services to users.

Fires

- There should be strict procedures for monitoring fire risks, maintaining and servicing equipment, and the handling, storage and removal of flammable materials from work sites.
- Maintain regular inspections and servicing of electrical equipment to detect early signs of overheating, leakage, or malfunction.
- In the event of a fire, there should be sufficient, available and well-maintained firefighting equipment (e.g., fire extinguishers). All workers should be trained in the use of firefighting equipment and evacuation procedures.
- If the fire escalates, the local fire brigade/service shall be called to extinguish it. The contact information for the fire department on the island should be displayed in a location where it is visible to all workers.

Heavy Rainfall and Flood Prevention

- As much as possible, work should not be done during torrential rain.
- In the event of pending heavy rainfall, all equipment should be removed from nearby drains.

- Use native plants to vegetate disturbed areas to promote soil stabilisation and reduce erosion. This also helps to manage runoff and improves the ability of the land to absorb rainfall.
- Use sediment traps to capture any soil or sediment that may be displaced by water runoff, particularly in areas where excavation is occurring (i.e., during transmission pole replacement activities).

EARTHQUAKES

- Though not a direct threat for the island, the use of appropriate techniques to mitigate the effects of soil instability during seismic events should still be applied. Techniques include establishing deep foundations for the plant and supporting infrastructure as well as the controlled compaction of soil.
- Engage local communities in earthquake preparedness and safety awareness programs. Provide information on what to do in the event of an earthquake.

6.5.5.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the emergency response measures.

Table 6-8: Key Performance Indicators for Disaster Risk Management

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Log of Safety Equipment (serviced)	Review and inspection of documentation	Monthly	BWS and/or Contractor; Results to be presented by the EHS Officer to the BWS Technical Leads for the Project
Hazard-specific Plans	Review and inspection of documentation	Annual	
Training of Workers on Hazard-specific Plans	Review and inspection of documentation		
Emergency Drills Conducted	Participation in drills	Every 3 months	

6.5.5.4 Roles and Responsibilities

It is the responsibility of the BWS and contractors to ensure that the emergency response measures are clearly understood by all workers and that all management and mitigation measures are carried out and that monitoring reports are prepared.

6.5.6 Mangrove Management Plan

6.5.6.1 Monitoring and Compliance

The works should be monitored by the BWS and its contractors based on adherence to the Forestry Department's guidelines. Monitoring should be carried out by the Contractor (via a qualified environmental specialist) according to the frequency and guidelines of the Forestry Department. The project requires that a portion of the mangrove forest within the project area be modified to accommodate the construction of foundations to support the WWTP. Restoration obligations will be guided by the Forestry Department.

6.5.6.2 Management Measures

BWS and/or its contractors will ensure that the following measures are put in place to manage the flora across project sites:

GENERAL FLORA MANAGEMENT

- Properly maintain and service equipment.
- Conduct refuelling activities away from vegetated areas.
- All construction sites should be clearly demarcated, including areas where pylons will be installed; no clearing of vegetation, storage of materials or other construction-related activities shall be permitted outside the demarcated construction area.
- Areas where priority plant species are growing must be removed as needed; where the uprooting of trees is unavoidable, replantation must be prioritised to conserve the biodiversity of the area, as guided by the Forestry Department.
- The required permits will be obtained from the Forestry Department prior to the modification of mangroves. The BWS will be guided by the Forestry Department on any requirements for pruning during operation, as needed.
- Ensure that proper handling, use, storage, disposal and application of all chemicals are done according to best practices, if used.
- Have spill containment and clean-up equipment on site and dispose of waste in accordance with best practices. Report and clean accidental spills immediately; contaminated soils must be removed and disposed of at a registered disposal site. Any remains will be remediated.
- Engage with the local communities and stakeholders to raise awareness about the importance of the conservation of vegetation.

PESTICIDE AND HERBICIDE MANAGEMENT

- Use mechanical or manual methods (e.g., mowing, cutting) where feasible to reduce reliance on pesticides and herbicides.

- Follow the manufacturer's instructions and regulatory limits for application rates. Use targeted application techniques to minimise overspray and reduce waste.
- Avoid applying pesticides during windy, rainy, or high-temperature conditions to reduce runoff or drift.
- Establish no-spray zones around sensitive areas like wetlands and water supplies to prevent contamination.
- Equip work areas with spill kits containing absorbents, gloves, and disposal bags. Train workers to contain and clean up spills quickly and safely.
- Provide comprehensive training on pesticide handling, storage, application, and waste disposal. Workers must be equipped with the appropriate PPE to minimise the risk of exposure:
    - Chemical-resistant gloves that cover the hands and forearms
    - Close-toed shoes or rubber boots
    - Safety glasses or goggles
    - A respirator
    - Washable coveralls or a protective suit
- Use leak-proof containers and secondary containment systems to prevent spills or leaks. Regularly inspect and calibrate spray equipment to avoid overuse or leakage.

MANGROVE GUIDELINES

- Avoid large-scale clearing of land and focus on the footprint of the development to minimise the loss of vegetation in mangrove habitats.
- After clearing, replant the acreage of mangroves that was lost to facilitate a no net loss environment for the project area for mangrove species, according to the guidelines provided by the Forestry Department.
- Consider planting a diverse range of native species, including trees, shrubs, and ground cover, to enhance biodiversity and restore ecological functions around the WWTP.
- For disturbed habitats, implement restoration techniques with community stakeholders that help restore the functionality of ecosystems, such as forest planting, and coastal vegetation restoration.

6.5.6.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the management of vegetation.

Table 6-9: Key Performance Indicators for Mangrove Management

KEY PERFORMANCE INDICATOR	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
No major losses to priority species	Review and inspection of documentation/ ecological monitoring reports	As outlined in Forestry Department Guidelines	BWS and/or Contractor; Results to be presented to the Forestry Department
Demarcated key/ sensitive habitats	Inspection of the site		

6.5.6.4 Roles and Responsibilities

It is the responsibility of the BWS and all contractors to ensure that all mitigation measures are carried out and that monitoring reports are prepared. The Contractor should ensure that an Environmental Health and Safety (EHS) Officer is employed to oversee the specific requirements of this plan.

Any contractor assigned by the BWS assumes the responsibility of undertaking the monitoring required and implementing the mitigation measures necessary. The site and surrounding environment will be monitored by the contractor for negative impacts caused by the works.

If there are any violations, this will be reported immediately to the BWS's and/or the Contractor's EHS Officer to allow for management strategies to be changed according to the results.

6.5.7 Traffic Management Plan

6.5.7.1 Monitoring and Compliance

Recommendations received from the Belize Police Services with responsibility for traffic will serve as the standards to be adhered to during activities that will impact the normal flow of traffic. Monitoring will be carried out by the Belize Police Services with responsibility for traffic according to the frequency that is stipulated in their authorisation. The roads in Caye Caulker are narrow, and therefore the following will help to minimise impact on all users.

6.5.7.2 Management Measures

The Contractor will ensure that the following measures are put in place to manage potential traffic disruptions:

- Implement the use of proper signage; construction vehicle speed limits; reinforce speed limits near schools, churches and populated areas; training of drivers; defensive driving; maintenance of construction vehicles; and use of traffic wardens, as needed.
- Establish procedures for the transport of equipment and heavy loads, a protocol for reporting vehicle accidents and a log for traffic-related incidents.

- Material delivery to the site should be limited in peak traffic times during weekdays:
  - 6-9 am
  - 4-7 pm
- Notices should be posted/shared as regularly as possible or when required to communicate on any issue that may lead to disruptions in traffic flow. The Contractor's Community Liaison Officer (CLO) should establish communication channels with potentially affected communities so information on changes in traffic flow can be easily disseminated.
- Dirt/debris should not be stored on sidewalks or roadways.
- Wherever work is taking place (particularly during the laying of pipelines), pedestrian and vehicular traffic must not be completely obstructed. The use of flag persons will be required. Where routes will be rendered impassable, alternative routes must be identified in advance and these routes shared with affected communities.
- Avoid blocking entrances to businesses. Alert businesses about local construction works two weeks in advance (or a stipulated time frame as agreed between local businesses and the BWS and contractors) and of any changes in the initial scheduling.
- Promote the efficient and effective use of the Grievance Redress Mechanism, including timely responses linked with the use of a Community Interaction Form signed off on by all parties, including the contractor and the persons engaged.
- Establish a project community road safety awareness plan for residents living close to the road and for workers, and a monitoring mechanism to ensure effective implementation of the plan. This is the responsibility of the Contractor's CLO.

6.5.7.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the traffic management system.

Table 6-10: Key Performance Indicators for Traffic Management

<table>
<tr><th>KEY PERFORMANCE INDICATOR</th><th>HOW WILL IT BE MONITORED AND MEASURED</th><th>FREQUENCY</th><th>RESPONSIBILITY</th></tr>
<tr><td>Detour signs</td><td>Inspection of the site</td><td>Daily</td><td rowspan="4">Contractor

Results to be presented to the BWS/Caye Caulker Police (major accidents)</td></tr>
<tr><td>Traffic Wardens</td><td colspan="2">Inspection of the site</td></tr>
<tr><td>Log of complaints</td><td>Review and inspection of documentation</td><td rowspan="2">Weekly</td></tr>
<tr><td>Accidents/near misses</td><td>Inspection of the site and review of the incident log</td></tr>
</table>

KEY PERFORMANCE INDICATOR	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Advertisements in the media	Review and inspection of documentation	Two weeks prior to the commencement of works	

6.5.7.4 Roles and Responsibilities

It is the responsibility of the BWS and all contractors to ensure that all mitigation measures are carried out and that monitoring reports are prepared. The Contractor should ensure that an Environmental Health and Safety (EHS) Officer is employed to oversee the specific requirements of this plan.

Any contractor assigned by the Implementing Agency assumes the responsibility of undertaking the monitoring required and of implementing the mitigation measures necessary. The site and surrounding environment will be monitored by the contractor for negative impacts caused by the Works.

If there are any violations, this will be reported immediately to the BWS's and/or the Contractor's EHS Officer to allow for management strategies to be changed according to the results.

6.5.8 Worker Health and Safety Management Plan

6.5.8.1 Monitoring and Compliance

The mitigation measures presented in this plan address the risks posed by different occupational health and safety hazards. These hazards include:

- falling from heights or into pits and trenches,
- injuries from the projection of fragments of rocks or falling objects,
- slips/trips and falls (especially while carrying heavy loads),
- musculoskeletal injuries (especially of the back) resulting from lifting and moving heavy loads,
- injuries caused by vehicles,
- hearing impairment/loss,
- chemical hazards from exposure to various chemicals,
- injuries from the operation of heavy machinery, medical health cases and electrocution,
- exhaustion and/or dehydration, and
- Sexual and Gender-Based Violence (SGBV) and Sexual Exploitation, Abuse, and Harassment (SEAH).

The BWS and all contractors and subcontractors will be responsible for the daily monitoring of work sites for occupational health and safety hazards.

6.5.8.2 Management Measures

The BWS and all contractors will ensure that these mitigation measures are followed during construction and operational activities:

- The contractor must have a health and safety policy that is known and understood by all workers. It must be visible/accessible to workers and must clearly describe the potential occupational health and safety hazards and risks, as well as preventative measures that must be taken to address these risks.
- Inform workers of their legal rights and obligations and provide them with the necessary training on project's occupational health and safety.
- It is recommended that a worker's Code of Conduct (CoC) be refined based on the template provided in Appendix 1 and a training program for workers on the CoC be implemented. The CoC should stipulate the key principles in serving as a member of the project workforce. The CoC should be adopted by the BWS and contractors.
- Establish a reasonable and adequate work schedule to minimise the overexposure of workers.
- Workers should be properly trained in the proper use of construction equipment, the use of all health and safety equipment, and in the proper handling and management and disposal of all types of waste.
- Ensure all workers have the PPE required of them to work on the Project and to regularly monitor to ensure compliance. PPE recommended for a project of this nature includes, but is not limited to:
    - Hard Hats (Helmets)
    - Face Shields
    - Safety Glasses and Goggles
    - Rubber Gloves
    - Washable Coveralls
    - Earplugs or Earmuffs
    - Respirators
    - Steel-Toed Boots
    - High-Visibility Vests
    - Harnesses and Lanyards
- Health and safety equipment, most importantly a first aid kit, must be present on site at all times during works. Emergency medical supplies must be available and easily accessible in the case of an incident. At least two members of the workforce must be trained in the delivery of first aid, and at least one must be present on site at any given time. Perform routine checks of health and safety equipment to ensure that it is properly functioning. If the onsite medical supplies are not adequate, and the incident needs to be escalated to the nearby medical centre – an accident/incident response plan should be easily accessible to all workers.

- Construction areas should be clearly demarcated with safety signs and barriers to prevent possible incidents.
- Clear labelling of hazard risks on the construction site will be critical.
- Contractor has procedures for high-risk work activities, working at heights, working in trenches, working in heat, hot works, confined spaces, etc.
- Workers should be protected from all forms of exploitation, abuse as well as harassment and have access to tools and systems to seek redress.
- The EHS Officer of the BWS and/or the contractors shall maintain a register of all EHS-related incidents that have occurred as a result of the activities associated with the contract. EHS incidents that should be recorded include electrocution, fires, accidents, spills of hazardous materials that contaminate soil or water resources and stop-order notices issued by any relevant agency due to non-compliance with this ESMP.
- All accidents whatsoever arising out of, or in connection with, the performance of the Work, whether on or adjacent to the Site, which caused death, personal injury or property damage must be reported on (in writing) giving full details and statements of witnesses. In addition, if death or serious injuries or serious damages are caused, the accident shall be reported immediately. EHS incident reports will include, as a minimum, a description of the incident, actions taken to contain any damage to the environment, personnel or the public, and the corrective actions to repair/remediate any damage.
- Sensitize workers on SGBV and SEAH in the workplace at least annually. All workers must sign a Code of Conduct that explicitly condemns SGBV and SEAH. Victims of any form of violence in the workplace should have easy access to a grievance, complaint or referral mechanism that allows for the prompt and anonymous handling of any related incidents in the work environment.
- Ensure adequate toilets are easily accessible for workers.
- Ensure drinking water and access to shade for breaks.
- In the event that a worker is exposed to hazardous material, they should immediately be taken for medical attention.
- Label and isolate exposed electrical wires, keeping them far from busy areas.
- At least two persons will always be present when work is being carried out on electrical equipment. No attempt will be made to service or adjust unless another person capable of rendering first aid and CPR is also present.
- Arrange for initial and periodic medical examinations.
- In the event of a road accident involving BWS employees or contractors:

- The EHS Officer and the Police will be contacted immediately with details of the location and nature of the incident,
- The accident site will be cordoned off to keep the public at a safe distance from the scene and to allow easy access for first responders and emergency services,
- If it is safe to do so, first responders under the guidance of the EHS Officer will remove victims of the crash and place them in an area where they can receive first aid treatment and assessment. Victims should be moved as little as possible until the extent of their injuries is determined,
- Vehicles involved in the crash are not to be moved until the Police arrive,
- Victims will be moved to the medical centre if required (for serious injuries, steps will be taken to transport the injured personnel to the Belize mainland),
- If members of the public are involved in an accident which has occurred as a result of a BWS employee or contractor, the injured persons will either be given first aid and/or taken to the nearest medical centre for treatment, depending on their injuries (for serious injuries, steps will be taken to transport the injured person to the Belize mainland), and
- Details of the accident, including how it was caused, number of persons involved, police reports, etc. will be recorded by the EHS Officer.

6.5.8.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the health and safety management system.

Table 6-11: Key Performance Indicators for Worker Health and Safety Management

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONIORED AND MEASURED	FREQUENCY	RESPONSIBILITY
GRM for workers	Review and inspection of documentation	Daily	BWS and/or Contractor; Results to be presented by the EHS Officer to the BWS Technical Leads for the Project
Health and Safety Signs	Inspection of the site		
Emergency Kit (one at each site)	Inspection of site offices		
Register of all EHS-related incidents	Review and inspection of documentation		
Training log and schedule	Review and inspection of documentation	Monthly	
Equipment maintenance log and schedule	Review and inspection of documentation	Bi-annual	
Accident/Incident Response Plan	Review and inspection of documentation	Annual	
Health and Safety Policy, including workers' code of conduct and procedures for high-risk activities	Review and inspection of documentation	Annual	

6.5.8.4 Roles and Responsibilities

It is the responsibility of the BWS and all contractors to ensure that all mitigation measures are carried out and that monitoring reports are prepared. The Contractor should ensure that an EHS Officer is employed to oversee the specific requirements of this plan.

Any contractor assigned by the Implementing Agency assumes the responsibility of undertaking the monitoring required and of implementing the mitigation measures necessary. The Site and the surrounding environment will be monitored by the Contractor for negative impacts caused by the Works. If there are any violations, this will be reported immediately to the BWS's and/or the Contractor's EHS Officer to allow for management strategies to be changed according to the results.

6.5.9 Community Health and Safety Management Plan

6.5.9.1 Monitoring and Compliance

The mitigation measures presented in this chapter addresses the threats to nearby communities due to the proposed works. These include:

- shocks or electrocution,
- fire risks,
- temporarily reduced access to essential services (primarily emergency and utility services),
- noise due to machinery and equipment use, as well as vehicular movement and worker chatter,
- injuries caused by work vehicles,
- SGBV and SEAH,
- pest proliferation, and
- chemical exposure from the use of hazardous material.

The BWS and all contractors and subcontractors will be responsible for the daily monitoring of work sites for health and safety threats to potentially affected communities.

6.5.9.2 Management Measures

The Contractor will ensure that the following mitigation measures are followed during construction and operational activities:

- Perform routine checks of health and safety equipment to ensure that they are properly functioning to prevent accidents that can negatively impact the public.
- Utilise communication channels, such as the TV/radio and signs, to inform the public of the ongoing works and possible risks, including vector-borne risks. The communication strategy employed should be as per the Stakeholder Engagement Plan.
- Assign an officer with responsibility for community health and safety.
- Construction areas should be clearly demarcated with safety signs and barriers to prevent possible incidents, including information to report any issues or incidents that may occur.

- The contractor EHS Officer shall ensure that they utilise the consultation plan to inform community members of planned activities and safety protocols that must be adhered to. This should take place before the start of construction or maintenance works. The community and workers should be informed of the Grievance Redress Mechanism (GRM) that is to be utilised if there are any issues or complaints.
- The EHS Officer of the BWS and/or the contractors shall maintain a register of all EHS-related incidents that have occurred as a result of the activities associated with the contract. EHS incidents that should be recorded include electrocution, fires, accidents, spills of hazardous materials that contaminate soil or water resources and stop-order notices issued by any relevant agency due to non-compliance with this ESMP.
- All accidents whatsoever arising out of, or in connection with, the performance of the work, whether on or adjacent to the Site, which caused death, personal injury or property damage must be reported on (in writing) giving full details and statements of witnesses. In addition, if death or serious injuries or serious damages are caused, the accident shall be reported immediately. EHS incident reports will include as a minimum, a description of the incident, actions taken to contain any damage to the environment, personnel or the public, and the corrective actions to repair/remediate any damage.
- Areas under construction should be clearly demarcated and restricted access to members of the community.
- In the event that a community member is exposed to hazardous material, they should immediately be taken for medical attention.
- Any holes dug and depressions caused by equipment or supplies must be refilled in a timely manner to avoid creating opportunities for the breeding of vectors such as mosquitoes or accidents (in the case of larger holes).
- Conduct community sensitization on SGBV, its impact, and available support mechanisms in which the understanding of gender equality and respectful relationships are promoted.
- Train project staff and contractors on SGBV risks, prevention, and zero-tolerance policies.
- Encourage the implementation of the Grievance Redress Mechanism to address community concerns and to report issues of concern.

6.5.9.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the health and safety management systems.

Table 6-12: Key Performance Indicators for Community Health and Safety Management

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Health and Safety Signs	Inspection of the site	Daily	BWS and/or Contractor; Results to be presented by the EHS Officer to
Log of Complaints	Review and inspection of documentation		
Emergency Kit	Inspection of the site	Weekly	

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Health and Safety Policy	Review and inspection of documentation	Monthly	the BWS Technical Leads for the Project
Register of all EHS-related incidents	Review and inspection of documentation	When occur	
Equipment maintenance log and schedule	Review and inspection of documentation	Weekly	
Project landing page with relevant information for the community	Review and inspection of documentation	Prior to the commencement of works; When necessary (e.g., in the event of project updates)	

6.5.9.4 Roles and Responsibilities

It is the responsibility of the BWS and all contractors to ensure that all mitigation measures are carried out and that monitoring reports are prepared. The Contractor should ensure that an EHS Officer is employed to oversee the specific requirements of this plan.

Any contractor assigned by the BWS assumes the responsibility of undertaking the monitoring required and of implementing the mitigation measures necessary. The site and the surrounding environment will be monitored by the contractor for negative impacts caused by the Works. It is the responsibility of the Contractor to assign a Community Liaison Officer (CLO) to act as a bridge between the project team and the community. This officer should always be aware of the project activities and the diversity of the community, and should be linked to relevant local authorities or an established and trusted NGO. The Contractor's CLO will ensure that the community is aware of planned activities and the health and safety protocols that they need to abide by for their protection and safety. It is important that all mitigation measures are carried out and that monitoring reports are prepared.

If there are any violations, this will be reported immediately to the BWS's and/or the Contractor's EHS Officer to allow for management strategies to be changed according to the results.

6.5.10 Stakeholder Engagement Plan (SEP)

Stakeholder engagement is the basis for building strong, constructive, and responsive interrelationships that are essential for the inclusive design of development plans. As the Government of Belize seeks to enhance its wastewater infrastructure into one that is more inclusive with biodiversity considerations and resilience to the persistent threat of climate change impacts, this is an essential component of the development plan.

It is an iterative process that involves stakeholder identification, analysis, and consultation planning; presentation and sharing of information and participation; collation of feedback and inputs; and integration into the Environmental and Social Management Plan of the Strategic Environmental and Social Framework. The objectives' multivariate nature guides/informs the nature, frequency, and level of participatory engagement.

Based on the multidisciplinary nature of this project in South Caye Caulker, Belize, the project team will engage in a charette-style consultation process. This involves the engagement of a wide range of stakeholders within the mainland of Belize and South Caye Caulker in semi-structured interviews, focus group discussions, and in-person stakeholder consultations. Specifically, the project team will target key government officials, representatives from hotels, tour operators, fisherfolk, civil society groups, residents, and other critical stakeholders across various sectors in these locations. These stakeholders include representatives from Belize Water Services, the Caye Caulker Chapter of the Belize Tourism Foundation, the Caye Caulker Group for Environmental Sustainability (CCGES), Belize Solid Waste Management Authority (BSWaMa), the Belize Public Utilities Association, the Department of the Environment within the Ministry of Sustainable Development, Climate Change and Solid Waste Management, the Bureau of Gender Affairs, within the Ministry of Human Development, Family Support and Gender Affairs.

Other stakeholders will be engaged via a digitally administered survey, which will complement the findings from the stakeholder consultations.

This process provides unique insights into the social context in which the project operates and will therefore inform a comprehensive management plan for Belize Water Services as it seeks to improve the wastewater infrastructure in Caye Caulker.

6.5.10.1 Objectives of the Stakeholder Engagement Pl

The goal of these engagement strategies will be:

- to share information on the proposed project;
- to incorporate perspectives and knowledge of the area into the management plan;
- to understand public sentiment and opinion with respect to the proposed project and document concerns including access to wastewater infrastructure and costs associated with this resource across the capital and South Caye Caulker;
- to identify perceptions of impacts and discuss issues as it relates to this project and natural resources, and
- to inform the development of the SEP as a part of the ESMP/ESMS.

This feedback is critical as it forms a significant part of the environmental, social, and cultural baseline data for the development of the ESS framework. Research has shown that early involvement

of all interested and affected parties increases the likelihood of long-term stakeholder buy-in which will enable the sustainability of development projects.

6.5.10.2 Stakeholder Considerations

This methodology details the implementation plan of activities for stakeholder engagements that will be necessary for Deliverable 2: Disclosable versions of the ESA/ESMP and Stakeholder Engagement Plan, and development of the socioeconomic survey; Deliverable 3: Final versions of the ESAS/ESMP and ESMS and will form the basis of Deliverable 4: Meaningful Consultation Report and Final Version of Stakeholder Engagement Plan. Additionally, as a part of the methodology, there is a focus on gender equality and social inclusion.

Figure 6-1: Gender Sensitive Stakeholder Consultations

Developing the Environmental and Social Management Plan for implementation requires, firstly, the engagement of stakeholders to be categorised by their level of impact and interest in the project. This was categorised using stakeholders based on their influence and interest levels.

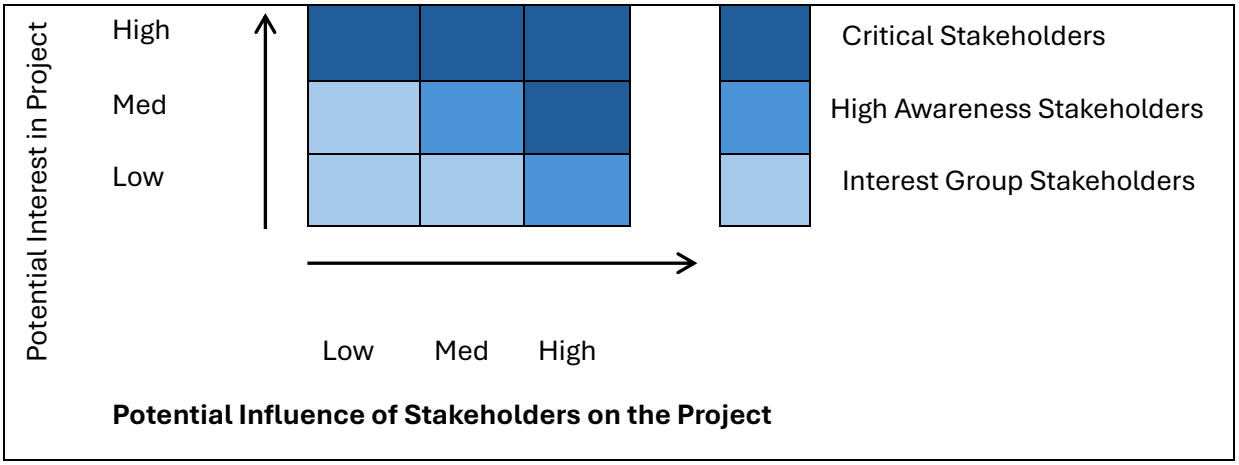


Figure 6-2: Process of stakeholder selection

6.5.10.3 Stakeholder Prioritisation and Categorisation

From the list of organisations and groups identified, the stakeholders are placed in a category based on whether they may be interested in the activity and/or may have the power to either block or advance the activity. The diagram below can be used to classify the stakeholders by their power over the activity and by their interest.

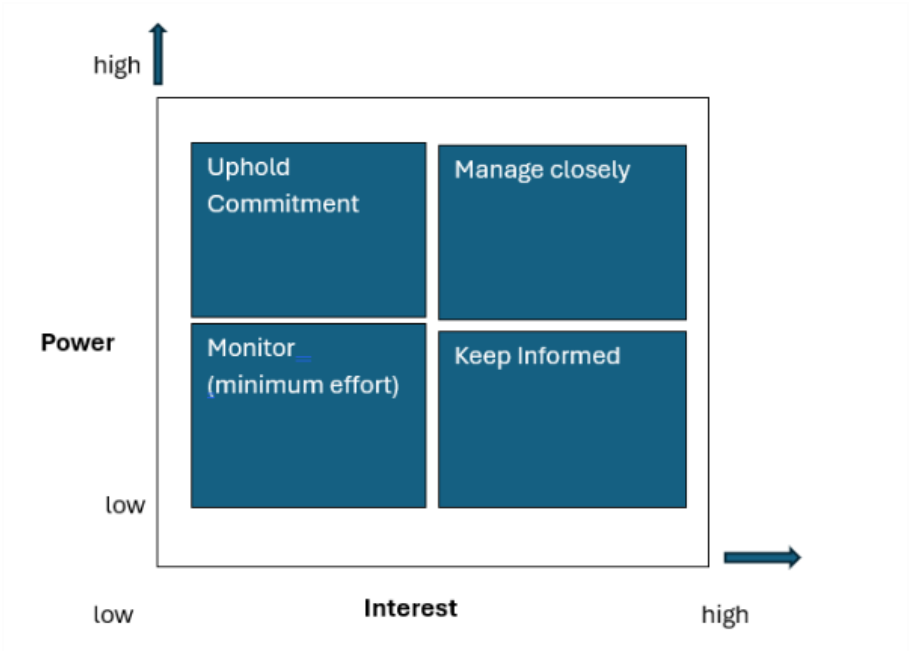


Figure 6-3: Power/Interest Grid for Stakeholder Categorisation

The position of an organisation may fall in one of the following categories:

- High power interested stakeholders: these are the stakeholders you must fully engage and make the greatest efforts to uphold commitment.
- High power, less interested stakeholders: put enough work in with these stakeholders to uphold commitment, but not so much that they become bored with your message.
- Low power interested stakeholders: keep these stakeholders adequately informed and talk to them to ensure that no major issues are arising. These people can often be very helpful with the details of your project.
- Low power, less interested stakeholders: monitor these stakeholders, but do not bore them with excessive communication.

Based on the categorisation of each stakeholder, the various levels of engagement will apply as reflected in the table below.

Table 6-13: Stakeholder Level of Engagement and Approaches

Level	Role or responsibility	Communication	Nature of Relationship	Engagement Approaches
Monitor	Monitor stakeholders' views.	One-way; stakeholder to company	Long term	Media and internet tracking. Second-hand reports from other stakeholders possibly via targeted interviews.
Inform	Inform or educate stakeholders.	One-way; company to stakeholder, no invitation to reply.	Short- or long-term relationship with stakeholders.	Bulletins, letters, brochures, reports, and websites. Speeches, conference, and public presentations. Open house and facility tours. Road shows and public displays. Press releases, press conferences, media advertising, lobbying.
Transact	Work together in a contractual relationship where one partner directs the objectives and provides funding.	Limited two-way; setting and monitoring performance according to terms of contract.	Relationship terms set by contractual agreement.	Public Private Partnerships and Private Finance Initiatives, Grant-making, cause related marketing.

Level	Role or responsibility	Communication	Nature of Relationship	Engagement Approaches
Consult	Gain information and feedback from stakeholders to inform decisions made internally.	Limited two-way; company asks questions and the stakeholder's answer.	Short- or long-term involvement.	Surveys, focus groups, workplace assessments, one-to-one meetings. Public meetings and workshops. Standing stakeholder advisory forums. On-line feedback and discussion.
Involve	Work directly with stakeholders to ensure that their concerns are fully understood and considered in decision making.	Two-way, or multi-way between company and stakeholders. Learning takes place on both sides. Stakeholders and company take action individually.	May be one-off or longer-term engagement.	Multi-stakeholder forums. Advisory panels. Consensus building processes. Participatory decision-making processes.
Collaborate	Partner with or convene a network of stakeholders to develop mutually agreed solutions and joint plan of action.	Two-way, or multi-way between company and stakeholders. Learning, negotiations, and decision making on both sides. Stakeholders work together to take action.	Long-term.	Joint projects, voluntary two-party or multi-stakeholder. Initiatives, partnerships.
Empower	Delegate decision-making on a particular issue to stakeholders.	New organizational forms of accountability; stakeholders have formal role in governance of an organization or decisions delegated out to stakeholders.	Long-term.	Integration of stakeholders into governance structure (e.g., as members, shareholders or on particular committees etc.)

Based on the categorisation of each stakeholder, the various levels of engagement will apply.

These stakeholders include representatives from Belize Water Services, Belize Public Utilities Commission, Department of Environment, Bureau of Gender Affairs, Belize Solid Waste

Management Authority (BSWaMa), Salt Life Eco Tours, Belize Hotel Association, Caye Caulker Chapter of the Belize Tourism Association and the Northern Fisherman Cooperative Society.

As previously mentioned, these stakeholder consultations will be held via various media, including key informant interviews, focus group discussions and questionnaires. This will be facilitated by the project team and BWS-approved data collectors. See the full stakeholder listing below and their ranking.

Table 6-14: Categories of Stakeholders

Organization	Role/Function	Level of influence	Level of interest	Method of engagement
Belize Water Services (BWS)	Primary utility company that provides both water and wastewater (sewer)services to all municipalities and many villages across the country. It is the executing agency for this project.	High	High	Consult, Inform, Involve, Collaborate
Belize Solid Waste Management Authority (BSWaMa)	This authority is responsible for protecting human health and the environment through proper waste management in Belize. This includes developing and maintaining landfill systems and safe transfer and disposal of solid waste.	High	High	Consult, Inform, Involve, Collaborate
Department of Environment, Ministry of Sustainable Development, Climate Change and Sustainable Development	This ministry is responsible for promoting sustainable development, addressing climate change and managing disaster risk in Belize. It advises the government on policies related to natural resources and the environment.	Medium	High	Consult, Inform, Involve

Organization	Role/Function	Level of influence	Level of interest	Method of engagement
Belize Public Utilities Commission	The Public Utilities Commission regulates the electricity, water and telecommunications in Belize, to ensure that these services are accessible,of high quality and affordable for consumers.	Medium	Medium	Consult, Inform
Bureau of Gender Affairs, Ministry of Human Development, Family Support and Gender Affairs	This department was established to coordinate, advocate and inform policy related to gender.	Medium	Medium	Consult, Inform, Involve
Ministry of Human Development, Families and Indigenous People's Affairs	This government entity is responsible for addressing issues related to policy and social development. The Ministry also has social protection that provides immediate assistance to vulnerable populations and families facing hardship.	Low	Medium	Consult, Inform
Ministry of Forestry, Fisheries, and Sustainable Development	This ministry is responsible for managing and conserving the nation's natural resources, including forests, fisheries and protected areas to ensure their sustainable use and benefit for present and future generations.	Medium	High	Consult, Inform, Involve, Collaborate

Organization	Role/Function	Level of influence	Level of interest	Method of engagement
Statistical Institute of Belize	This institute is mandated to collect and disseminate statistics including the national census.	High	High	Consult
Ministry of Education, Science and Technology (MoECST)	This ministry is focused on developing and implementing national policies and programmes related to education, science and technology.	Medium	High	Consult, Collaborate
The Northern Fishermen Cooperative Society	This fishing cooperative is a pioneer in deep sea fishing, shrimp trawling and fish production. They operate as a producer-owned processor of fish, conch and crab in Caye Caulker and Belize.	Low	Medium	Inform, Consult
Caye Caulker Chapter of the Belize Tourism Industry Association	This is the local chapter of the Belize Tourism Industry Association which acts as a leading advocate and representative for the private tourism sectors (hotels, tour operators, restaurants etc.) in Belize, focusing on the growth and sustainability of the industry.	High	High	Inform, Consult, Collaborate, Involve
Caye Caulker Group for Environmental	This group co-manages one hundred acres of the Caye Caulker Forest	Medium	High	Consult, Inform, Collaborate, Involve

Organization	Role/Function	Level of influence	Level of interest	Method of engagement
Sustainability (CCGES)	Reserve. There work centres littoral forest and mangrove preservation which are vital for both resident and migratory birds and provides nursery habitats for fish and crustaceans.			
Belize Hotel Association	This association actively promotes responsible tourism and community engagement.	Medium	High	Inform, Consult
Belize Assembly for Persons with Diverse Abilities (BAPDA)	This assembly is a non-profit, community-based organisation that advocates for the rights and inclusion for people with disabilities in Belize.	Medium	Medium	Inform, Consult
Caye Caulker Village Council	This council is responsible for the governance and improvement of the village, which includes managing public works, environmental concerns, disaster preparedness and supporting the development of sustainable tourism.	High	High	Consult, Collaborate, Inform, Involve
Salt Life Eco Tours	Snorkelling; diving and other recreational offerings provider	Low	Low	Consult, Inform
Women in Fisheries' Forum	This forum acknowledges the contributions of women in the fishing industry and strives to ensure their access to			Consult, Collaborate, Inform, Involve

Organization	Role/Function	Level of influence	Level of interest	Method of engagement
	resources and participation in management.			
The United Belize Advocacy Movement (UNIBAM)	This is a leading organisation advocating for LGBTQ+ rights and equality in Belize.	Low	Medium	Inform, Consult

6.5.11 Consultation Plan

This consultation plan is an approach detailing the methodology of stakeholder engagement for the lifetime of this wastewater infrastructure improvement project in Caye Caulker, Belize which includes gender-sensitive considerations. This includes, gendered differences in the access and use of resources and the different impacts across genders, ages, communities, and economic status This plan is meant to promote inclusive dialogue and will be applied between stakeholders (different organisations, hotels, tour operators, community and civil society groups, vulnerable and indigenous groups, institutions, the private sector) and public authorities on the mainland and in Caye Caulker, ensuring alignment with IDB's social and environmental safeguards.

BWS will conduct their outreach activities and consultations throughout South Caye Caulker with the support of Caye Caulker Village Council and other groups, in areas that are easily accessible to these beneficiaries and other project-impacted businesses and civil society groups.

The objectives of these consultations would be to inform the public about the proposed project as well as to gather stakeholder input on identifying perceptions of this project and identify possible risks and environmental and social impacts associated with this proposed intervention. At this stage, these consultations also provide a forum for public expression of concerns and how they will be mitigated, informing the public, mitigating conflicts, and refining project design with community feedback.

Key Issues to be Addressed:

- Identifying environmental and social risks and impacts associated with this project,
- Willingness to pay for wastewater services in Caye Caulker,
- Identifying how benefits will be distributed.

Below is a table proposing the communication methodologies and dissemination methods throughout the project life cycle.

Table 6-15: Proposed Communication Methodologies and Target Groups

Method/Tool	Description and Use	Contents	Dissemination Method	Target Group /s
Key Informant Interviews	This method of engagement will be used with the representatives of government entities on the mainland and in Caye Caulker and with the leadership of civil society groups, tourism operators and hotels, to identify perspectives about this proposed project specifically regarding any possible environmental and social risks and impacts.	Details about the project including proposed objectives and its specific interventions.	Advanced meeting notification would be circulated through email by the Belize Water Services with addressed letters requesting consultations. This would be followed up with calls to confirm participation.	Include local representative of Belize: Ministry of Forestry, Fisheries and Sustainable Development Ministry of Environment and Natural Resources Belize Solid Waste Management Authority Caye Caulker Chapter of the Belize Tourism Industry Association Bureau of Gender Affairs, Ministry of Human Development, Family Support and Gender Affairs Statistical Institute of Belize Ministry of Human Development, Families and Indigenous People's Affairs Ministry of Education, Science and Technology (MoECST) Belize Assembly for Persons with Diverse Abilities

Method/Tool	Description and Use	Contents	Dissemination Method	Target Group /s
				The United Belize Advocacy Movement (UNIBAM).
Focus Group Discussions / Community Meetings	These discussions are used to raise awareness about the project, facilitate discussion, and allow stakeholders to express any specific issues or concerns. This type of engagement is relevant for issues that merit collective examination with various groups of stakeholders that operate within the same space or have similar focus. These group categories would include hotel associations, tour operators or cooperatives, community focused entities, fisherfolk groups, climate and environmental organisations and gender and women organisations and community-based organisations in South Caye Caulker.	Details about the project and its proposed objectives	A communications officer from Belize Water Services could disseminate that internally and externally. Internally targeted invitations are sent out to stakeholders via email (for those with internet access) with follow-up phone calls through the groups email and externally to local departments and external media outlets. BWS could also use broadcast messages in the community groups These announcements for the upcoming meetings would be widely circulated to participants at least one week in advance via Whatsapp broadcast messages in the community groups. Subsequently, they would could be supplemented by an on-the-ground town-crier in the community or posted on a community notice board. For	Caye Caulker chapter of Belize Water Services and other groups on the island: Tourism Interest Groups, community-focused entities, climate and environmental organisations including: Caye Caulker Group for Environmental Sustainability, The Northern Fishermen Cooperative Society Caye Caulker Village Council Women in Fisheries Forum Gender and women organisations on the island of Caye Caulker disadvantaged/ socially vulnerable Groups

Method/Tool	Description and Use	Contents	Dissemination Method	Target Group /s
			example, Caye Caulker Village Community Bulletin Board and social media.	
Socioeconomic Survey	This survey will be used to collect updated socioeconomic profiles and demographic information about South Caye Caulker, historical hazards in the area and perception of the potential social and environmental impact, and risks regarding the proposed project and the willingness to pay for the wastewater services among the residents and business operators.	Questions requesting information pertaining to demographic and socioeconomic profiles, access to utilities (including sanitation services), willingness to pay, history of historical hazards in the project area, awareness of the project and perception of potential environmental and social impacts and associated risks.	Digitised survey tool which will be administered via the data collectors' smartphones	Domestic households in South Caye Caulker -Tourism providers such as: Salt Life Eco Tours Anwar Tours - Hotels such as: Island Magic Villas Sea Dreams Hotel The Bounty Sky Inn The Caye Hotel Caye Caulker Coral View Hotel and Resort - Restaurants such as: The Lazy Lizard, The Pelican Sunset Bar

Method/Tool	Description and Use	Contents	Dissemination Method	Target Group /s
				Palapas Restaurant
Feedback; Form & Suggestion Box	A digital feedback form can be circulated after the stakeholder consultation to those persons/ entities with an email address. A designated email address could be used as a site to localize all the stakeholders concerns. A physical suggestion box could also be used for the community meetings whereby affected parties such as community residents, service sector workers, interest groups etc to leave written feedback and comments about the project.	Any questions, queries or concerns, especially for stakeholders that may have difficulties expressing their views during public meetings.	A QR code could also be developed and linked to the digital feedback form on the posters An appropriate location for a suggestion box should be selected in a safe public place to make it readily accessible to the community. Information about the availability of the suggestion box should be communicated as part of project's regular interaction with local stakeholders.	All engaged stakeholders
Internet/ Digital Media	Project digital space to promote various information and updates on the overall project, impact assessment and impact	Information on the project, updates, environmental and social aspects	Limitation: Not all parties/stakeholders have access to the internet, especially in the more scarcely populated islands. A communications officer from Belize water Services (BWS) could be	All affected and interested parties.

Method/Tool	Description and Use	Contents	Dissemination Method	Target Group /s
	management process, procurement, employment opportunities, and on the project's engagement activities with the public. The project's digital space should have a built-in feature that allows visitors to leave comments or ask questions.		tasked with the responsibility of hosting periodical townhall meetings to advise the stakeholders of the project updates. These updates could also be reflected online on the BWS webpage. Project info could also be posted on social media, for example the Facebook page of the company. Instagram reels could also be used to appeal to younger audiences about this project.	

6.5.12 Grievance Mechanism

A grievance mechanism will need to be put in place prior to the start of construction and operational activities at the BWS. This mechanism will allow for concerns/ complaints to be received and facilitate resolutions for the affected individuals. It will require the project proponent and/or the Contractor to respond within a specified time. This mechanism offers the contractor and affected communities/ stakeholders an alternative to external dispute resolution processes.

It will be the responsibility of the BWS to update and modify this procedure or complaint mechanism as the full contours of the final project are known and agreed upon.

The grievance process outlined below covers both the construction and operation phases, should the BWS receive complaints and facilitate the resolution of the affected communities' or individual members' concerns about the environmental and/or social performance. The grievance mechanism is scaled to the risks and adverse potential impacts of the project. It facilitates the prompt address of concerns using an understandable and transparent process that is appropriate based on the Belize Caye Caulker scenario and readily accessible to all segments of the affected communities.

The mechanism is at no cost and is without retribution. The mechanism will not impede access to judicial or administrative remedies. The BWS will inform the affected communities about the mechanism during its community engagement process and, as appropriate to safeguard the interests of the Project.

The recommended approach below is specific to internal stakeholders and external stakeholders. Both internal and external stakeholders will place any complaints through the mechanism proposed.

STEP 1

The process of accepting grievances is the first step, which can take on varying levels of formality as outlined in the table below. The following section outlines the Grievance Collection Form that complainants will first need to complete. Grievances can be recorded at the temporary facility. Grievances can also be logged anonymously based on the nature of the problem.

Table 6-16: Methods for Grievance Receipt, from Least to most formal

Level of Formalization	Examples
Least formal: Oral complaints received face to face	Staff charged with collection of grievances writes down complaints at group or individual meetings, during field visits, or at designated locations.
Somewhat formalised: Oral complaints received through remote-access methods	Staff accepts grievances through a designated telephone line.
More formalised: Written complaints received face-to-face	Staff accepts written submissions from an individual or a group at groups or individual meetings, during site visits, or at designated locations.

Level of Formalization	Examples
Most formalised: Written complaints received through remote access methods	Complaints come in via regular mail, internet, or grievance collection boxes (consider having multiple locations). Complainants submit written grievances to third parties (to be forwarded to the local Contractor or the third party designated to administer the grievance redress mechanism.

While oral complaints are accepted from both internal and external stakeholders, the grievance collection form provided in the following section should be completed by the stakeholder following oral face-to-face or remote communication. This form will be made available at the BWS's office and at the site office in Caye Caulker. All complaints should always be recorded, even if made orally, on a form. The form must be completed by interested parties, and assistance should always be provided to persons who are illiterate, disabled and/or have difficulty in completing the form.

STEP 2

The logging and addressing of complaints rest with the local Contractor. Following the logging of a complaint, the grievance will be addressed at this level. A response must be prepared for the grievant. Appropriate attention should be given to gender-based grievances.

Should the grievant not be satisfied with the response provided, then move on to step 3.

STEP 3

Grievances that cannot be handled in Step 2 will be taken to the designated authority within or assigned by the BWS. A further root cause analysis should be done to identify another appropriate corrective action and complete the Grievance Monitoring Form in the following section.

The complainant will then be informed in writing of the decision to correct the action within a forty (40) working day period.

STEP 4

If the complainant does not feel that the grievance has been adequately addressed, they would go to court if the complainant so desires. Local Non-governmental organisations (NGOs) also provide support for victims and persons affected by gender-based violence and can be accessed by the complainant.

6.5.12.1 Grievance Collection Form

(Used by Stakeholder)

Case No. _____

Applicant's Name _____

Sex: [Male] [Female]

Age: _____

☐ I wish to submit complaint anonymously

☐ I demand that my personal details not be disclosed without my consent

Address:_____
_____

Telephone: _____

Email: _____

Description of Comment/Complaint: *(Subject of case, when did it occur, location, who is involved, effects of situation)*

_____
_____
_____
_____

Date of Incident: _____

☐ One-time incident/complaint (date_____)

☐ Happened more than once (indicate how many times: _____)

☐ Ongoing (a currently existing problem)

According to the applicant, what measures would provide solution to the problem?

_____
_____
_____

_____

_____

Signature: _____

Date: _____

Note: Please forward this form to:

Belize Water Services (BWS)

7 Central American Boulevard,

Belize City, Belize

Telephone: _+501 222-4757_____

Email: customercare@bwsl.com.bz_____

6.5.12.2 Grievance Monitoring Form

(Used by Grievance Manager)

This Form is the responsibility of the Grievance Officer.

Case No. _____

Applicant's Name _____

Sex: [Male] [Female]

Age: _____

Address: _____

_____

Telephone: _____

Email: _____

Complaint

_____
_____
_____
_____
_____
_____

Root Cause Analysis

- List all the possible contributing factors
- Identify most probable reason

_____
_____
_____
_____

Corrective Action

_____
_____

_____
_____

Preventative Action if problem can re-occur

_____
_____
_____
_____

A Community Feedback Mechanism will have to be in place prior to the start of construction and operational activities in southern Caye Caulker. This mechanism would allow for receiving, analysing, responding to, and acting on community input, such as grievances, inquiries, requests, recommendations, rumours, or compliments. It is recommended that a Community Engagement Officer be assigned to ensure that the feedback mechanism is effectively communicated to community beneficiaries and that received feedback is adequately dealt with.

Both the construction and operation phases are covered by the feedback mechanism that is described below. The Implementing Agency will be responsible for receiving all feedback and assisting in the resolution of grievances and concerns, as well as responding in a timely manner (within two weeks) to all other forms of feedback regarding the environmental and/or social performance from impacted communities or individual members, including suggestions, inquiries and commendations. The feedback mechanism is scaled to the project's risks and potentially harmful effects. It makes it possible for immediate issues to be addressed in a way that is transparent, relevant for the Caye Caulker scenario, and easily reachable by all groups within the impacted populations.

The mechanism is free of charge and without consequences. The method will not prevent people from using administrative or judicial remedies. BWS shall discuss the mechanism with the impacted communities during its community engagement process and as necessary to protect the Project's interests.

Specific to both internal and external stakeholders is the suggested course of action listed below. Internal and external stakeholders shall use the suggested mechanism to file any complaints.

The feedback mechanism will take the general form as indicated in the figure below.

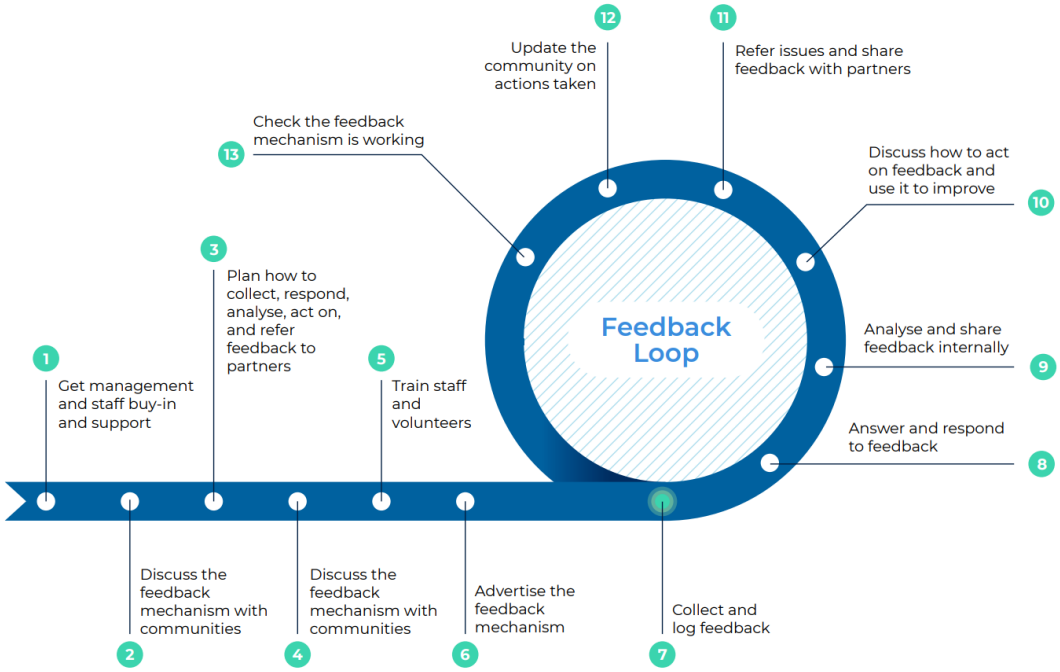


Figure 6-4: General Method of Setting Up and Running a Feedback Mechanism[8]

Regardless of the feedback mechanism used, a log should be kept of all community feedback, how they were addressed and how they were used to improve the efficiency of construction and operational activities.

6.5.12.3 Suggested Feedback Mechanisms

COMMUNITY FEEDBACK FORM

(Used by Community Engagement Officer)

Case No. _____

Applicant's Name _____

Sex: [Male] [Female]

Age: _____

[8] Obtained from A Red Cross Red Crescent Guide to Community Engagement and Accountability (2019)

Address:_____

Telephone: _____

Email: _____

Comment

_____
_____
_____
_____
_____

6.5.12.4 Two-way Communication Channels

This could take the form of a WhatsApp group in which willing community members are provided the opportunity to share feedback with project representatives. This group would also facilitate the sharing of key information to community members and the opportunity for issues to be streamlined, addressed and responded to in a timely manner.

It is also recommended that public consultations be facilitated to provide an opportunity for community members to share their concerns in a public forum with persons directly involved in the implementation of the project.

6.5.13 Security Management Plan

6.5.13.1 Monitoring and Compliance

The safety and security of the workers and equipment would be the responsibility of the BWS and its Contractors. Coordination with the Belize Police Department (BPD) when operating in areas with high risk will be key for securing Project equipment and all related stakeholders. Monitoring for safety and security should be carried out daily throughout all phases of the project.

6.5.13.2 Management Measures

The BWS will be responsible for the following measures to ensure the safety and security of personnel and equipment during all phases of the project. The risk level and impact on the site(s) will have to be assessed, and the appropriate mitigation measures devised. Some mitigation measures include:

- A site-specific security plan will be created based on an assessment of the security risk.
- Liaise and communicate with the Belize Police Department (BPD) to assess the risk associated with each site for every stage of the project.
- Contact the Caye Caulker Police Station to advise of areas where work will be conducted prior to the commencement of work.
- Conduct background checks and security clearances on all personnel involved in the project, particularly those working in sensitive areas or with critical infrastructure.
- Ensure that key assets and property are secured or removed to a secure location when not in use.
- Engage with community members and encourage them to report suspicious activities to the Caye Caulker Police Station.
- Encourage security awareness among workers and ensure security supervisor is always at the site.
- Maintain a security risk register and periodically review the security risk plan to update the security mitigation measures.
- Contract licensed security services to guard and patrol sites where necessary. Security personnel should be unarmed and properly trained in de-escalation techniques.
- Consider the use of technology, such as tagging, GPS tracking and video surveillance to detect and alert for any security issues or threats.
- Ensure that police forces and/or private security guards safeguarding the project area comply with the project's Code of Conduct provisions regarding the prohibition of SEAH.
- Ensure the participation of the police force/private security guards in training related to the prevention of sexual and gender-based violence.

6.5.13.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the plan to mitigate against threats to security.

Table 6-17: Key Performance Indicators for Security Management

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Security Risk Register	Review and inspection of documentation	Daily	BWS and/or Contractor; Results to be presented by the EHS Officer to the BWS Technical Leads for the Project
Incident Log	Review and inspection of documentation		
Total number of Police Officers and Private Security Guards safeguarding the project	Review of training schedules and attendance sheets	Monthly	

6.5.13.4 Roles and Responsibilities

If there are any security incidents, these are to be reported to BWS within 24 hours. BWS will be required to ensure the appropriate mitigation measures are implemented and that all incidents are appropriately investigated.

6.5.14 Contractor Management Plan

6.5.14.1 Monitoring and Compliance

Although the project is being implemented by the BWS, a Contractor will be hired to undertake the development of the plant and the installation of its supporting infrastructure. In this case, the works of the Contractor will be monitored by the BWS. Weekly monitoring will be carried out during the construction phase.

6.5.14.2 Management Measures

The BWS will ensure that the following measures are put in place to manage all contractors throughout the project:

- The BWS will provide the Contractor with all their working requirements and obligations as outlined in the ESMP. A Work Statement for the various phases of work, including models for standard documents will also be provided.
- All contractors are expected to abide by this Contractor Management Plan.

- The Contractors will enter a business partnership with the BWS after completing a successful tender process following the government procurement guidelines.
- Each contractor will have a legally binding, written contract that defines specific terms and conditions, including a workers' Code of Conduct (CoC).
- The Contractor will abide by the management actions and mitigations measures provided in the Environmental and Social Management Plan developed for the Project.
- The Contractor will follow the IDB guidelines regarding the sourcing of materials.
- The Contractors will present to BWS, all the information for all subcontractors and the procedures for verification and validation services.
- Each Contractor will have a single point of contact with the BWS for contractual matters. The contact points, for each site, will monitor the activities. The Point of Contact will ensure compliance of the Project against the General Commitments Register. Weekly, they will report about achievements and problems and the current situation to BWS.
- Each Contractor/Subcontractor will identify the responsibilities and authorities of the Project staff. This information will be published in a project contact sheet and approved by BWS.
- Each Contractor will have requirements for quality assurance clearly identified within the Statement of Work, including the requirement to allow independent quality inspections of materials and work processes.
- The Contractor is responsible for project management, for control and monitoring activities regarding constructors' actions and has overall responsibility for environmental, social, and health and safety aspects of the project.
- The Contractors will prepare work plans in compliance with the project's requirements and submit them to BWS for their approval. These workplans should include site specific method statements for work in sensitive habitats, including mangroves and frequently flooded landscapes.
- Contractors must nominate the following employees:
    - representative for EHS responsibilities;
    - representative for site coordination;
    - representative for traffic management and coordination;
    - representatives for technical execution, budget, Project phases;
    - first aid competent persons;
    - representative for waste management;
    - team for guarding the site;
    - team responsible for intervention on accidental pollution events; and
    - Representative for communication/stakeholder engagement.
- All Contractors are also required to comply with all relevant national regulatory requirements.
- Each week, the Contractors will prepare and deliver to BWS a weekly progress report for each aspect of the work.

- Each week, the Contractors will prepare and deliver to BWS weekly progress reports on environmental, social and health and safety performance including reports on the KPIs presented in this entire ESMP.

6.5.14.3 Indicators

The following KPIs in the following table have been selected to evaluate the effectiveness of the contractor management process.

Table 6-18: Key Performance Indicators for the Contractor Management Plan

KEY PERFORMANCE INDICATOR	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Weekly Report on achievements and problems; Progress Reports on each aspect of the works	Review and inspection of documentation	Weekly	BWS and/or Contractor; Results to be presented by the EHS Officer to the BWS Technical Leads for the Project
Project contact sheet	Review and inspection of documentation		
Reports on quality inspections	Quality inspections of materials and work processes		
Work plan	Review and inspection of documentation		

6.5.14.4 Roles and Responsibilities

It is the responsibility of the Contractor to ensure that there is compliance with all contractual requirements. BWS is responsible for assigning the Contractor as the responsible parties for undertaking the monitoring required and for implementing the mitigation measures necessary. BWS may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted, or equitable adjustments allowed to the Contractor for any such suspensions. This is in addition to any other actions BWS may take under the Contract, or in accordance with applicable laws.

6.5.15 Labour Management Plan

6.5.15.1 Monitoring and Compliance

The BWS will be responsible for the daily monitoring of its labour force and the conditions in which works are conducted.

6.5.15.2 Management Measures

The BWS will ensure that the following measures are put in place to manage labourers throughout the proposed works:

- It is recommended that the ILO standards for minimum age requirements for employment be adopted – The ILO Convention No. 138 states that the minimum age for admission to work should not be less than the age of completion of compulsory schooling and not less than 15 years.
- It is imperative that the labour management benefits the local community in terms of providing jobs for local workers, particularly in the context of Belize/Caye Caulker. The Labour Management Plan should support local hires, particularly those populations for which employment is less available, namely women and youth.
- It is encouraged that appropriate labour be sourced from Caye Caulker as a matter of priority and then other areas of Belize where skillsets or labour complement is not available.
- Given the size and scale of the project, opportunities should be encouraged for the local population, including the mentioned groups, if not only in the form of casual labour supporting the project.
- This equitable hiring framework should be honoured by project contractors where possible and supported by the Project Team.
- The Contractor should work with local government and agencies to encourage participation from vulnerable groups (particularly women and youth) and small business owners in providing services to sites, food services, for example, where relevant.
- Local media, radio and social media (Facebook, Instagram, etc.) could be used to disseminate equal opportunity hiring notices, as well as provide information on available related skills training opportunities.
- In keeping with social and gender standards in this context, principles for ensuring fair and equal access to employment as well as non-discriminatory hiring practices that avoid Sexual Exploitation and Abuse and/or forced labour are key.
- It is essential to ensure that work is decent, fairly paid, non-discriminatory and also free of all forms of violence, abuse and exploitation.
- The Labour Management Plan will adhere to all provisions as outlined in the labour policy and the draft sexual harassment policy, including any provisions that exist regarding migrant labour or forced labour.
- A CoC is to be followed, with training for all site workers on the CoC being done prior to the commencement of construction works.

6.5.15.3 Indicators

The following KPIs are recommended to evaluate the effectiveness of the Labour Management Plan.

Table 6-19: Key Performance Indicators for Labour Management

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONITORED AND MEASURED	FREQUENCY	RESPONSIBILITY
Decent Work Matrix	Review and completion of the Decent Work Matrix	Monthly	BWS and Contactor; Results to be presented by the EHS Officer to the BWS Technical Leads for the Project
Sensitization and Gender Risk Management Training	Sensitization training completed (including training on GRM/GBV) for key stakeholders as well as contractors and employees on the Project (2 sessions held – in person or hybrid)	Prior to commencement of construction works and agreed intervals	Social and Gender Advisor/Consultant
Gender Sensitive Monitoring Training	1-2 sessions for contractors/project management staff/CLO		Social and Gender Advisor/Consultant
Code of Conduct Training	1-2 training sessions provided to site workers		Contractor

6.5.15.4 Roles and Responsibilities

It is the responsibility of the BWS and all its possible contractors to ensure that the Labour Management Plan is sufficiently implemented and monitored. If there is a potential challenge due to planned works, the BWS and contractors must ensure that all workers and community members are adequately aware, and the alternatives are clearly expressed to minimize social impacts.

6.5.16 Operation and Maintenance Plan for WWTP

A preventative maintenance plan is necessary to mitigate the failure of any component or equipment within the Wastewater Treatment Plant. This should assist the operator in planning the daily/routine tasks of maintaining the plant.

All components of the treatment plant should be monitored on a frequent basis to ensure problem-free operation of the plant. This section outlines the major components and the recommended actions to be taken to maintain the plant. The major components listed are:

- Screen Channel

- Equalization Tank
- Membrane Aerated Biofilm Reactor
- Secondary Clarifier
- Chlorination Contact

The preventative maintenance chart is shown in the table below. It shows the foreseeable tasks and their frequencies along with recommended spare parts. This is by no means exhaustive and may be improved by the operator.

An inspection check sheet is used to inspect the system on a fortnightly basis. Whenever servicing or maintenance of the system is conducted, such as the haulage of the sewage, it is recorded in the Septic System Maintenance Log by the Maintenance Technician and verified by the Plant Manager (see sample of the log in Appendix 2).

Table 6-20: Preventative Maintenance Chart

Component	*Maintenance Activity*	*Maintenance Frequency*	*Minimum Spare Parts List*	*Personnel Responsible*	*Comments*
Screen Channel & headworks	Cleaning	weekly	Screens and connectors	Maintenance Technician	Ensure debris removal and check sediment levels.
Equalization Tank	leak test, check mixing system, inspecting FOG trap, clean sediment	Weekly	Mixer components, greased trap parts	Maintenance Technician	Monitor pump start/stop cycles
Flat Sheet Membrane Aerated Bioreactors	Monitor air supply, membrane surface, clean membranes (CIP)	Cleaning weekly	Flat Sheet Modules	Maintenance Technician	Maintain flow
	Air Scrubbing	Continuous during operation	Air diffusers and associated parts	Maintenance Technician	Stops only for cleaning cycles
	Clear water backwashing	Every 18 minutes intervals daily	Backwash Pump components	Maintenance Technician	Removes fouling and buildup
	Soaking recovery Cleaning (CIP)	Weekly	Deep Cleaning	Maintenance Technician	Cleaning of Membrane and sludge removal from tank
Clarifier	Check sludge blanket level, clean weirs and scum baffle, inspect scraper arms	Weekly	Scum removal tool, scraper blades	Maintenance Technician	Prevents carryover of solids to the disinfection stage.
Centrifugal Decanter	Clean and service joints Clear and wash storage container	Weekly	Servicing kit for Decanter	Maintenance Technician	Prevents build up and mechanical wear
Sludge Drying Bed	Remove Dried sludge , check for cracks, clean drainage layer	Weekly	Shovel, Wheelbarrow	Maintenance Technician	Monitor dry time during the wet season.
UV-Disinfection or chemical Disinfection unit	Clean and remove fouling	Weekly	Bulbs/lamps	Maintenance Technician	Bulbs may need changing annually

6.5.16.1 Emergency Maintenance for WWTP

Signs of operational issues with the wastewater treatment system:

- Unusual flow behaviour, such as overflow, ponding, or foaming in the membrane aerated bioreactor (MABR) tanks. Sewage backups in pipes lead to unintended discharge points.
- Elevated transmembrane pressure (TMP) in the MABR unit which indicates membrane fouling or blockage.
- Visible damage or corrosion on tank walls, pipes, or aeration equipment.
- Biofilm Loss or Excess Build up: The visible Biofilm Detachment on the flat sheet membrane will affect the oxygen transfer and the treatment performance.
- Strong, persistent odours around process tanks, suggesting anaerobic imbalances, oxygen deficiency, or sludge accumulation.
- Poor effluent quality, such as turbidity, colour change, or unpleasant odour, indicating system underperformance.
- If any of these issues arise, immediate corrective action will be taken. The maintenance team will first attempt to diagnose and resolve the issue. If unresolved, a licensed waste management contractor will be contacted to pump sewage or remove accumulated sludge. Persistent system failures will be escalated to the designated engineering consultant for further assessment and remedial action.
- All emergency repairs will be documented in the Wastewater Treatment System Maintenance Log.
- Contact with untreated or partially treated wastewater should be minimised due to the presence of pathogens, toxins, and chemical contaminants. All maintenance personnel must wear full personal protective equipment (PPE), including gloves, rubber boots, goggles or face shields, and waterproof protective clothing.
- In the event of accidental exposure, the affected person should thoroughly wash the affected area with clean water and soap and seek medical attention as required.
- All tools and surfaces that encounter wastewater must be thoroughly cleaned and sanitized after use. In case of accidental exposure, affected individuals must immediately wash and disinfect exposed skin and seek medical evaluation if necessary.

6.5.16.2 Environmental Management and Monitoring of the WWTP

For the proposed Wastewater Treatment Plant to comply with national environmental regulations and to minimise any potential negative effects on nearby ecosystems, environmental management and monitoring are crucial. See the table below.

Table 6-21 Environmental Management and Monitoring

Component	Management Action	Monitoring Parameter	Monitoring Frequency	Responsible Party	Reporting Requirements
Screening Channel	Regularly remove screenings and clean the bar screen to avoid blockage and odour buildup.	Solid waste accumulation, odour.	Weekly	Maintenance Technician	Log Waste volume and Disposal records.
Equalization Tank	Inspect tank for sediment build-up and proper mixing. Ensure FOG trap is functioning.	Water level and FOG presence and Mixing Performance.	Weekly	Maintenance Technician	
Flat sheet MABR Unit	Monitor transmembrane pressure and inspect biofilm growth. Clean the membranes as needed. Ensure regular inspection of the tank for sludge buildup, cracks, and leaks	Transmembrane pressure (TMP), Biofilm thickness, DO concentration	Weekly	Maintenance Technician	Log Transmembrane readings and Membrane Cleaning records
Clarifier	Check scum accumulation, Sludge blanket height and weir cleanliness.	Scum presence	Weekly	Maintenance Technician	
Sludge Drying bed	Inspect for cracks, proper drainage, and sludge drying performance. Prevent leachate runoff.	Inspect for cracks, proper drainage, and sludge drying performance. Prevent leachate runoff.	Inspect for cracks, proper drainage, and sludge drying performance. Prevent leachate runoff.	Inspect for cracks, proper drainage, and sludge drying performance. Prevent leachate runoff.	Inspect for cracks, proper drainage, and sludge drying performance. Prevent leachate runoff.
Disinfection Unit	Check Chlorine dosing system, Chemical levels and inspect for leaks or cracks.	Residual Chlorine	Daily	Operator	
Stormwater Management	Install stormwater	Floodwater levels	After rainfall events	Maintenance Technician	

Component	Management Action	Monitoring Parameter	Monitoring Frequency	Responsible Party	Reporting Requirements
	diversion structures to prevent flooding of the treatment plant area.				
Discharge Point	Sample and analyse water quality	BOD, COD, TN TP, TSS, & FC	Weekly	Plant Manager	Monthly reporting to BWS

6.5.16.3 Contingency Plan

The contingency plan is an outline of the foreseeable failures and issues and the minimum responses required of the operator running the plant. This plan may be improved upon by the operator with the consent of the engineer over time. See the table below for the contingency plan.

Table 6-22 Contingency Plan for WWTP

Equipment or Component	Observation	Possible Impact	Possible Causes	Action to take	Equipment Inventory	Material Inventory	Contact
Screen Channel and Headworks	Water level increase	flooding of site with raw sewage	Pump Failure	1. check for debris build-up 2. Remove debris 3. repair/replace screens	General and Specialized tools	spare screen	Plant manager
	Water level increase	flooding of site and offsite areas with raw sewage	Pipe blockage	1. Check for debris build-up 2. remove debris	1. Plunger 2. Drain Snake 3. Drain Auger 4. General pipe repair kits	General Pipe fittings (spares)	Plant manager
Equalization Tanks	Water level increase	Discharge of sewage into the ground	pump failure - Electrical outage Failure of tanks base or walls	1. Cesspool Company to evacuate tank 2. Check breaker and electrical elements leading to pumps and check pumps 3. Check backup generator	electric tester & basic tools trash Pump	fuel for generator, Sealant	Contractor
	Water level increase	flooding of site and offsite areas with raw sewage	Pump failure - Mechanical	1. Disconnect Power supply 2. Lift pump and check for blockages 3. Call assigned specialist if the problem cannot be identified/rectified	manhole cover remover electric tester basic tools	spare pump	Pump Technician/contractor

Equipment or Component	Observation	Possible Impact	Possible Causes	Action to take	Equipment Inventory	Material Inventory	Contact
	Water level increase	flooding of site and offsite areas with raw sewage	Stormwater flooding	Divert stormwater flows secure manhole cover	manhole cover remover basic tools		
	Water level drop	Discharge of Sewage into Ground	Structural failure of walls or base	1. cesspool company to diver sewage and empty LS 2. repair crack with nonshrink grout	3 inch mobile trash pump and flexible hose		cesspool contractor grouting contractor
	Mal Odour	Social	Excess standing time	1. Check for blockages 2. Ensure discharge operational 3. check pump is operational	basic tools		Plant Manager
MABR (Flat Sheet)	TMP increase	Reduced treatment efficiency	Membrane Blockage	1. Check for TMP logs 2. Schedule CIP cleaning	Pressure gauges, CIP setup	Cleaning Chemicals, Spare membranes	Plant manager
	Drop in Water level	Discharge of Sewage into Ground	Structural failure of walls or base	1. cesspool company to diver sewage and empty LS 2. repair crack with non shrink grout	Mobile trash pump and flexible hose		cesspool contractor grouting contractor
	Mal Odour	Social	Blower Malfunction or diffuser clogging	1. Check for blockages 2. Ensure discharge operational 3. check blower is operational	basic tools		Plant Manager
Clarifier	Water level increase	Overflow of solids	Weir Blockages	1. Cesspool company to diver sewage.	Hand tools	Weird Parts	Maintenance Technician

Equipment or Component	Observation	Possible Impact	Possible Causes	Action to take	Equipment Inventory	Material Inventory	Contact
				2. Clean weir/scum baffles			cesspool contractor grouting contractor
Decanter	Fluid on ground and equipment	Discharge of Sewage into Ground and on surface	Damaged seals, clogged outlets, damaged pipes	1.Cesspool company to collect sludge 2.Repair leaks		Servicing kit, Additional seals And hoses	
Sludge Drying bed	Sludge not drying	Odours, Vector attraction	Poor Drainage or rainy conditions	1.Improve Surface Drainage 2. Cover Bed during rain periods.			Plant Manager

6.5.16.4 Troubleshooting Guide

The table below outlines the troubleshooting guide for the sewage treatment system.

Table 6-23: Troubleshooting Guide for Wastewater Treatment Plant

Symptom	Possible Problems	Solution
Wastewater odours indoors	• Faulty plumbing seal	• Replace Johni-ring.
	• Sewer vent is plugged, or vents not installed properly.	• Contact qualified plumber to evaluate plumbing and make necessary corrections.
Wastewater odours outdoors	• Temporary weather conditions with little air movement	• Wait and watch as weather conditions change
		• Adjust aeration and sludge removal schedule.
	• Sludge build-up in anaerobic chambers.	• Increase sludge removal frequency.
Evidence of leaks/overflow at manholes	• Blocked inlet or outlet pipes.	• Inspect and clear blockages.
	• Cracks in manhole/ cover	• Conduct repairs as needed including sealing the manhole to prevent odors.
	.	• Inspect and service pumps as needed; ensure back up is functional.
Surface water or soggy soil around sludge drying beds	• Clogged drainage system	• Check outlet structures and openings for blockage by debris or sediment and clean as necessary
	• Excess sludge loading	• Adjust sludge application rates.
	• Heavy rainfall saturation	• Improve storm water management and drainage.
Vector and pest problems	• Standing water in oxidation ditches or clarifiers.	• Maintain proper water levels to prevent stagnation.
	• Open sludge storage areas.	• Cover and properly manage sludge storage.

6.5.17 Sludge Management Plan

6.5.17.1 Source of sludge

Based on the Design Brief Report and Functional Engineering Report, the WWTP will use Membrane Aerated Biofilm Reactor (MABR) technology with modular capacity (initially ~200,000 GPD). Sludge produced will include Waste Activated Sludge (WAS) from MABR modules; settled solids from influent screens or pre-treatment units; and collected septage from vacuum trucks

serving legacy septic tanks or emergencies. The plant will include sludge drying beds designed for gravity drainage and solar drying.

It is estimated that sludge generation will be as follows:

- WWTP sludge production: Approx. 10–15 m^3/month of dewatered solids (depending on influent load and operational efficiency).
- Vacuum truck septage: Variable; 2 vacuum trucks with 2–4 m^3 capacity each, used for septic servicing during transition and emergencies.

6.5.17.2 Sludge treatment and storage

Collection and Removal

Waste-activated sludge from MABR basins will be pumped to the sludge drying beds. Influent screening waste and grit will be manually removed and stored in sealed containers. Septage collected by vacuum trucks will be offloaded into receiving facilities at the WWTP, designed for controlled, hygienic transfer.

Dewatering and Drying

Sludge will be spread in designed solar drying beds with impermeable liners and underdrain systems to collect filtrate. Filtrate will be routed back to the head of the treatment works for re-treatment. Drying beds will be designed to withstand flooding and heavy rainfall; elevated berms and covers may be used if needed to protect drying areas from stormwater.

Storage

Once sufficiently dried (target ~20–30% solids), sludge will be stockpiled temporarily in designated, sealed, and covered storage areas on site. Storage areas will have secondary containment, stormwater diversion features, and be designed to prevent leachate generation.

Transport and Disposal

Dried sludge will be placed in durable, covered containers or trucks for transport, likely to the transfer station. Final disposal will comply with Belize's Hazardous Waste Regulations (2009) and any local authority requirements. Records will be maintained of all sludge quantities, transport, and disposal locations.

Odour and Vector Control

Drying beds will be managed to avoid anaerobic conditions (regular turning, thin-layer spreading). Sludge storage areas will be covered to minimize odour release. Pest control measures (screens, traps) will be installed to deter flies and rodents. Staff will be trained in prompt cleaning and sealing of sludge transfer areas. Emergency procedures will include moving sludge offsite or sealing containers prior to storm events.

6.5.17.3 Management and Mitigation Measures

General Measures

- In general, the sludge should be considered harmful to health and is to be handled and managed with this in mind. Gloves and other relevant PPE must be utilised, and equipment should be periodically scraped and cleaned to prevent anoxic sludge buildup in the treatment facility.

- The personnel are to be appropriately trained on hygiene, spill response, and safe handling procedures and have a clear understanding of the process and the purpose of the process.

- Access controls and signage will limit unauthorized entry to sludge drying and storage areas.

Biosolid Application

- The anaerobic and aerobic digestion that class B biosolids have undergone may not completely eliminate all pathogens present in the sludge. Therefore, it is important that monitoring is done to ensure that the biosolids used for land application meet the specified level of indicator organisms, such as faecal coliforms or Salmonella bacteria. These levels should be determined in consultation with the relevant regulatory bodies.

- Proper application rates and management practices are necessary to minimise risks of nutrient runoff, groundwater contamination and potential exposure to pathogens. These practices include undergoing a process of screening sites for the application. Application sites must meet regulatory requirements and should consider soil type, slope, proximity to water bodies, groundwater depth and potential for runoff or erosion.

- Conduct soil testing and analysis to determine baseline conditions of soils to inform the biosolid application rates. Analysis should be done for nutrient levels, pH, and other soil characteristics.

- Biosolid application should be done outside of periods of heavy rainfall, high winds or soil saturation to reduce runoff, nutrient loss or contamination of soil and groundwater resources.

- Use appropriate methods of application such as surface spreading, injection or incorporation. The method should also be informed by the conditions of selected sites and regulatory requirements. The even distribution of biosolids are recommended to optimize nutrient utilization and minimize nutrient runoff.

- Establish buffer zones or setbacks around sensitive areas such as water bodies, well, residential areas and public facilities to minimize the risk of contamination and human exposure.

- Maintain detailed records of biosolid applications, including application rates, dates, locations and weather conditions. Regular monitoring of soil, water and crop quality is also recommended to assess the effectiveness of biosolids application.

6.5.17.4 Key Performance Indicators

The following Key Performance Indicators (KPIs) have been selected in order to evaluate the effectiveness of the sludge management process.

Table 6-14: Key Performance Indicators for Sludge Management

KEY PERFORMANCE INDICATOR	HOW WILL IT BE MONITORED AND MEASURED	RESPONSIBILITY	FREQUENCY
No leakages or spills	Monitor possible spills Inspection of site by Contractor	Contractor; Results to be presented to the Implementing Agency	Annually
Limited sediment-laden run-off during heavy rain	Monitor nearby/downstream wells and water bodies for significant Sludge to be covered during rainy periods	Contractor; Results to be presented to the Implementing Agency	
Approved Contractors	Inspection of licenses and documentation	Contractor; Results to be presented to the Implementing Agency	
Sludge managed properly	Inspection of site by Contractor	Contractor; Results to be presented to the Implementing Agency	Monthly
Biosolid Application Log and Schedule	Inspection of licenses and documentation	Contractor; Results to be presented to the Implementing Agency	

6.5.17.5 Roles and Responsibilities

It is the responsibility of the BWS to ensure all workers are made aware of the importance of following the management and mitigation and that monitoring reports are prepared. It is also the responsibility of the BWS to ensure that the proposed sludge management process are done in compliance with regulatory requirements.

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8 Appendix

Appendix 1: Code of Conduct

Introduction

The project is committed to ensuring a work environment which minimizes any negative impacts on the local environment, communities, and its workers. The project also strongly commits to creating and maintaining an environment in which sexual exploitation and abuse and sexual harassment have no place, and where they will not be tolerated by any employee, sub-contractor, supplier, associate, or any representative of the company implementing the proposed works.

The purpose of this *Code of Conduct* is to:

- Create a common understanding of what constitutes acceptable and unacceptable forms of conduct during work and in any interactions with the community and beneficiaries. This includes the prohibition of sexual exploitation and abuse, and sexual harassment, including their forms, the reasons behind their prohibition and the sanctions to be deployed.
- Create a shared commitment to fair, appropriate and socially responsive behaviours and guidelines for company employees as well as contractors/third-party suppliers to prevent, report, and respond to sexual exploitation and abuse and sexual harassment, and
- Create understanding that breach of this code of conduct will result in disciplinary action.
- Guide the frequency and content of the training for the prevention of sexual exploitation and abuse.

Definitions

SEXUAL EXPLOITATION AND ABUSE[9]

Defined as any actual or attempted abuse of a position of vulnerability, differential power, or trust, for sexual purposes, including, but not limited to, profiting monetarily, socially or politically from the sexual exploitation of another[10].

- **Sexual Abuse:** "The actual or threatened physical intrusion of a sexual nature, whether by force or under unequal or coercive conditions." Usually, between the project team members and beneficiaries.
- **Sexual Harassment:**[11] Unwelcome sexual advances, requests for sexual favours, and other verbal or physical conduct of a sexual nature. Usually between members of the project team, within the BWS and between the project team and contractors.

[9] As defined in the UN Secretary's bulletin – Special Measures for protection from sexual exploitation and abuse October, 9, 2003 ST/SGB/2003/13
[10] In the context of World Bank Financed operations exploitation occurs when access to, or benefit from a World Bank Financed good or service is used to extract sexual gain.
[11] Inter-Agency Standing Committee *Protection against Sexual Exploitation and Abuse (PSEA): Inter-agency cooperation in community based complaint mechanism. Global standard Operating Procedures*. May 2016

SEXUAL HARASSMENT VERSUS SEA[12]

SEA occurs against a beneficiary or member of the community. Sexual harassment occurs between personnel/staff of an organization or company and involves any unwelcome sexual advance or unwanted verbal or physical conduct of a sexual nature. The distinction between the two is important so that agency policies and staff trainings can include specific instruction on the procedures to report each.

CONSENT

The choice behind a person's voluntary decision to do something. Consent for any sexual activity must be freely given, ok to withdraw, made with as much knowledge as possible, and specific to the situation. If agreement is obtained using threats, lies, coercion, or exploitation of power imbalance, it is not consent. Under this Code of Conduct[13] consent cannot be given by anyone under the age of 18, regardless of the age of majority or age of consent locally. A mistaken belief regarding the age of the child is not a defence.

There is no consent when agreement is obtained through:

- the use of threats, force or other forms of coercion, abduction, fraud, manipulation, deception, or misrepresentation
- the use of a threat to withhold a benefit to which the person is already entitled, or
- a promise is made to the person to provide a benefit.

While all forms of violence against a community resident or a co-worker are forbidden, this code of conduct is particularly concerned with the prevention and reporting of sexual exploitation and abuse and sexual harassment, which constitute gross misconduct, are grounds for termination or other consequences related to employment and employment status:

- Examples of sexual exploitation and abuse include, but are not limited to:
    - A project worker tells women in the community that he can get them jobs related to the work site (cooking and cleaning) in exchange for sex.
    - A worker who is laying pipeline network and connecting them to households says that he can connect women-headed households to the grid in exchange for sex.
    - A project worker gets drunk after being paid and rapes a local woman.
    - A project worker denies passage of a woman through the site that he is working on unless she performs a sexual favour.
    - A manager tells a woman applying for a job that he will only hire her if she has sex with him.
    - A worker begins a friendship with a 16-year-old girl who walks to and from school and lives where project-related work is taking place. He gives her rides on his golf cart to school. He tells her that he loves her. They have sex. In this case, even though the age of consent for the country may be 16, this is still illegal for the purposes of the project, as the acceptable age of consent in this case is 18 years of age.
- Examples of sexual harassment in a work context include, but are not limited to:

[12] Ibid
[13] In accordance with the United Nations Convention on the Rights of the Child.

- Male staff comment on female staffs' appearances (both positive and negative) and sexual desirability.
- When a female staff member complains about comments male staff are making about her appearance, they say she is "asking for it" because of how she dresses.
- A male manager touches a female staff members' buttocks when he passes her at work.
- A male staff member tells a female staff member he will get her a raise if she sends him naked photographs of herself.

Individual signed commitment (example):

I, _____, acknowledge that sexual exploitation and abuse and sexual harassment are prohibited. As an *(employee/contractor)* of *(contracted agency / sub-contracted agency)* in (*country)*, I acknowledge that sexual exploitation and abuse and sexual harassment activities on the work site, the work site surroundings, at workers' camps, or the surrounding community constitute a violation of this *Code of Conduct*. I understand sexual exploitation and abuse and sexual harassment activities are grounds for sanctions, penalties or potential termination of employment. Prosecution of those who commit sexual exploitation and abuse and sexual harassment may be pursued if appropriate.

I agree that while working on the project I will:

- Treat all persons, including children (persons under the age of 18), with respect regardless of sex, race, colour, language, religion, political or other opinion, national, ethnic or social origin, gender identity, sexual orientation, property, disability, birth or other status.
- Commit to creating an environment which prevents sexual exploitation and abuse and sexual harassment and promotes this code of conduct. In particular, I will seek to support the systems which maintain this environment.
- Comply with the laws governing the land with regard to employment and will strive to provide equal opportunities to all, ensure work environments are safe and compensate those employed under me with fair wages.
- Not participate in sexual exploitation and abuse and sexual harassment as defined by this *Code of Conduct* and as defined under *the* laws of Belize.
- Not use language or behaviour towards women, children or men that is inappropriate, harassing, abusive, sexually provocative, demeaning or culturally inappropriate.
- Not participate in sexual contact or activity with anyone below the age of 18. A mistaken belief regarding the age of a child is not a defence. Consent from the child is also not a defence. I will not participate in actions intended to build a relationship with a minor that will lead to sexual activity.
- Not solicit/engage in sexual favours in exchange for anything as described above.

Unless there is full consent by all parties involved, recognising that a child is unable to give consent and a child is anyone under the age of 18, I will not have sexual interactions with members of the surrounding communities. This includes relationships involving the withholding or promise of actual provision of benefit (monetary or non-monetary) to community members in exchange for sex—such sexual activity is considered "non-consensual" under this Code.

I commit to:

- Adhere to the provisions of this code of conduct both on and off the project site.
- Attend and actively partake in training courses related to preventing sexual exploitation and abuse and sexual harassment, as requested by my employer.

If I am aware of or suspect sexual exploitation and abuse and sexual harassment at the project site or the surrounding community, I understand that I am encouraged to report it to the Grievance Reporting Mechanism (GRM) or to my manager. The safety, consent, and consequences for the person who has suffered the abuse will be part of my consideration when reporting. I understand that I will be expected to maintain confidentiality on any matters related to the incident to protect the privacy and security of all those involved.

Sanctions

I understand that if I breach this Individual Code of Conduct, my employer will take disciplinary action which could include:

- Informal warning or formal warning
- Additional training.
- Loss of salary.
- Suspension of employment (with or without payment of salary)
- Termination of employment.
- Report to the police or other authorities as warranted.

I understand that it is my responsibility to adhere to this code of conduct. That I will avoid actions or behaviours that could be construed as sexual exploitation and abuse and sexual harassment. Any such actions will be a breach of this Individual Code of Conduct. I acknowledge that I have read the Individual Code of Conduct, do agree to comply with the standards contained in this document, and understand my roles and responsibilities to prevent and potentially report sexual exploitation and abuse and sexual harassment issues. I understand that any action inconsistent with this Individual Code of Conduct or failure to act mandated by this Individual Code of Conduct may result in disciplinary action and may affect my ongoing employment.

Signature: _____

Printed Name: _____

Title: _____

Date: _____

8.1.1.1 Key Performance Indicators

The following KPIs have been selected in order to evaluate the effectiveness of the Labour Management Plan.

Table 13-8-1: Key Performance Indicators for Labour Management

KEY PERFORMANCE INDICATORS	HOW WILL IT BE MONITORED AND MEASURED	RESPONSIBILITY	FREQUENCY
Decent Work Matrix	Review and completion of the Decent Work Matrix	Contactor; Results to be presented to the Implementing Agency	Monthly
Sensitization and Gender Risk Management Training	Sensitization training completed (including training on GRM/GBV) for key stakeholders as well as contractors and employees on the Project (2 sessions held – in person or hybrid)	Social and Gender Advisor/Consultant	Prior to commencement of construction works
Gender Sensitive Monitoring Training	1-2 sessions for contractors/project management staff/CLO	Social and Gender Advisor/ Consultant	Prior to commencement of construction works
Code of Conduct Training	1-2 training sessions provided to site workers	Contractor	Prior to commencement of construction works

Roles and Responsibilities

It is the responsibility of the Contractor to ensure that the Labour Management Plan is sufficiently implemented and monitored. If there is a potential challenge due to planned works, the contractor must ensure that all workers and community members are adequately aware and that the alternatives are clearly expressed to minimise social impacts.

BWS is responsible for assigning the engineer and the contractor as the responsible parties for undertaking the monitoring required and for implementing the mitigation measures necessary.

The site and surrounding coastal/marine environment will be monitored by the engineer for negative impacts caused by the construction Works. The engineer will notify the contractor in writing of any observed noncompliance with local environmental laws regulations, permits, and other elements of the ESMP. The contractor shall, after receipt of such notice, inform the engineer of the proposed corrective action and take such action when approved by the BWS.

BWS may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No time extensions shall be granted or equitable adjustments allowed to the contractor for any such suspensions. This is in addition to any other actions BWS may take under

the Contract, or in accordance with applicable laws. If there are any violations, this will be reported immediately to the EHS Officer and any incidents logged.

Appendix 2: Maintenance Log Template

Service Date	Maintenance Activity	Servicing Company	Activities Completed	Comments	Inspected By	Approved By	Signature