DRAFT ENVIRONMENTAL AND SOCIAL ASSESSMENT AND ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

For the Refurbishment of the Acono Water Treatment Plant) and Refurbishment and Upgrade of the Siparia Water Treatment Plant

TRINIDAD AND TOBAGO NATIONAL WATER SECTOR TRANSFORMATION PROGRAM PHASE 2 (TT-L1071)

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ACRONYMS AND ABBREVIATIONS

CCLIP	Conditional Credit Line for Investment Projects
CEC	Certificate of Environmental Clearance
EMA	Environmental Management Authority
ESA	Environmental and Social Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ESPF	Environmental and Social Policy Framework
ESPS	Environmental and Social Performance Standards
IDB	Inter American Development Bank
IMGD	Imperial Million Gallons per Day
MPU	Ministry of Public Utilities
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
SESA	Strategic Environmental and Social Assessment
WASA	Water and Sewerage Authority
WHO	World Health Organisation
WRA	Water Resources Agency
WTP	Water Treatment Plan

EXECUTIVE SUMMARY

An Environmental and Social Assessment (ESA) and Environmental and Social Management Plan (ESMP) have been prepared for the proposed refurbishment of the Acono Water Treatment Plant (WTP) and the refurbishment and upgrade of the Siparia Water Treatment Plant (WTP) in Trinidad. The projects are being implemented by the Ministry of Public Utilities (MPU), which will serve as the executing agency and the Water and Sewerage Authority (WASA), which will serve as the sub executing agency, under Phase 2 of the Trinidad and Tobago National Water Sector Transformation Program (TT-L1071), financed by the Inter-American Development Bank (IDB). The ESA provides a comprehensive framework for identifying, assessing, and managing the environmental and social risks associated with the projects, while the ESMP establishes the mitigation, monitoring, and institutional measures required to ensure compliance with national regulations and the IDB Environmental and Social Performance Standards.

The projects form part of a broader national strategy to improve the efficiency, reliability, sustainability, and resilience of potable water supply services throughout Trinidad and Tobago. Despite previous investments under Phase 1 of the National Water Sector Transformation Program, significant challenges persist, including intermittent water supply, high levels of non-revenue water, ageing infrastructure, limited operational efficiency, and increasing climate-related pressures on water resources. Phase 2 of the Program seeks to address these challenges through targeted infrastructure upgrades, institutional strengthening, and network optimisation initiatives designed to improve water security and service delivery across the country. The refurbishment of the Acono and Siparia Water Treatment Plants represents a critical component of this broader transformation programme.

Project Scope and Description

Acono Water Treatment Plant

The Acono Water Treatment Plant is a critical water supply facility serving communities in north-eastern Trinidad. The proposed project involves the refurbishment and modernisation of the existing facility to improve treatment efficiency, operational reliability, and resilience under increasingly variable raw water conditions.

The proposed Refurbishment of the Acono Water Treatment Plant (WTP) involves a comprehensive modernization programme aimed at improving the reliability, efficiency, and treatment capacity of an aging facility that has been in operation for more than 35 years. The project is designed to address existing operational deficiencies, reduce service interruptions, and improve potable water quality for communities served by the plant. Key works include the replacement and upgrading of critical treatment infrastructure, installation of advanced process control systems, and implementation of measures to improve resilience against variable raw water quality conditions, particularly elevated

turbidity and suspended solids. The project also incorporates environmental, health, safety, and social management requirements, alongside staff training and capacity-building initiatives to support long-term operational sustainability.

The principal engineering activities include the supply and installation of a new high-rate coagulation, flocculation, and clarification system to improve treatment performance and increase production reliability. Existing filters and clarifiers will undergo structural and mechanical refurbishment to extend their service life and enhance operational efficiency. The chemical treatment process will be upgraded through modifications to the alum dosing system to better manage fluctuations in raw water quality. In addition, new desilting equipment and sludge management systems will be installed to improve sediment handling and reduce maintenance burdens. Mechanical upgrades include the installation of a trash rack and automated screen-wash system to prevent clogging at raw water intakes and improve plant reliability. These interventions will be supported by associated civil, electrical, instrumentation, and process improvements throughout the facility.

Siparia Water Treatment Plant

The proposed Refurbishment and Upgrade of the Siparia Water Treatment Plant (WTP) involve a comprehensive modernization of the existing 1.32 IMGD to 2.0 IMGD. This is set to improve the reliability, efficiency, resilience, and quality of potable water production in south-western Trinidad. A key aspect of the project is that all refurbishment and construction activities will be undertaken while maintaining continuous plant operations through phased implementation and temporary works, ensuring uninterrupted water supply to the communities served by the facility. The project encompasses the rehabilitation and replacement of aging treatment infrastructure, modernization of treatment processes, integration of advanced automation and monitoring systems, enhancement of occupational health and safety measures, and strengthening of environmental compliance systems. The overall objective is to deliver a modern treatment facility capable of consistently producing water that meets WHO drinking water quality standards under varying raw water conditions.

The civil and structural scope includes demolition and removal of obsolete treatment units and deteriorated infrastructure, construction of new reinforced concrete structures for clarifiers, rapid gravity filters, sludge handling facilities, equipment foundations, and support buildings, as well as rehabilitation and strengthening of existing structures. Additional works include installation of a new factory-coated bolted steel clearwell for treated water storage and chlorine contact, construction of access stairways, platforms, handrails, and safety barriers, and implementation of supporting site infrastructure such as drainage improvements, internal roads, fencing, and restoration of disturbed areas. Process and mechanical upgrades will include installation of a new tray-type aeration system, construction of a new lamella clarifier and refurbishment of an existing clarifier with lamella settling technology, construction of new rapid gravity filtration units with modern underdrain systems and filter media, development of sludge management facilities including sludge holding tanks and

recirculation systems, installation of new high-lift and backwash pumps, air scour blowers, chlorination systems, ventilation systems, and all associated process pipework, valves, and fittings necessary for raw water, treated water, sludge, backwash, and chemical handling systems.

The project also includes extensive electrical, instrumentation, automation, testing, and commissioning works. These activities comprise upgrading the plant's electrical supply infrastructure, installation of transformers, switchgear, motor control centers, distribution panels, grounding systems, lighting systems, and power and control wiring for all process equipment. New instrumentation will be installed for monitoring flow, level, pressure, turbidity, and other water quality parameters, all integrated into a centralized Supervisory Control and Data Acquisition (SCADA) system to enable automated plant operation and real-time monitoring. The final phase of the project will involve pre-commissioning inspections, equipment calibration, hydraulic testing, disinfection, performance verification, full commissioning of the upgraded facility, and training of operations and maintenance personnel. The contractor will also be required to provide detailed design documentation, operations and maintenance manuals, as-built drawings, environmental and health and safety management plans, quality assurance records, permits, certifications, and warranties to support the long-term operation and sustainability of the upgraded water treatment plant.

Existing Environment

Acono Water Treatment Plant

The Acono project is located within a predominantly rural and forested environment in the Tunapuna/Piarco region of northern Trinidad. The facility is situated within an area characterised by steep terrain, abundant vegetation, and proximity to sensitive watershed resources. The surrounding environment supports natural habitats and ecosystem functions associated with the Northern Range. The area is exposed to natural hazards including extreme rainfall events, landslides, flooding, earthquakes, and increasing temperatures associated with climate change.

The surrounding communities are relatively small and dispersed, with socio-economic characteristics typical of rural northern Trinidad. The facility provides an important public service to communities that depend on reliable potable water supply. Existing social conditions indicate moderate levels of vulnerability associated with infrastructure reliability and access to essential services, underscoring the importance of maintaining continuous water supply throughout the refurbishment programme.

Siparia Water Treatment Plant

The Siparia project is located within the south-western region of Trinidad and is surrounded by a mixture of residential, agricultural, and commercial land uses. The facility is supplied by groundwater resources from the Siparia/Coora wellfield and serves numerous communities throughout the region. The surrounding environment is characterised by modified vegetation, developed land uses, and infrastructure associated with urban and peri-urban settlement patterns.

The Siparia area is exposed to a range of climate and natural hazard risks, including flooding, extreme heat, earthquakes, and localized landslide susceptibility. The surrounding communities rely heavily on the facility for potable water supply, making the plant a critical public utility asset. Socio-economic conditions within the area of influence reflect a diverse population with varying levels of vulnerability, highlighting the importance of maintaining reliable water services and minimising disruptions during project implementation.

Environmental and Social Impacts and Risks

The ESA identifies a range of environmental and social risks associated with both projects during construction and operation. For the Acono WTP, potential construction impacts include temporary vegetation disturbance, erosion and sedimentation risks, increased noise and dust generation, construction waste generation, traffic disruptions, worker health and safety risks, and temporary disturbances to nearby communities. Given the site's location within a sensitive watershed environment, particular attention is required for erosion control, water quality protection, and biodiversity management.

For the Siparia WTP, construction activities may result in temporary noise, dust, traffic disruptions, waste generation, occupational health and safety risks, and temporary inconvenience to nearby residents and businesses. Additional considerations include the management of demolition materials, hazardous substances, construction runoff, and maintaining uninterrupted potable water production during refurbishment activities.

Both facilities are exposed to climate and disaster risks including flooding, extreme rainfall, earthquakes, and increasing temperatures. Operational risks include equipment failures, process interruptions, chemical handling hazards, and potential impacts to water quality. However, the projects are expected to generate substantial long-term positive impacts through improved water quality, enhanced reliability of potable water services, increased treatment efficiency, improved operational resilience, strengthened climate adaptation capacity, and improved public health outcomes.

Environmental and Social Management Plan

To address identified risks and impacts, a comprehensive Environmental and Social Management Plan (ESMP) has been developed for both projects. The ESMP establishes the mitigation measures, monitoring requirements, institutional responsibilities, and performance indicators necessary to ensure effective environmental and social management throughout project implementation.

The ESMP includes:

Management Plan	Acono WTP	Siparia WTP	Main Risks/Impacts Addressed

Construction Environmental and Social Management Plan (C-ESMP)	✓	✓	Overall environmental and social management
Water Quality Management Plan	✓	✓	Water contamination, sedimentation, runoff
Air Quality and Dust Control Plan	✓	✓	Dust emissions and air quality impacts
Noise and Vibration Management Plan	✓	✓	Construction noise and vibration
Waste Management Plan	✓	✓	Construction and operational waste
Hazardous Materials Management Plan	✓	✓	Chemical handling and storage
Disaster Risk Management Plan	✓	✓	Flooding, earthquakes, extreme weather
Local Employment and Gender Inclusion Management Plan	✓	✓	Local employment and social inclusion
Worker Health and Safety Management Plan	✓	✓	Occupational health and safety risks
Stakeholder Engagement Plan	✓	✓	Community consultation and disclosure
Grievance Redress Mechanism	✓	✓	Community and worker grievances
Worker Behaviour and Anti-Harassment Plan	✓	✓	Workforce conduct and community relations
Emergency Management Plan	✓	✓	Emergency preparedness and response
Biodiversity and Habitat Management Plan	✓	✓	Habitat disturbance and ecological protection

The ESMP will be implemented through WASA's project-specific Environmental and Social Management System (ESMS), supported by contractors, consultants, and regulatory agencies. Monitoring, reporting, stakeholder engagement, and adaptive management processes will be

undertaken throughout construction and operation to ensure compliance with national regulations and IDB safeguard requirements.

Conclusion

The proposed refurbishment of the Acono Water Treatment Plant and refurbishment and upgrade of the Siparia Water Treatment Plant represent strategically important investments in Trinidad and Tobago's water infrastructure. Both projects address critical operational deficiencies within existing facilities and support national objectives related to water security, service reliability, infrastructure resilience, and sustainable development.

Although the projects present a range of environmental and social risks during construction and operation, these impacts are generally temporary, site-specific, and can be effectively managed through implementation of the proposed ESMP and associated management plans. The anticipated long-term benefits, including improved water quality, enhanced service reliability, increased treatment capacity, improved operational efficiency, strengthened climate resilience, and improved public health outcomes, are expected to substantially outweigh the potential adverse impacts. Consequently, the projects are considered environmentally and socially viable and consistent with the objectives of the Trinidad and Tobago National Water Sector Transformation Program Phase 2.

1 INTRODUCTION

The Water and Sewerage Authority of Trinidad and Tobago (WASA) is undertaking ***the refurbishment of several key water treatment plants across the country, including the Acono Water Treatment Plant and Siparia Water Treatment Plant***. These interventions form part of a national initiative to stabilise, modernise, and strengthen the country's water supply systems, improving service reliability, water quality, and operational efficiency.

This Environmental and Social Assessment (ESA) forms part of a broader environmental and social due diligence process required under the IDB Environmental and Social Policy Framework (ESPF) and relevant Environmental and Social Performance Standards (ESPS 1–10). It provides the analytical foundation to identify, predict, and evaluate the potential environmental and social impacts associated with the design, construction, and operation of the proposed project, and to recommend appropriate mitigation and management measures through a comprehensive Environmental and Social Management Plan (ESMP).

This ESA and ESMP also support the development of a project-specific Environmental and Social Management System (ESMS) to guide WASA's ongoing compliance with national regulatory requirements and IDB safeguards throughout project implementation.

1.1 Objectives

This report seeks to achieve the following objectives:

- To describe and evaluate the existing environmental, ecological, and socio-economic conditions at and around each project site to establish a baseline for impact assessment.
- Identify, evaluate, and document the potential environmental and social risks and impacts associated with the refurbishment activities at Acono and Siparia.
- Develop appropriate mitigation, management, and monitoring measures to ensure that adverse impacts are avoided, minimised, or mitigated in accordance with national legislation and IDB environmental and social standards.
- Establish a systematic environmental and social management framework that will guide implementation, oversight, and continuous improvement during project execution and operation.
- Support WASA's transition toward a modern, efficient, and climate-resilient utility, while maintaining compliance with environmental, health, safety, and social safeguard requirements.

2 Programme and Projects Description

2.1 Background and Justification

2.1.1 Phase 1: National Water Sector Transformation Program (TT-L1055)

In previous years, the National Water Sector Transformation Program (TT-L1055) for Trinidad and Tobago was approved to enhance the efficiency, reliability, and quality of potable water services. The project was launched because potable water is not supplied to all households in Trinidad and Tobago on a 24/7 basis; only 53% of customers receive water on a 24/7 basis in the wet season and 31% in the dry season (Water and Sanitation Division of the IDB, 2020). There is also a high rate of non-revenue water (NRW) lost through leaks, inefficient operations of water treatment plants, and metering and billing issues. NRW is as high as 40-50% and in some cases estimated at 60% of total water produced. The lack of infrastructure in some areas limits the ability to take advantage of abundant water resources to meet dry season demand due to WASA's lack of storage capacity, the ageing infrastructure and bottlenecks in the network inhibit the transmission of water from water-rich areas to water-scarce areas.

With the compounding issues and growing population, Trinidad and Tobago successfully launched and received funding from the Inter-American Development Bank (IDB) through a Conditional Credit Line for Investment Projects (CCLIP) to address some of these major issues. The first operation focused on the North-Western region of Trinidad, including Diego Martin, San Juan/Laventille, and Port of Spain.

The first operation comprised three components:

- Component 1. Water Stabilisation and Improvement: (US$44 Million)
- Component 2. Support for Water Sector Transformation Plan: (US$2.74 Million)
- Component 3. Network Optimisation: (US$31 Million)

In compliance with IDB safeguards, an Environmental and Social Assessment (ESA) and supporting instruments were prepared, including an Environmental and Social Management Plan (ESMP), Strategic Environmental and Social Assessment (SESA), and Environmental and Social Management Framework (ESMF). Funding was granted for this first loan operation.

2.1.2 Phase 2: National Water Sector Transformation Program (TT-L1071)

This current programme represents Phase 2, which is the second loan operation under the CCLIP TT-O0007 – Trinidad and Tobago National Water Sector Transformation Program with funding of US$235M. This operation is designed to strengthen and build on the objectives and achievements of the first operation, TT-L1055. The General objective of the second operation is to improve the efficiency, quality, sustainability and resilience of potable water supply service and water security in Trinidad and Tobago. This second loan aims to build on the efforts of the first loan operation to ensure long-term sustainability and efficiency in the water sector. The overall objective of the second loan is to continue improving water services in Trinidad and Tobago. The specific objectives of the second

operation are to: (i) enhance the operational efficiency and financial sustainability of WASA; (ii) reduce non-revenue water through targeted investments in pipeline rehabilitation and leak detection; (iii) expand access to potable water services, especially to underserved communities in T&T; and (iv) strengthen regulatory frameworks and governance in the sector.

2.2 Components of this Programme (TT-L1071)

As outlined in the IDB preparation documents provided, the programme components associated with this loan include:

- **Component 1: Water Service Improvement and Infrastructure Upgrade:** This component aims to enhance water service reliability and efficiency through critical infrastructure upgrades. It will finance the development of a comprehensive program to prevent further service decline throughout the country and to ensure access to water, sanitation and hygiene to unserved and underserved households.
- **Component 2: Network Optimisation and Water Loss Reduction:** This component is designed to improve network efficiency by reducing water losses and optimising system performance. Under this component, water loss reduction and monitoring will be improved through (i) the replacement of aged and fragile transmission and distribution networks to reduce water loss and high leakages; and (ii) Continuation of efforts to reduce Non-Revenue Water across Trinidad and Tobago to increase WASA operational efficiency and reliability.
- **Component 3: Capacity Building and Strengthening Regulatory Frameworks:** This component focuses on institutional strengthening to improve the governance, sustainability, and operational efficiency of the water sector. It includes capacity-building programs to modernise utility management practices. Additionally, it will support aspects of regulatory improvements towards strengthening oversight, promoting accountability, and ensuring long-term sector sustainability. In addition, this component will finance the institutional improvements to support the implementation of Integrated Water Resources Management (IWRM) strategies.

2.3 Implementation Arrangements

The Executing Agency for this loan operation will be the Ministry of Public Utilities, and the sub-Executing Agency is Water and Sewerage Authority (WASA). They will be responsible for the overall administration of the proposed operation, including:

- planning, monitoring, evaluating, and supervising the operation;
- conducting procurement for works, goods, consulting and non-consulting services;
- handling loan disbursement requests and maintaining financial records;
- managing work supervision and inspection;
- overseeing environmental and social management;

- preparing documents such as the multiyear execution plan, annual work plan, procurement plan, semi-annual progress reports, audited financial statements, midterm evaluation, and final evaluation;
- monitoring works and service contracts;
- supervising environmental and social aspects; and
- liaising with the IDB.

Essentially, WASA will implement a project-specific Environmental and Social Management System (ESMS) in accordance with ESPS 1, covering the full lifecycle of the Acono and Siparia Refurbishment of their WTP . The ESMS is a dynamic and continuous process organised around four cycles: Plan, Execute, Verify, and Act.

WASA has been the sub-executing or executing agency for several IDB-funded operations. The most recent of which was the Trinidad and Tobago National Water Sector Transformation Program (TT-L1055) for $80Mn, currently under execution. Previous projects executed by WASA include the Multi-Phase Wastewater Rehabilitation Program (TT-L1026) for $246 Mn and the WASA Modernisation and Wastewater Infrastructure Rehabilitation Program (TT-L1018) for $50 Mn. WASA was a key partner in the recently executed Technical Cooperation, Support for the Preparation of Trinidad and Tobago Water Supply Improvement Program (TT-T1108) for US$800,000.

2.4 Project Rationale

In Trinidad and Tobago, the Water and Sewerage Authority (WASA) is mandated to ensure the sustainable delivery of potable water and wastewater services to all communities. However, decades of ageing infrastructure, inadequate maintenance, increasing demand, and intensifying climate variability have placed significant strain on the nation's water supply system.

The refurbishment work across the island represents an urgent and strategic national investment designed to restore reliability, operational efficiency, and resilience across critical nodes in the water supply network.

The Acono Water Treatment Plant (WTP) is a key component of the Water and Sewerage Authority's potable water supply network serving communities within the Maracas Valley and surrounding areas. The plant currently operates in conjunction with the Lluengo and Naranjo (L&N) Water Treatment Plant through an interconnected distribution network that provides potable water to approximately 12,100 persons. However, hydraulic modelling and operational assessments undertaken by WASA identified that the existing configuration is unable to consistently satisfy system demand under a continuous 24-hour supply regime. The Acono WTP currently produces an average of approximately 0.30 IMGD during the dry season and 0.40 IMGD during the wet season, while the interconnected network remains heavily dependent on supplementary supply from the L&N WTP due to inadequate production capacity, hydraulic constraints, and limited operational flexibility. The assessment concluded that these deficiencies restrict the system's ability to provide reliable service, particularly

to higher elevation communities, and increase the complexity of operating the interconnected network.

Hydraulic modelling undertaken for the project demonstrated that the existing interconnected system is highly sensitive to fluctuations in production from either treatment plant, resulting in unstable flow distribution, reverse flow potential, source dominance, and limited operational control. To address these issues, the study evaluated an upgraded Acono WTP supplied by new raw water intake sources at Acono Point 2 and Don Juan, together with hydraulic separation of the Acono and L&N systems. The proposed upgrade is projected to increase average production capacity to approximately 0.72 IMGD during the dry season and 1.65 IMGD during the wet season, thereby significantly improving system resilience and reducing dependence on the L&N WTP. Modelling also confirmed that the upgraded system would support expansion of the Acono supply boundary, improve service reliability, and facilitate continuous (24/7) water supply to a substantially larger portion of the service area.

Critical deficiencies identified through the hydraulic assessment include:

- **Insufficient production capacity:** The existing Acono WTP produces only approximately 0.30 IMGD during the dry season and 0.40 IMGD during the wet season, which is inadequate to meet the potable water demand within the interconnected supply area without significant support from the L&N WTP.
- **Hydraulic instability:** The interconnected Acono–L&N network is highly sensitive to changes in treatment plant production and operating pressures, resulting in unstable flow distribution, reverse flow conditions, and frequent shifts in source dominance that reduce operational reliability.
- **Limited operational control:** The current network configuration creates a high dependency between the two treatment plants, limiting operational flexibility, restricting future expansion, and complicating system management during varying demand conditions.
- **Inadequate service to high-elevation communities:** Existing system pressures are insufficient to reliably supply elevated communities including Caurita Road, Acono Gardens Tank Farm, La Rue Pomme Road, El Chorro Road, and Alta Garcia, resulting in persistent pressure deficiencies that cannot be resolved simply by increasing treatment plant discharge pressures.
- **Transmission network constraints:** The existing 4-inch distribution main along Maracas Royal Road exhibits excessive flow velocities and head losses, restricting hydraulic performance and reducing the efficiency of water conveyance throughout the distribution network.
- **Insufficient storage and pressure management infrastructure:** The existing system relies on limited storage capacity and lacks adequate localized storage and booster pumping

facilities required to maintain acceptable pressures and reliable service throughout the mountainous supply zone under a continuous 24/7 operating regime.

The Siparia (Coora) Water Treatment Plant (WTP) is a critical component of the Water and Sewerage Authority's south-western water supply network, designed to treat and distribute potable water to communities in the Siparia region and environs. The plant is fed exclusively by groundwater abstracted from a network of production wells within the Siparia/Coora wellfield. An assessment was conducted by WASA to justify the need to invest in refurbishment and upgrade works at the WTP in Siparia[1]. The assessment revealed that the plant was originally designed to treat raw water at a rate of 1.32 IMGD (approximately 6,000 m^3/day). However, the current measured production across its eleven (11) operational wells indicates a total raw-water supply of only approximately 0.583 IMGD (2,649 m^3/day) entering the plant. After accounting for water losses in the raw-water transmission mains, effective net supply is estimated at 0.539 IMGD (2,449 m^3/day). This represents a production deficit of more than 57% below the original design capacity. As such, the plant is operating at less than 43% of its design output. This shortfall directly limits potable water availability to communities served by the Siparia system and is compounded by the deterioration of treatment infrastructure, which further reduces effective output and compromises treated water quality. Critical plant deficiencies identified include:

- **Non-functional Aeration System:** The existing aerator is non-operational, fitted with makeshift PVC nozzles, missing louvres, and heavy algal fouling. These conditions result in inefficient iron oxidation, with large volumes of raw water bypassing the aeration stage. Incoming iron concentrations of 2–3 mg/L are inadequately treated, causing discoloured water to reach consumers.
- **Compromised Clarification:** The clarifier is impaired by perforated inflow piping that disrupts sludge blanket formation, significantly reducing sedimentation and iron removal efficiency.
- **Aged and Degraded Filtration:** Of three filter units, only two are operational. All contain spent media exceeding 15 years in service, with porous troughs and corroded pipework. Backwashing is required every 8 hours, which exceeds the industry standard of 36–72 hours, resulting in substantial water losses and reduced net output.
- **Absence of Instrumentation and Automation:** There is no SCADA/PLC system, automated valve control, or online water quality monitoring, preventing real-time process optimisation and increasing the risk of undetected treatment failures.

[1] Water and Sewerage Authority PMO. (2026). Project Justification for the Refurbishment and Upgrade of the Siparia (Coora) Water Treatment Plant Increase in Design Capacity From 1.32 IMGD To 2.0 IMGD.

- **HYDRAULIC AND MECHANICAL LIMITATIONS:** Severely encrusted raw-water transmission mains, limited pumping capacity (a single 60 HP unit), and suboptimal contact tank configurations constrain hydraulic throughput and reduce the volume of water that can be effectively treated and distributed.

As such, it was determined that without urgent and comprehensive intervention, the Siparia WTP will continue its operational decline, jeopardising the water security of the communities it serves.

2.5 Project Overview

The proposed project involves the rehabilitation, upgrade, and modernisation of existing water treatment plants operated by WASA in Acono and Siparia across Trinidad. These interventions form part of WASA's broader national modernisation initiative aimed at stabilising and strengthening water supply systems, improving operational efficiency, ensuring compliance with national and international water quality standards, and enhancing resilience to climate-related risks.

2.5.1 Project Description

ACONO WATER TREATMENT PLANT

The Rehabilitation of the Acono Water Treatment Plant (10.705444°N, -61.398278°W) focuses on replacing ageing treatment infrastructure, improving hydraulic performance, strengthening raw water handling systems, and integrating modern automation and process control technologies. The refurbishment will optimize coagulation, flocculation, clarification, filtration, and chemical dosing processes to improve treatment efficiency under highly variable raw water quality conditions, particularly during periods of elevated turbidity and suspended solids. Integration of advanced instrumentation, SCADA systems, and automated process controls will improve operational reliability, reduce emergency maintenance requirements, enhance energy efficiency, and provide operators with real-time monitoring and process optimization capabilities. Collectively, these improvements will increase asset longevity, strengthen climate resilience, reduce operational risks, and improve the Authority's capacity to deliver sustainable and reliable potable water services.

In parallel with treatment plant rehabilitation, the project includes strategic hydraulic improvements identified through detailed network modelling to enhance overall system performance. These include modifications to the existing transmission network to improve hydraulic independence between the Acono supply systems, thereby reducing reverse flow conditions, improving operational flexibility, and increasing network resilience. The upgraded Acono WTP will ultimately support expansion of the supply boundary, improve pressure management throughout the distribution system, and facilitate continuous (24/7) water supply to communities currently affected by inadequate pressures and intermittent service.

The project site comprises the existing Acono Water Treatment Plant compound located along Acono Road, including all treatment units, raw water intake infrastructure, pumping systems, chemical storage and dosing facilities, sludge management infrastructure, electrical systems, instrumentation, internal pipework, and associated ancillary facilities. In addition, the project incorporates selected improvements to the adjoining transmission network required to optimize hydraulic performance and support the upgraded treatment facility. Upon completion, the project will increase potable water production to approximately 2,400 m^3/day (approximately 0.53 IMGD), while significantly improving operational reliability and enabling continuous water supply within the service area.

The proposed scope of works includes:

Civil and Structural Works

The civil and structural component includes all works necessary to rehabilitate and support the upgraded treatment processes and associated infrastructure, including but not limited to:

- Rehabilitation and structural upgrading of existing clarifier and filtration units to improve operational efficiency and extend service life.
- Construction and modification of concrete structures necessary to accommodate upgraded treatment equipment and process improvements.
- Installation of foundations and supporting structures for new mechanical equipment, pumping systems, and process units.
- Construction of facilities required to accommodate sludge handling, desilting, and associated treatment processes.
- Rehabilitation of internal access areas, drainage systems, utility corridors, and all disturbed site surfaces upon completion of construction.

Process and Mechanical Systems

The process and mechanical works will provide a modern, efficient, and resilient treatment system capable of maintaining consistent performance under varying raw water conditions, including:

- Supply and installation of a new high-rate coagulation, flocculation, and clarification system.
- Rehabilitation and upgrading of existing filter units and clarifiers, including replacement of deteriorated mechanical components.
- Installation of optimized alum dosing and chemical treatment systems designed to improve suspended solids and turbidity removal.
- Procurement and installation of desilting equipment and sludge management facilities to improve solids handling and operational efficiency.
- Installation of mechanical trash racks and automated screen-wash systems to reduce clogging of raw water intake screens and improve intake reliability.

- Replacement and upgrading of pumps, valves, mechanical equipment, interconnecting pipework, fittings, and associated process appurtenances required for reliable plant operation.

Hydraulic and Transmission Network Improvements

The hydraulic improvement works will optimize system performance and improve operational flexibility throughout the Acono supply network, including:

- Hydraulic separation of the Acono Water Treatment Plant distribution systems to eliminate reverse flow conditions and improve operational independence.
- Installation of a new 8-inch transmission main between Acono Junction and Quartz Road to facilitate the revised network configuration.
- Installation of new isolation valves and associated control infrastructure required to implement the proposed hydraulic separation.
- Upgrading of hydraulically constrained pipeline sections where necessary to reduce excessive head losses and improve flow distribution.
- Construction of localized storage facilities and booster pumping stations, where required, to improve water pressure within higher elevation communities including Caurita Road, La Rue Pomme Road, El Chorro Road, Alta Garcia, and the Acono Gardens area.

Electrical, Instrumentation and Control Systems

The electrical and instrumentation scope includes all works necessary to operate, monitor, and control the upgraded treatment facility, including:

- Upgrading of the plant electrical distribution system and associated power supply infrastructure.
- Installation of new motor control centres, switchgear, transformers, electrical panels, grounding systems, and electrical distribution equipment.
- Provision of electrical power and control systems for all mechanical and process equipment.
- Installation of process instrumentation for continuous monitoring of flow, pressure, chemical dosing, turbidity, levels, and other critical treatment parameters.
- Integration of all instrumentation, alarms, telemetry, and process controls into a centralized Supervisory Control and Data Acquisition (SCADA) system to enable automated operation and real-time performance monitoring.

Testing, Commissioning and Training

This phase will include:

- Pre-commissioning inspections, testing, calibration, and functional verification of all treatment processes and mechanical, electrical, and instrumentation systems.

- Hydraulic testing, process optimization, disinfection, and performance verification in accordance with applicable industry standards.
- Full commissioning of the upgraded Acono Water Treatment Plant and associated transmission improvements.
- Comprehensive operational and maintenance training for WASA personnel covering process operations, SCADA systems, preventive maintenance, and emergency response procedures.

Documentation and Deliverables

The project will include preparation and delivery of:

- Detailed engineering designs, technical specifications, calculations, and construction drawings.
- Process flow diagrams, piping and instrumentation diagrams (P&IDs), hydraulic modelling documentation, and control philosophies.
- Operations and Maintenance Manuals covering all civil, mechanical, electrical, instrumentation, and control systems.
- As-built drawings and updated asset information compatible with WASA's engineering and GIS standards.
- Health and Safety Plans, Environmental Management Plans, Quality Assurance and Quality Control documentation, equipment certifications, warranties, and commissioning records.

Design Requirements – Sustainability and Operational Resilience

The refurbishment of the Acono Water Treatment Plant will emphasize sustainability, operational efficiency, and long-term resilience through the incorporation of durable construction materials, energy-efficient equipment, optimized treatment processes, and automated monitoring systems that minimize lifecycle operating costs. The design will account for seasonal variations in raw water quality, future increases in potable water demand, and opportunities for future system expansion. Hydraulic improvements will enhance network flexibility and reduce dependence on interconnected supply systems, thereby strengthening service reliability during both normal operations and emergency conditions.

All works will be undertaken in accordance with applicable national health, safety, and environmental legislation, as well as relevant international engineering standards. Construction and operational activities will be supported by comprehensive Health and Safety Management Plans, Emergency Response Procedures, Environmental Management Plans, quality assurance programmes, and continuous monitoring to ensure safe, environmentally responsible, and sustainable project implementation.

Hydrological Considerations

A hydrological assessment of the Acono River system was conducted by the Water Resources Agency (WRA) in May 2026 to evaluate the adequacy of the raw water supply for the proposed refurbishment and upgrade of the Acono Water Treatment Plant (WTP). The assessment was undertaken in response to the proposed increase in production reliability and specifically examined the capacity of the existing intake, the feasibility of a proposed second intake approximately 750 m upstream on the Acono River, and the potential contribution of the adjacent Don Juan River. The study also considered the existing groundwater production well, recognizing that the Acono WTP operates as a dual-source system utilizing both surface water and groundwater to meet its production requirements.

The assessment acknowledged that river flows at the existing intake are subject to seasonal variability, with reduced water levels occurring during prolonged dry periods. However, hydrological modelling and low-flow analyses concluded that the long-term reliability of the water supply would be enhanced through the integration of the proposed upstream intake, abstraction from the Don Juan River, and continued use of the existing groundwater source. Consequently, the proposed rehabilitation works are not dependent on increased abstraction from the current intake alone. Rather, the project adopts an integrated source management approach that is intended to improve operational resilience, strengthen drought reliability, and provide sufficient raw water to support the upgraded treatment plant while maintaining environmental flow requirements.

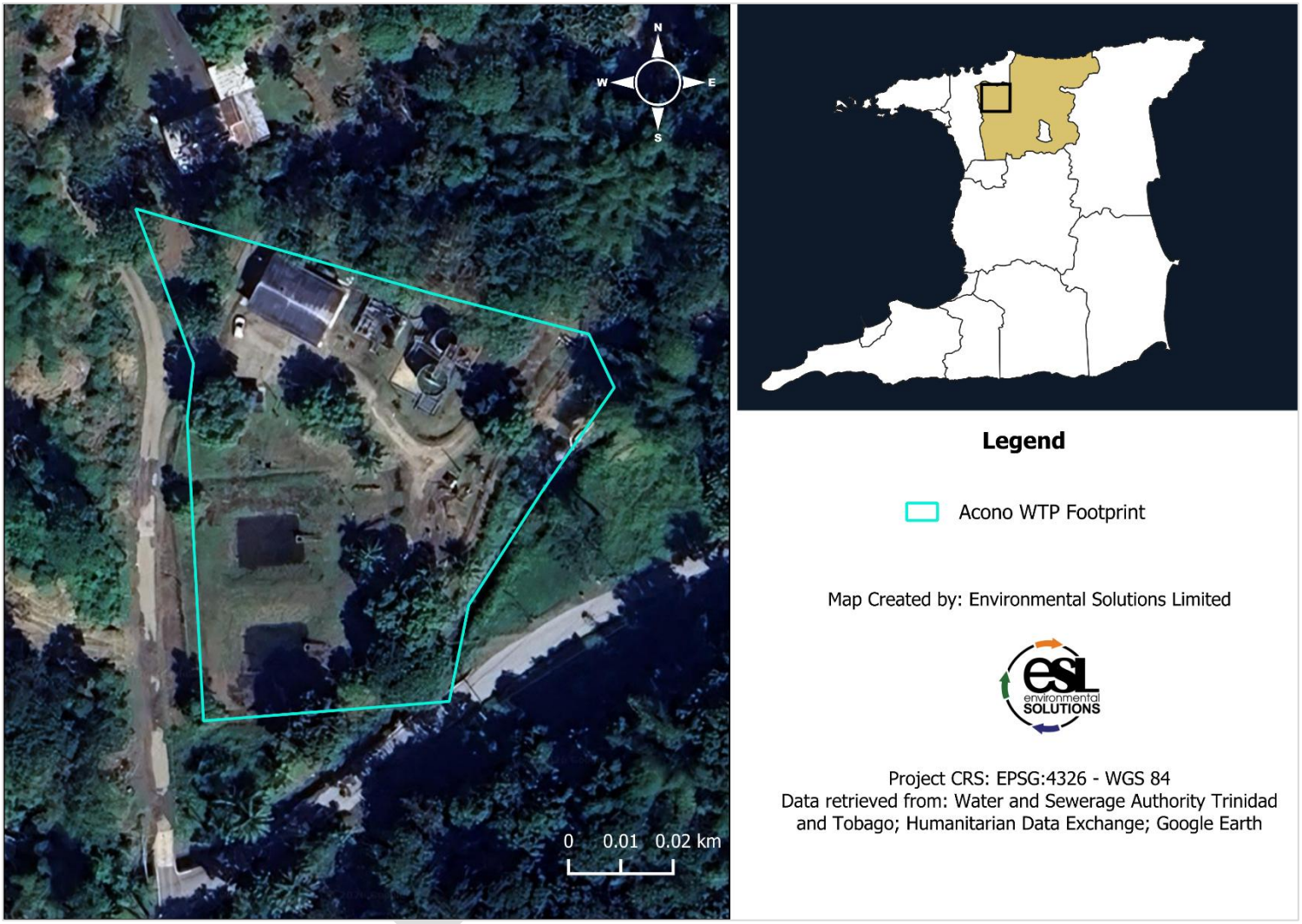


Figure 2-1: Location of the Acono Water Treatment Plant where the proposed refurbishment works will occur

Siparia Water Treatment Plant

This will involve the comprehensive refurbishment and upgrade of the Siparia Water Treatment Plant (WTP) (10.129332°N, -61.502201°W) to stabilise, modernise, and strengthen potable water supply services within south-western Trinidad. The Siparia WTP is a critical component of the regional water supply system and currently operates as an active facility; therefore, the project is specifically structured to ensure continuity of water production while construction and upgrade activities are undertaken. The overarching goal is to deliver a resilient, efficient, and sustainable water treatment facility capable of consistently producing potable water that meets WHO Guidelines for Drinking Water Quality under variable raw water conditions.

The project prioritises modernisation of treatment processes, rehabilitation of ageing infrastructure, and integration of advanced automation, control, and safety systems. In doing so, the initiative will reduce operational risks, enhance staff safety, improve energy efficiency, and extend the service life of the facility. The upgrade of the Siparia WTP will directly support improved public health outcomes, reduce reliance on emergency interventions, and reinforce stakeholder confidence in the Authority's capacity to deliver reliable, climate-resilient water services aligned with national development priorities.

The project site includes all existing treatment facilities, associated pumping infrastructure, chemical handling areas, storage tanks, and internal transmission systems within the Siparia WTP compound. The works are intended to restore and expand the plant's effective treatment capacity from its current design output of 1.32 IMGD to an upgraded design capacity of 2.0 IMGD, while stabilising production.

The proposed detailed scope of work includes:

Civil and Structural Works

The civil and structural scope includes all works necessary to support the upgraded treatment processes and associated infrastructure, including but not limited to:

- Demolition and removal of deteriorated or obsolete treatment units, structures, and foundations.
- Design and construction of new reinforced concrete structures for clarifiers, filters, sludge
- tanks, equipment foundations, and support facilities.
- Rehabilitation and modification of existing concrete structures to accommodate new process equipment, including surface repairs, protective linings, and structural strengthening where required.
- Construction and installation of a new factory-coated bolted steel clearwell for treated water storage and chlorine contact.

- Provision of access stairways, platforms, catwalks, handrails, and safety barriers to facilitate safe operation and maintenance.
- Site works including drainage improvements, internal roadways, fencing, and restoration of all disturbed areas upon completion.

Process and Mechanical Systems

The process and mechanical works shall deliver a fully functional, efficient, and redundant treatment system, including:

- Supply and installation of a new tray-type aeration system for raw water conditioning and iron oxidation.
- Design and construction of a new lamella clarifier and refurbishment of an existing clarifier to incorporate lamella plate settling systems.
- Construction of new reinforced concrete rapid gravity filters complete with nozzle-type underdrain systems and new filter media.
- Installation of sludge management facilities, including sludge holding tanks, decanting systems, recirculation pipelines, and associated pumps.
- Supply and installation of high-lift pumps, filter backwash pumps, air scour blowers, and auxiliary pumping systems.
- Installation of a new vacuum-operated chlorination system, chlorine handling equipment, ventilation systems, and safety devices.
- Provision of all interconnecting process pipework, valves, fittings, and appurtenances required for raw water, treated water, sludge, backwash, and chemical systems.

Electrical and Instrumentation Works

The electrical and instrumentation scope includes all works required to power, monitor, and control the upgraded facility, including:

- Upgrade of the existing electrical power supply in coordination with the utility provider.
- Supply and installation of transformers, switchgear, motor control centres, distribution panels, and grounding systems.
- Electrical power and control wiring to all mechanical and process equipment.
- Installation of interior, exterior, emergency, and site lighting systems.
- Supply and installation of instrumentation for flow, level, pressure, turbidity, and water quality monitoring.
- Full integration of instrumentation and controls into a centralized SCADA and automation system.

Testing, Commissioning, and Training

This phase includes:

- Pre-commissioning inspections, functional testing, and calibration of all equipment and systems.
- Disinfection, hydraulic testing, and performance verification in accordance with applicable AWWA and industry standards.
- Full commissioning of the upgraded Siparia Water Treatment Plant.
- Delivery of structured training programs for operations and maintenance personnel, including classroom and field-based instruction.

Documentation and Deliverables

- Detailed design reports, drawings, calculations, and technical specifications.
- Process flow diagrams, piping and instrumentation diagrams, control philosophies, and SCADA documentation.
- Operations and Maintenance Manuals covering all civil, mechanical, electrical, and control systems.
- As-built drawings in AutoCAD format, geo-referenced in accordance with national standards.
- Health and Safety Plans, Environmental Management Plans, QA/QC records, permits, certifications, and warranties.
- Design Requirements – Sustainability and Efficiency

The design of the Siparia Water Treatment Plant upgrade will emphasise sustainability and efficiency through the selection of energy-efficient equipment, durable materials, and environmentally responsible technologies; simple, robust, and maintainable design solutions that minimize lifecycle costs; integration of automation and monitoring systems to optimize process control and energy use; consideration of site-specific climatic conditions, including rainfall, flooding risk, and temperature; and flexibility to accommodate future expansion, process modifications, or regulatory changes.

The project shall be executed in full compliance with all applicable health, safety, and environmental regulations and standards. This includes the development and implementation of a comprehensive Health and Safety Management System; preparation of Emergency Response Plans for both construction and operational phases; implementation of Environmental Management Plans to mitigate impacts on surrounding land, water, and communities; and continuous monitoring, reporting, and corrective action related to health, safety, and environmental performance.

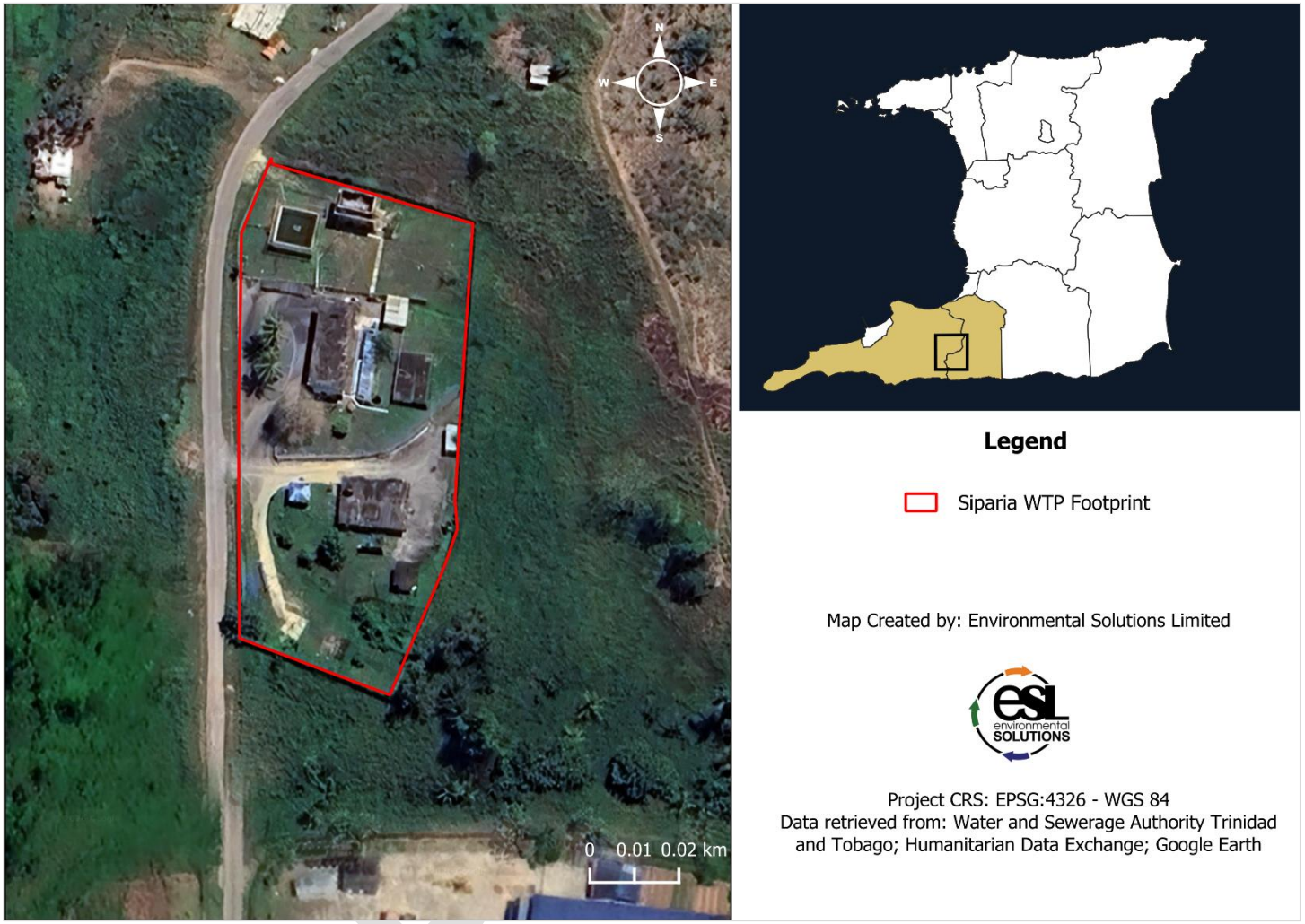


Figure 2-2: Location of the Siparia Water Treatment Plant where the proposed refurbishment works will occur

2.5.2 Expected Benefits

The Acono WTP refurbishment will improve the reliability and efficiency of potable water supply to rural and semi-urban communities, addressing chronic service interruptions caused by ageing infrastructure. More specific benefits anticipated include:

- Replacement of obsolete treatment units and installation of modern filtration and clarification systems will increase production capacity to 4,546 m^3/day, enabling a full 24/7 supply (Figure 2-3).
- Reduced downtime from mechanical failures and ageing equipment.
- Improved turbidity and solids control through optimised treatment and chemical dosing.
- More reliable water supply for approximately 11,353 residents in Acono Road, Belle View, Harmony Drive, Acono Gardens, Sarame Gardens, Green Hill, Caurita, Acono Ridge, Guamal, and Maracas St. Joseph.
- Lower operating costs from reduced emergency repairs and efficient dosing.
- Continuous access to potable water will strengthen community health and confidence.
- Extended equipment life through modern replacements and preventive maintenance.

Following the refurbishment of the Siparia Water Treatment Plant, the following benefits are anticipated:

- A fully refurbished and modernised Siparia Water Treatment Plant capable of producing 2.0 IMGD of potable water.
- Up to 24/7 water supply to service zones (Figure 2-4).
- Reliable and continuous water supply with improved treatment performance and redundancy.
- Treated water quality consistently compliant with WHO drinking water standards.
- Enhanced operational resilience, safety, and environmental protection.
- Reduced plant downtime, emergency interventions, and long-term maintenance costs.
- Strengthened public confidence in the Authority's ability to deliver modern, sustainable water services.

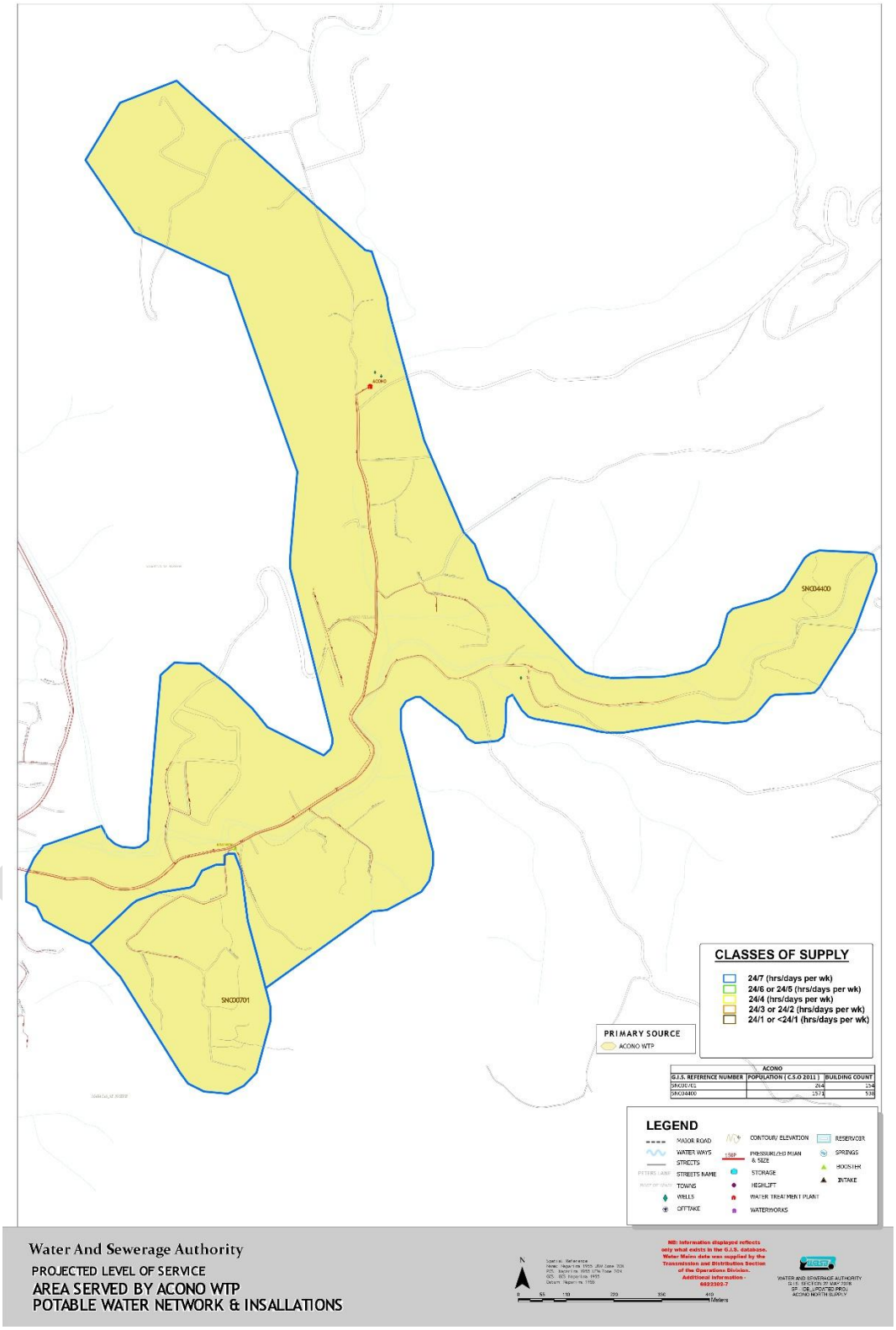


Figure 2-3: Acono Water Treatment Plant Service Zones (Source: WASA)

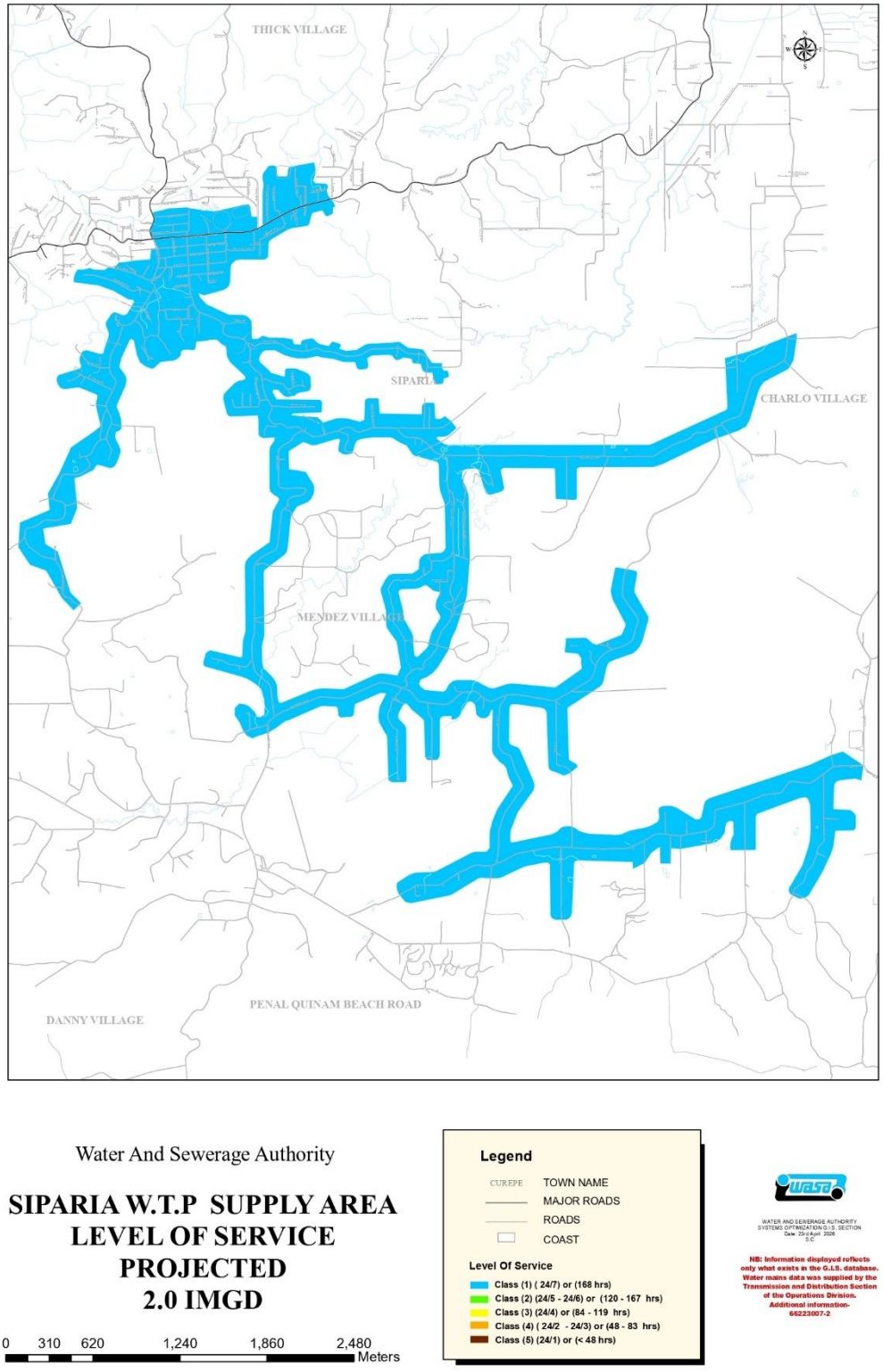
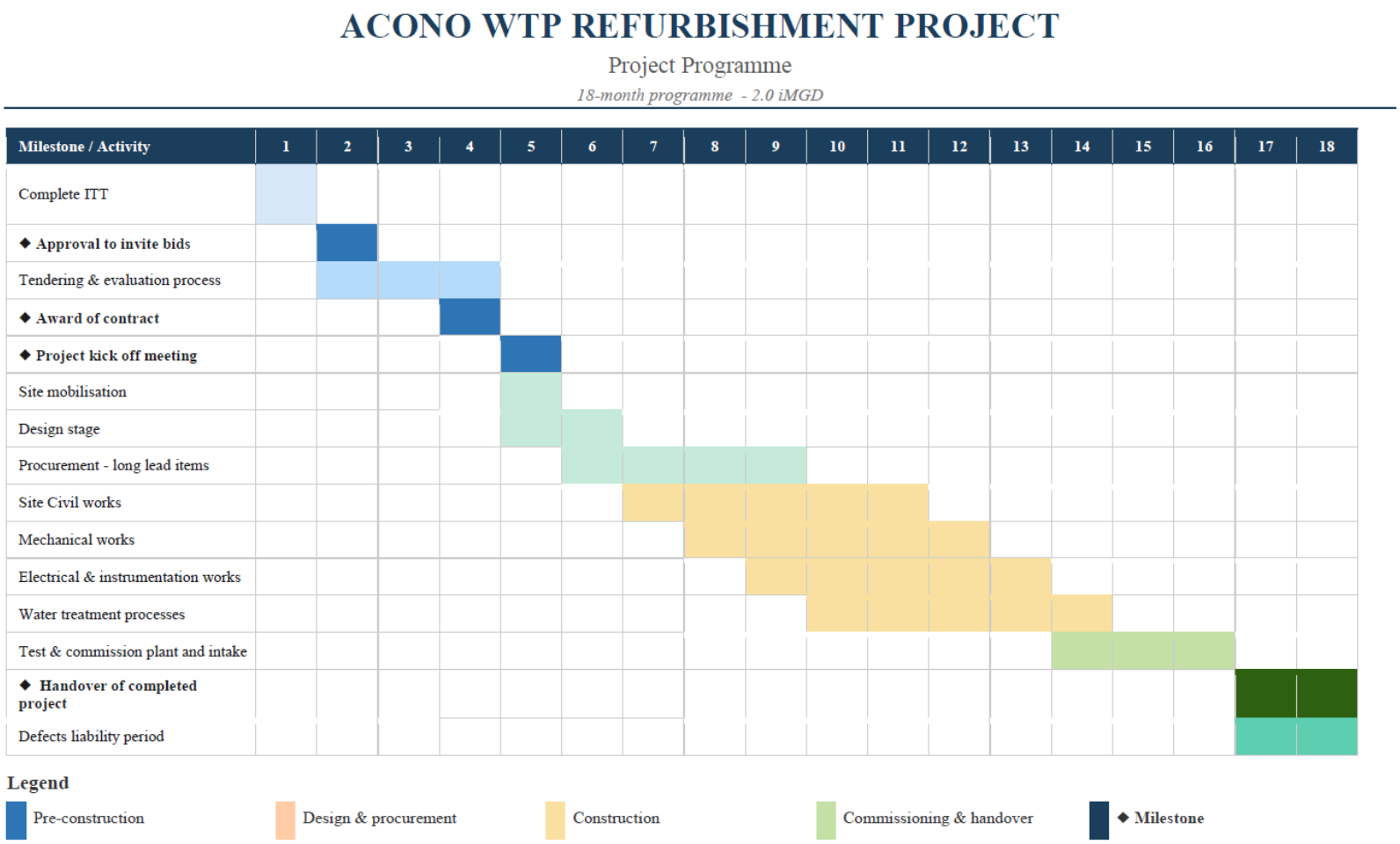


Figure 2-4: Siparia Water Treatment Plant Service Zones (Source: WASA)

2.5.3 Project Timelines

ACONO WATER TREATMENT PLANT



SIPARIA WATER TREATMENT PLANT

SIPARIA WTP REFURBISHMENT PROJECT

Project Programme

18-month programme - 2.0 iMGD

Milestone / Activity	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Complete ITT																		
◆ **Approval to invite bids**																		
Tendering & evaluation process																		
◆ **Award of contract**																		
◆ **Project kick off meeting**																		
Site mobilisation																		
Design stage																		
Procurement - long lead items																		
Site Civil works																		
Mechanical works																		
Electrical & instrumentation works																		
Water treatment processes																		
Test & commission plant and intake																		
◆ **Handover of completed project**																		
Defects liability period																		

Legend

Pre-construction | Design & procurement | Construction | Commissioning & handover | ◆ **Milestone**

3 Legal and Institutional Framework

3.1 Legislative Framework

Laws and Regulations	Relevance
Environmental Management Act, 2000 (Chap. 35:05)	Principal environmental legislation governing environmental protection and pollution control. Provides the legal basis for environmental permits, Certificates of Environmental Clearance (CEC), environmental reporting, and enforcement. The refurbishment works must comply with the Act's requirements regarding pollution prevention and environmental management.
Certificate of Environmental Clearance (CEC) Rules, 2001	Determines whether any aspect of the proposed upgrades, construction activities, water treatment infrastructure modifications, sludge management systems, or associated facilities require a CEC from the Environmental Management Authority (EMA) prior to implementation.
Environmentally Sensitive Species Rules (2001)	Allows the EMA to declare and protect endangered or vulnerable species. Requires the project to avoid harming listed species that may occur within forested or riparian habitats surrounding WTPs, particularly in the Northern Range.
Conservation of Wildlife Act (1958), including amendments	Protects wildlife species, regulates hunting, and preserves habitats. Construction activities must avoid harming protected fauna, especially birds, reptiles, and mammals likely present in forested and riparian zones.
Water and Sewerage Act, 1965 (Chap. 54:40)	Governs the operation of water supply and sewerage systems by the Water and Sewerage Authority (WASA). Relevant to all aspects of water treatment plant operation, potable water production, infrastructure upgrades, and service delivery.
Water Works and Water Conservation Act (1944)	Governs the construction, operation, and protection of waterworks infrastructure and water conservation practices. Directly applicable to WASA facilities; provides legal basis for operating and securing WTPs.
Public Health Ordinance, 1940 (Chap. 12 No. 4)	Establishes requirements for protecting public health, including drinking water quality, sanitation, nuisance prevention, and disease control. Relevant to ensuring treated water meets acceptable health standards and to managing construction-related public health risks.
Occupational Safety and Health (OSH) Act, 2004 (as amended 2006)	Primary legislation governing worker health and safety. Relevant to construction activities, confined space work, electrical installations, chemical handling, chlorine systems, excavation safety, work at heights, and operational safety management systems.
Water Pollution Rules, 2019	Regulates the discharge of pollutants into surface water and groundwater. Relevant to sludge handling, filter backwash water management, drainage runoff, dewatering activities, and operational wastewater generated during plant refurbishment and operation.
Waste Management Rules, 2021	Defines requirements for classification, storage, transportation, and disposal of waste, including hazardous waste. The project must manage

Laws and Regulations	Relevance
	construction debris, sludge, and chemical residues in accordance with EMA-approved waste handling procedures.
Air Pollution Rules, 2014	Establishes limits for air emissions and dust control. Applicable during demolition, excavation, construction activities, vehicle movements, and operation of backup generators or equipment.
Noise Pollution Control Rules, 2001	Regulates noise emissions from construction equipment, demolition works, pumps, generators, and other mechanical systems to minimize impacts on nearby communities.
Litter Act, Chap. 30:52	Requires proper management and disposal of construction debris, packaging materials, and other wastes generated during refurbishment activities.
Town and Country Planning Act, 1969 (Chap. 35:01)	Governs land use and physical development planning through the Town and Country Planning Division (TCPD). WASA must obtain development permission for the construction of the WTP and associated infrastructure, ensuring compatibility with existing land uses.
Fire Services Act, 1965 (Chap. 35:50)	Relevant to chemical storage areas, chlorine systems, electrical installations, fuel storage, emergency preparedness, fire protection systems, and evacuation planning.
Planning and Facilitation of Development Act, 2014	Governs development approvals and land-use planning considerations, where applicable. May apply to structural modifications, new tanks, clarifiers, buildings, or ancillary facilities requiring planning approval.
National Integrated Water Resources Management Policy	Promotes sustainable management of water resources using integrated approaches. Supports the project's goal of improving treatment, efficiency, and resource management to strengthen long-term national water security.
National Climate Change Policy, 2011	Promotes adaptation and mitigation strategies to address the impacts of climate change. The project's design integrates climate resilience by ensuring floodproofing, energy efficiency, and sustainable water sourcing under variable hydrological conditions.

International Conventions and Commitments

Agreement	Relevance
Convention on Biological Diversity (CBD)	Obligates conservation of biological diversity, sustainable use and benefit sharing. The project must consider all sensitive habitats within the sphere of influence.
United Nations Framework Convention on Climate Change (UNFCCC) & Paris Agreement	Requires national climate adaptation and mitigation efforts. Relevant to the project's climate-resilient design (flooding, drought), greenhouse gas considerations (generators, energy-efficiency) and inclusion of climate risk considerations.
Rotterdam Convention (Prior Informed Consent for certain	Relevant to import, use and information exchange for pesticides and industrial chemicals. Informs selection, procurement and safe use of chemicals, and national controls on restricted substances.

Agreement	Relevance
HAZARDOUS CHEMICALS AND PESTICIDES)	
STOCKHOLM CONVENTION (PERSISTENT ORGANIC POLLUTANTS - POPS)	Relevant where project activities might mobilise or generate POPs (e.g., contaminated soils) and for safe handling/disposal of POP-containing wastes; supports strict hazardous-waste controls and monitoring.

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

ESPS 1 is triggered for this project as it requires a comprehensive environmental and social assessment to identify and manage risks related to construction activities, operational improvements, and long-term water system performance. The refurbishment of water treatment plants involves physical works, worker interactions, the use of chemicals, and potential impacts on rivers, forests, and nearby communities. ESPS 1 guides the preparation of the ESA, ESMP, monitoring plans, and grievance redress mechanism (GRM), ensuring that environmental and social risks are systematically assessed, mitigated, and monitored. It also requires clear roles and responsibilities for WASA, contractors, and supervising bodies.

3.2.2 ESPS 2: Labour and Working Conditions

ESPS 2 is triggered due to the presence of construction workers, plant operators, maintenance personnel, and contractors who will engage in physically demanding and potentially hazardous activities. Risks include exposure to chemicals, heavy machinery, confined spaces, noise, dust, and electrical systems. ESPS 2 requires the project to establish safe and equitable working conditions, ensure fair labour practices, provide personal protective equipment (PPE), conduct worker training, enforce occupational health and safety protocols, and preventing threats against employees/contractors by providing sufficient security measures. It also mandates procedures for managing worker grievances, preventing discrimination, and safeguarding contracted and subcontracted workers.

3.2.3 ESPS 3: Resource Efficiency and Pollution Prevention

ESPS 3 is highly relevant, as the project directly involves the abstraction, treatment, and distribution of freshwater resources and the management of chemicals and sludge. The standard covers pollution prevention, water efficiency, energy consumption, chemical use, and waste management. It requires the adoption of best practices to reduce sedimentation, turbidity, and chemical releases during construction, as well as efficient operation of treatment units to minimise pollution and resource waste. Sludge handling, fuel storage, spill prevention, and energy optimisation are central considerations under this ESPS.

3.2.4 ESPS 4: Community Health, Safety and Security

This standard is triggered because construction and operational activities may affect nearby communities. Traffic movement, noise, dust, temporary water service interruptions, and the operation of heavy equipment present risks to public safety. Additionally, the use of hazardous chemicals such as chlorine poses potential risks if accidental releases occur. ESPS 4 requires the project to implement measures to safeguard communities, including traffic management plans, emergency response procedures, communication with residents, and protocols for handling dangerous substances. It also covers structural soundness of rehabilitated facilities to prevent failures or spills.

3.2.5 ESPS 8 – Cultural Heritage

ESPS 8 may be relevant as the project will involve excavation and earthworks in areas with potential for archaeological or cultural artefacts. Trinidad and Tobago's National Trust Act (1991) and Heritage Preservation Policy emphasise the protection of cultural resources. In compliance with ESPS 8, the project must implement a Chance Finds Procedure to ensure that any cultural or archaeological materials discovered during excavation are appropriately managed; halt works immediately if artefacts are found; and notify and collaborate with the National Trust of Trinidad and Tobago and the Ministry of Tourism, Culture and the Arts for proper evaluation and conservation. This standard ensures that project activities respect and preserve cultural heritage and traditional community values.

3.2.6 ESPS 9: Gender Equality

Gender considerations are relevant throughout the project cycle. Women may be disproportionately affected by water outages, employment access, or community health concerns. ESPS 9 is triggered to ensure gender-balanced hiring practices, prevent gender-based violence or harassment, and promote equitable access to project benefits and information.

3.2.7 ESPS 10: Information Disclosure and Stakeholder Engagement

This standard is critical to the project, as the rehabilitation works may impact nearby communities and businesses during both construction and operation. ESPS 10 requires meaningful engagement with stakeholders, timely dissemination of project information, and establishment of an accessible and culturally appropriate grievance mechanism. Engagement is essential for managing public expectations, communicating potential service interruptions, and addressing community concerns promptly and transparently.

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 projects across Trinidad.

The findings and conclusions presented in this Environmental and Social Assessment (ESA) are based on the information available at the time of the assessment and are subject to several limitations. The availability of site-specific secondary environmental and social data was limited in some cases, requiring reliance on broader national datasets, publicly available information, and professional judgement to characterise baseline conditions. While reasonable efforts were made to obtain relevant and reliable information, data gaps remain for certain environmental and social parameters.

The assessment was also undertaken within a constrained timeframe, which limited the extent to which additional data collection, verification, and detailed analyses could be completed. Consequently, the study focused on identifying key environmental and social risks and impacts based on the best available information and a proportionate level of assessment commensurate with the project stage.

In addition, the level of detail available for some project components was limited at the time of assessment. In certain cases, project descriptions, design information, construction methodologies, and operational details were preliminary, incomplete, or subject to further refinement. As a result, some impact assessments have been undertaken using reasonable assumptions regarding project activities and footprints. Where uncertainties exist, a precautionary approach has been applied, and recommendations have been made for further assessment, data collection, and management planning during subsequent stages of project design and implementation.

These limitations do not preclude the identification of the project's principal environmental and social issues; however, they should be considered when interpreting the assessment findings. The ESA should therefore be regarded as a living document that will require updating as additional project information and baseline data become available.

4.1.1 Area of Influence

The Area of Influence (AoI) of the proposed project encompasses all geographic zones and environmental, socio-economic receptors that may experience direct or indirect impacts from the project’s construction, operation, and maintenance activities. Defining the AoI is critical to understanding the spatial and temporal extent of project-related effects, and to ensuring that environmental and social risks are comprehensively assessed and managed in accordance with the

Environmental Management Authority (EMA) requirements and IDB Performance Standards. The Area of Influence is categorised into two primary components, direct and indirect, each described below.

For this project, which focuses on the rehabilitation and refurbishment of existing water treatment and supply infrastructure, the AoI is generally limited to the existing facility footprints and their immediate surrounding environments. However, due to the ecological sensitivity of certain locations and the role of water infrastructure in broader watershed systems, some project components have extended indirect areas of influence, particularly where water quality, hydrology, riparian zones, and downstream users may be affected.

Direct Area of Influence

The Direct Area of Influence for these projects refer to the immediate physical footprint where project activities will take place and where direct, on-site, construction-related impacts may occur within the property boundary. Across each project site, the Direct AoI includes:

- The existing compound boundaries of each water treatment plant.
- The treatment infrastructure, sedimentation tanks, filtration units, clarifiers, chemical storage areas, workshops, operator buildings, electrical and mechanical rooms, and internal circulation routes.
- Construction and material laydown areas located within the facility boundary or directly adjacent to it.

The Direct AoI is highly localised, encompassing mainly the infrastructure footprint and immediately adjoining land, where noise, dust, vibration, vegetation disturbance, soil excavation, equipment operation, and other direct construction impacts occur. Figure 4-1and Figure 4-2 below defines the 1-km study area for the proposed projects at the Acono and Siparia WTPs. During the operation phase, project upgrade works are anticipated to impact communities within the service zones indicated in Figure 2-3 and Figure 2-4.

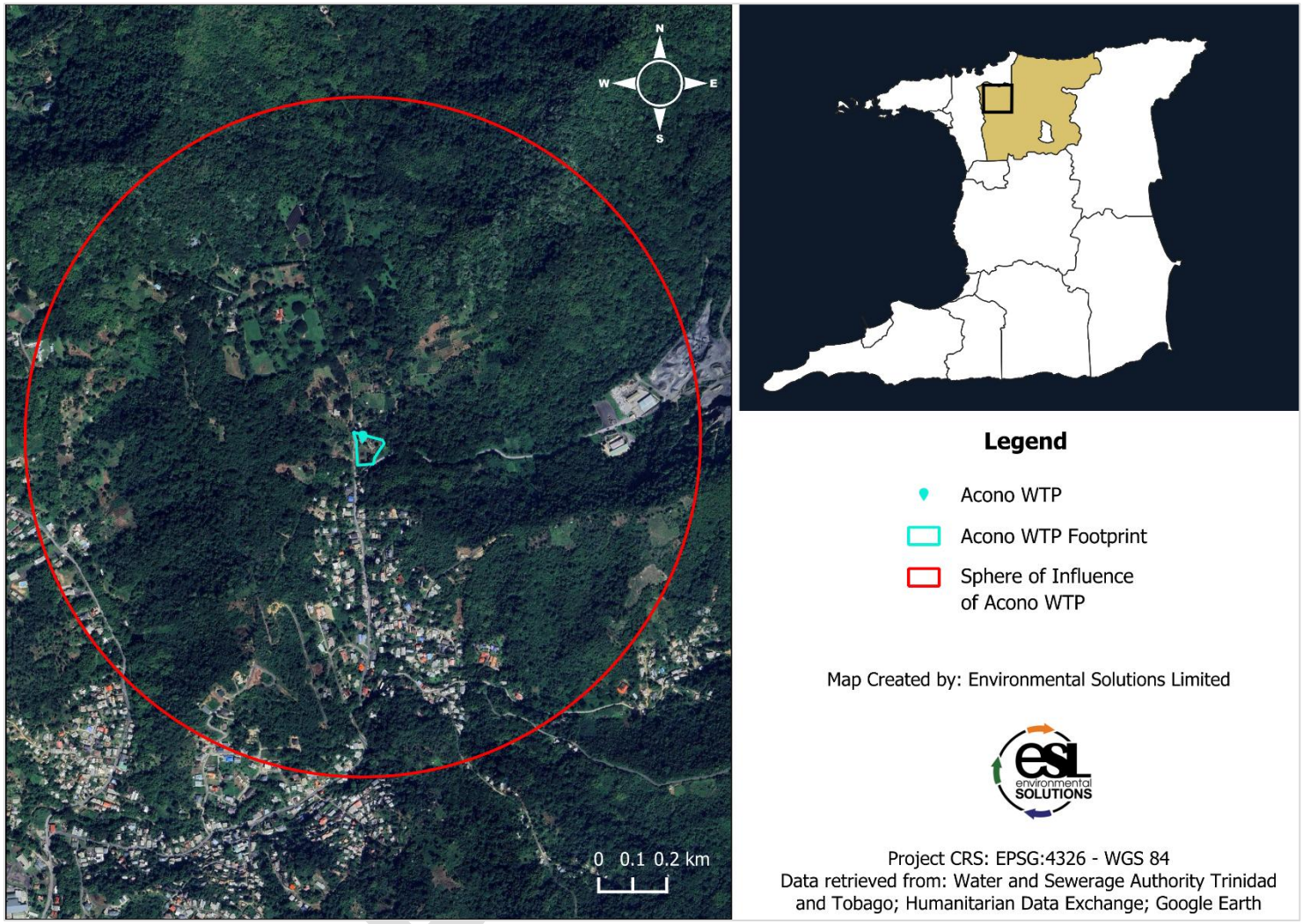


Figure 4-1: Sphere of Influence for the proposed project in Acono

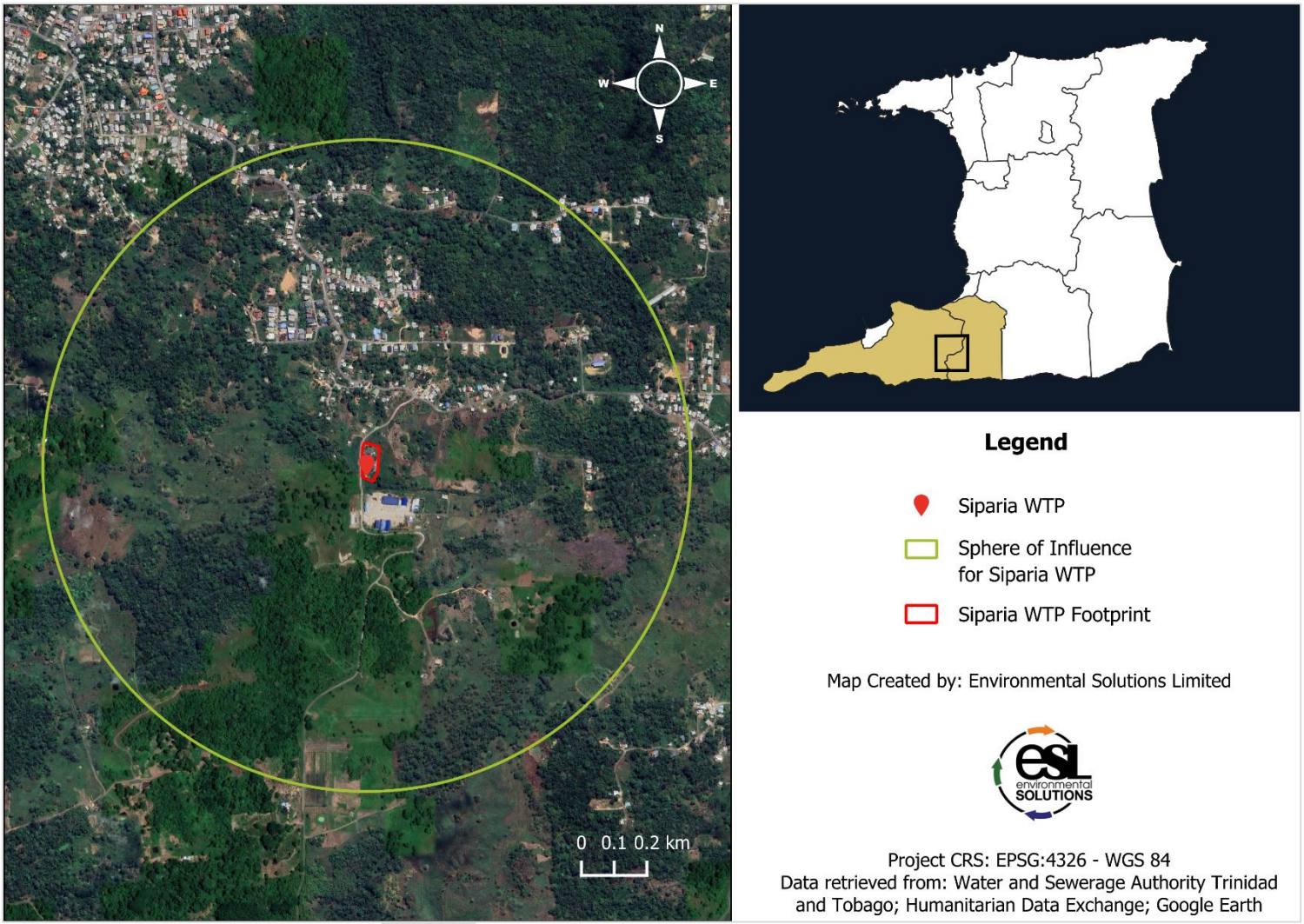


Figure 4-2: Sphere of Influence for the proposed project in Siparia

4.2 Physical Environment Baseline

4.2.1 Climate

Trinidad and Tobago's geographic proximity to the equator affords it the influence of two prevailing climate regimes, giving rise to two contrasting seasonal patterns. These seasons are delineated by distinct dry and wet phases. The dry season, extending from January to May, is typified by a tropical maritime climate marked by moderate to strong low-level winds, elevated daytime temperatures, and comparatively cool nocturnal conditions, with precipitation occurring primarily as convective showers during the daytime (Climate Change Knowledge Portal, 2025). The wet season, spanning the months of June to December, is characterized by a modified moist equatorial climate distinguished by low wind velocities, persistently hot and humid conditions both day and night, and a pronounced increase in rainfall. This heightened precipitation primarily results from the migration and latitudinal shifting of equatorial weather systems (Trinidad and Tobago Meteorological Service, 2025)The months of late May and December are regarded as transitional periods leading into the wet and dry seasons, respectively. Variations in the manifestation of these two climatic regimes between the islands of Trinidad and Tobago are largely attributed to differences in landmass, topography, elevation, orientation relative to the prevailing trade winds, and overall geographical positioning. Embedded within the wet season is the Atlantic hurricane season, which extends from June to November and typically peaks between August and October (Trinidad and Tobago Meteorological Service, 2025). Owing to its geographical location along the southern margin of the North Atlantic hurricane basin, Trinidad experiences fewer direct storm impacts than Tobago; nevertheless, both islands are similarly influenced by peripheral weather effects associated with the passage of tropical storm systems.

Trinidad and Tobago's climate exhibits pronounced interannual and seasonal variability, with rainfall demonstrating considerable spatial and temporal fluctuations even across relatively small geographic areas. The principal climatic drivers and influencing mechanisms are illustrated in the accompanying schematic, though it does not encompass all contributing factors. The Figure above highlights the predominant systems governing rainfall and temperature variability across Trinidad and Tobago, including the El Niño–Southern Oscillation (ENSO), the North Atlantic Subtropical High-Pressure System (NASH), the Northeast Trade Winds, the North Atlantic Oscillation (NAO), the Intertropical Convergence Zone (ITCZ), the Madden–Julian Oscillation (MJO), the Caribbean Low-Level Jet (CLLJ), the Tropical Upper-Tropospheric Trough (TUTT), upper-level troughs, shear lines, tropical waves, tropical cyclones, and the Saharan Air Layer; however, these do not represent the full suite of influencing factors.

TEMPERATURE

Trinidad and Tobago has a uniformly hot, maritime tropical climate with only modest seasonal variation (Trinidad and Tobago Meteorological Service, 2025). The long-term (1991–2020) monthly mean temperatures at the Piarco (Trinidad) and Crown Point (Tobago) reference stations are plotted below. It shows May and September as the warmest months and February as the coolest (Trinidad

and Tobago Meteorological Service, 2025). For example, Piarco's average daily high is about 33.0 °C in September and ~26 °C in February, while at Crown Point the highest mean maxima are 31.5 °C (September) and 31.3 °C (May). Nights are also warm; the warmest average low temperatures (~25.1 °C) occur in May and September (Trinidad and Tobago Meteorological Service, 2025). National extremes (1959–2021) are 36.5 °C (record high at Piarco on 25 Sep 1990) and 16.1 °C (record low at Piarco on 21 Jan 1964).

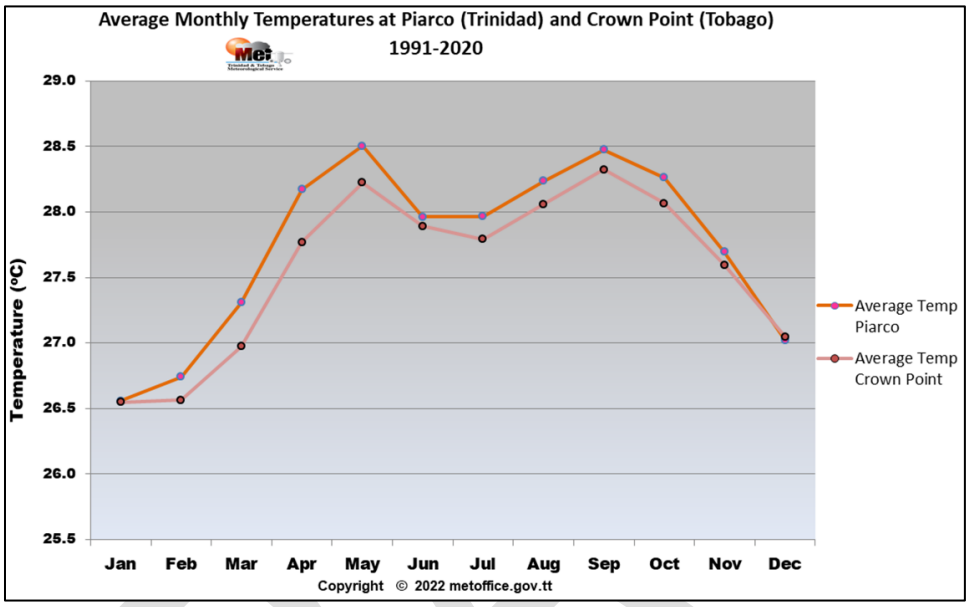


Figure 4-3 Average Monthly Temperatures in Trinidad and Tobago (1991-2020)

Additionally, the graph demonstrates a clear and sustained warming trend in Trinidad and Tobago's mean maximum temperatures over the seven-decade period from 1951 to 2020. After minor fluctuations and a slight cooling between the 1960s and 1970s, temperatures began rising steadily from the 1980s onward. By the 2000s and 2010s, mean maximum temperatures had reached 32.2°C, approximately 1.1°C higher than the 1961–1990 baseline. This consistent upward trajectory reflects a long-term increase in temperature; indicative of the broader regional warming associated with climate change.

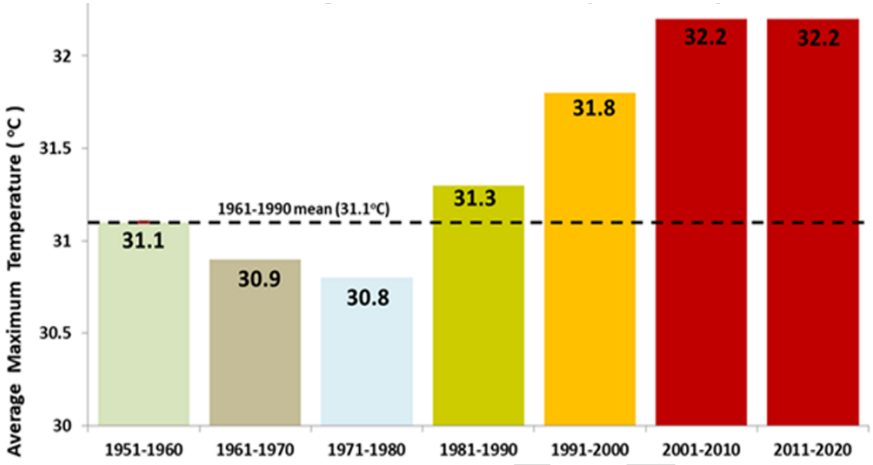


Figure 4-4 Trinidad Mean Maximum Temperatures by Decade

4.2.1.1 Acono (Maracas Valley, Northern Range Foothills)

Temperatures in Acono are moderated by elevation and topographic shading. Average daytime temperatures range from 28–30 °C, while nighttime conditions are noticeably cooler than in the adjacent lowlands. The overall thermal regime is tropical but tempered, contributing to the "cool, well-watered" environmental conditions characteristic of the Maracas Valley.

4.2.1.2 Siparia

Based on the graph displayed in Figure 4-5, Siparia recorded minimal variation in average temperature, ranging from 26.1 degrees Celsius (January) to 27.8 degrees Celsius (September). The average mean temperature recorded is lower than the general temperature recording of Trinidad and is also lower than the localized temperature of Acono.

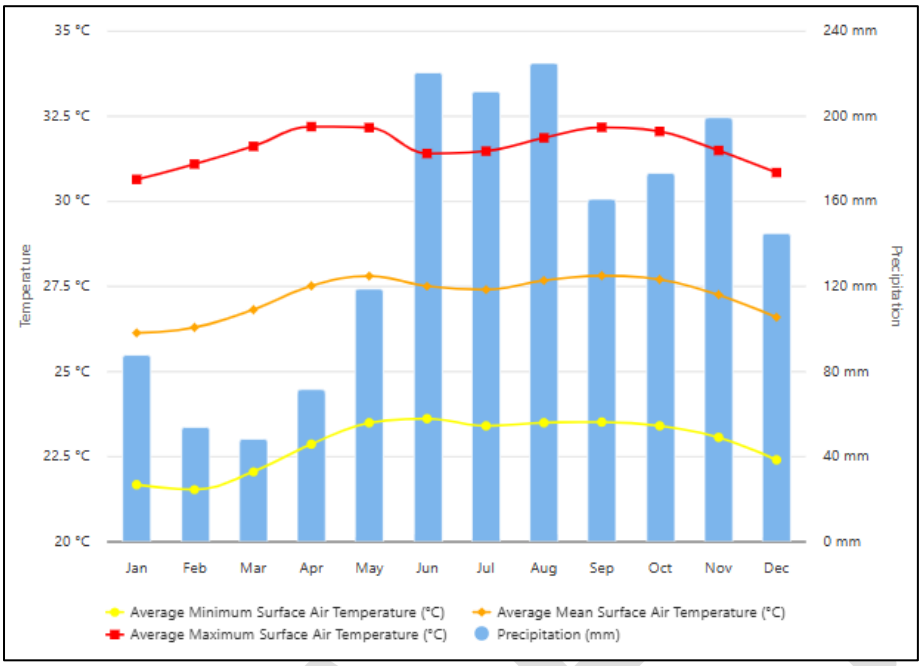


Figure 4-5 Average Minimum Surface Air Temperature, Average Mean Surface Air Temperature, Average Maximum Surface Air Temperature, Precipitation: Siparia, Trinidad and Tobago 1991-2020 (source: World Bank Group Climate Change Portal

RAINFALL

On both an annual and seasonal basis, Trinidad experiences higher rainfall totals than Tobago; however, both islands exhibit a distinct bimodal rainfall pattern, with early (June) and late (November) seasonal maxima. Trinidad's primary rainfall peak typically occurs in June, while Tobago's main peak is observed in November. Annual rainfall distribution is largely governed by the interaction of multiple, often competing, atmospheric and oceanic systems. The principal drivers include the latitudinal position and intensity of the North Atlantic Subtropical High (NASH) pressure cell, the meridional movement of the Intertropical Convergence Zone (ITCZ), westward-propagating tropical waves and cyclonic systems (depressions, storms, and hurricanes), the mid-Atlantic upper-level trough, localized sea-breeze circulations, cloud clusters generated by large-scale low-level convergence, and orographic influences.

At Piarco (north Trinidad) the wettest month is August (avg. 255.3 mm) and the driest month of the year is March (40.6 mm) (Trinidad and Tobago Meteorological Service, 2025). Notably, September can have short dry spells even in the wet season (Trinidad and Tobago Meteorological Service, 2025). below shows Piarco's long-term average monthly rainfall totals which visually depict the stark difference in total rainfall observed in the wet and dry season.

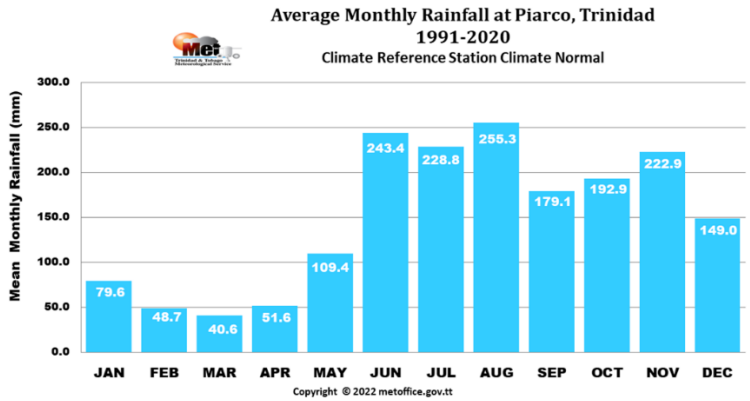


Figure 4-6 Average Monthly Rainfall in Trinidad (1991-2020)

During the dry season, the NASH pressure cell typically shifts southward and expands toward the equator, promoting subsidence, low-level moisture divergence, and enhanced trade winds over Trinidad and Tobago, collectively producing drier atmospheric conditions. By contrast, in May, the gradual poleward migration of the NASH and the resulting convergence along its southern flank permit rain-bearing systems such as the ITCZ and tropical waves to advance northward and eastward, thereby facilitating the transition to, and eventual establishment of, the wet season regime.

4.2.1.3 Acono (Maracas Valley, Northern Range Foothills)

Acono is situated within a deeply incised valley at the southern margin of the Northern Range, where orographic effects generate high and sustained rainfall. The wet season brings particularly intense precipitation as the Maracas watershed efficiently captures moisture transported by the northeast trade winds. Although rainfall persists year-round, the March–April period typically marks the relative minimum. The valley's hydrological behaviour and perennial streamflow reflect this consistently moist climatic signature. The graph below in Figure 4-7 there is significant variation in daily rainfall over the past decade with an observable declining trend since 2022 to present.

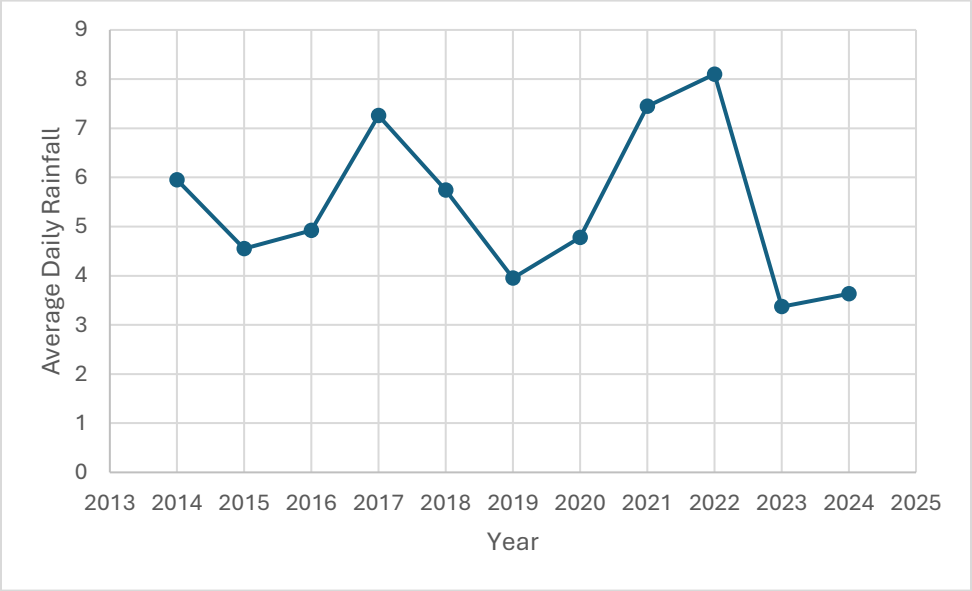


Figure 4-7 Average Daily Rainfall per year (2014-2024) Source: (rainfall data from the Rincon Weather Station)

4.2.1.4 Siparia

Similar to Acono, Siparia has recorded a significant and steady decline in daily rainfall since 2021 with daily averages falling below 4mm Figure 4-8.

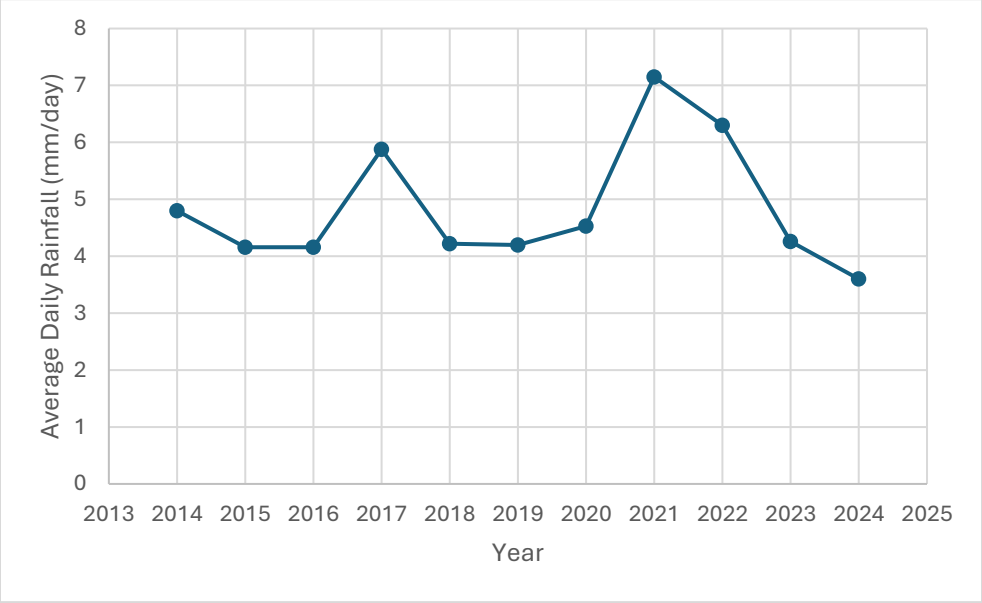


Figure 4-8 Average Daily Rainfall per year (2014-2024) Source: (Rainfall data from the Coora Weather Station)

CLIMATE CHANGE PROJECTIONS

Temperature

Statistical downscaling of the HadCM3 Global Climate Model (GCM) under the A2 and B2 emission scenarios indicates that mean surface temperatures across the Caribbean region, including Trinidad and Tobago, are projected to increase by approximately 1.5°C to 2.0°C by the 2080s, relative to the 1980–1999 baseline (Trinidad and Tobago Meteorological Service, 2025). This equates to an average warming rate of about 0.29°C per decade. Should these projections materialize, an estimated 8% extension of the dry season could occur by mid-century (2050), consequently shortening the wet season duration.

The projected warming is anticipated to exacerbate heat-related impacts, including increased evapotranspiration, higher agricultural irrigation demands, and elevated heat stress on both ecosystems and human populations. Furthermore, more intense but shorter rainfall events may diminish surface water quality and reduce groundwater recharge, thereby intensifying water resource constraints across the islands.

Rainfall

Projected rainfall trends for Trinidad and Tobago exhibit significant uncertainty, with model outputs displaying considerable variability. Among 21 global climate models assessed, the majority project an overall annual rainfall decline of approximately 15% by the 2080s, while a smaller subset (3–4 models) suggests a potential increase (Trinidad and Tobago Meteorological Service, 2025; The Republic of Trinidad and Tobago, 2023). The prevailing drying trend is linked to a modeled shift toward

a more positive phase of the North Atlantic Oscillation (NAO) and the emergence of El Niño–like conditions in the Pacific, both associated with regional reductions in precipitation.
Despite this general drying signal, downscaled projections from the HadCM3 model (A2 and B2 scenarios) indicate a notable increase in early wet-season rainfall (June–August) for Trinidad and Tobago which is contrasting with much of the wider Caribbean, except Barbados. Such variability underscores the complexity of regional hydroclimatic responses.

If the drying projections are realized, Trinidad and Tobago may face more frequent and prolonged dry spells and droughts by the end of the century. These conditions, compounded by sea-level rise which is projected to exceed 0.35 m by 2100 may amplify coastal inundation, storm surge impacts, and saline intrusion, placing further pressure on freshwater resources and coastal infrastructure (Trinidad and Tobago Meteorological Service, 2025; The Republic of Trinidad and Tobago, 2023).

4.2.2 Topography

Trinidad's landscape is dominated by three east–west mountain ranges separated by broad plains. The northernmost is the high Northern Range (peaks ~935–940 m). South of this lies the Caroni Plain (a flat alluvial lowland) and the Central Range (low hills ~300 m), and at the south is the Southern Range (up to ~305 m). Each community site falls into a distinct subregion:

[Map to be provided for the final version]

Figure 4-9 Topography Map of Trinidad and Tobago with Sites Identified

4.2.2.1 Acono

Situated in the Maracas Valley, Acono's topography is rugged and steep. Two high ridges (including El Tucuche ~940 m and El Cerro del Aripo nearby) flank the valley. Elevations in Acono range from ~150 m at the valley bottom to several hundred meters on the ridges. The terrain is forested and deeply incised by streams (Maracas River and tributaries) that flow down from the peaks.

4.2.2.2 Siparia

The topography of Siparia is that of a low-lying plateau punctuated by minor hills and shallow valleys. The terrain is largely vegetated (agricultural fields, scrub, and secondary forest) with no abrupt escarpments. This setting reflects the town's position on the southern flank of the Central Range/Southern Range system: it lies just north of the Nariva Swamp and Naparima Plain but south of any major highland. The gentle, near-flat topography facilitates unimpeded surface runoff and gradual elevation changes. From an engineering and hydrologic perspective, the mild slopes imply that stormwater drainage must be managed by properly graded channels, since natural conveyance is weak. In summary, Siparia sits on a gently rolling coastal plain: average elevations of 20–25 m, rising to about 70–75 m at isolated crests, with all low points draining to the south and southwest.

4.2.3 Geology and Soils

Trinidad is located on the southeastern edge of the Caribbean Plate and the South American Plate margins (Webber, et al., 2011). This plate boundary-zone represents an area of significant Neogene structural deformation. Several east-west strike-slip faults which cut across Trinidad are associated with this plant-boundary margin. The island therefore sites within an active earthquake zone.

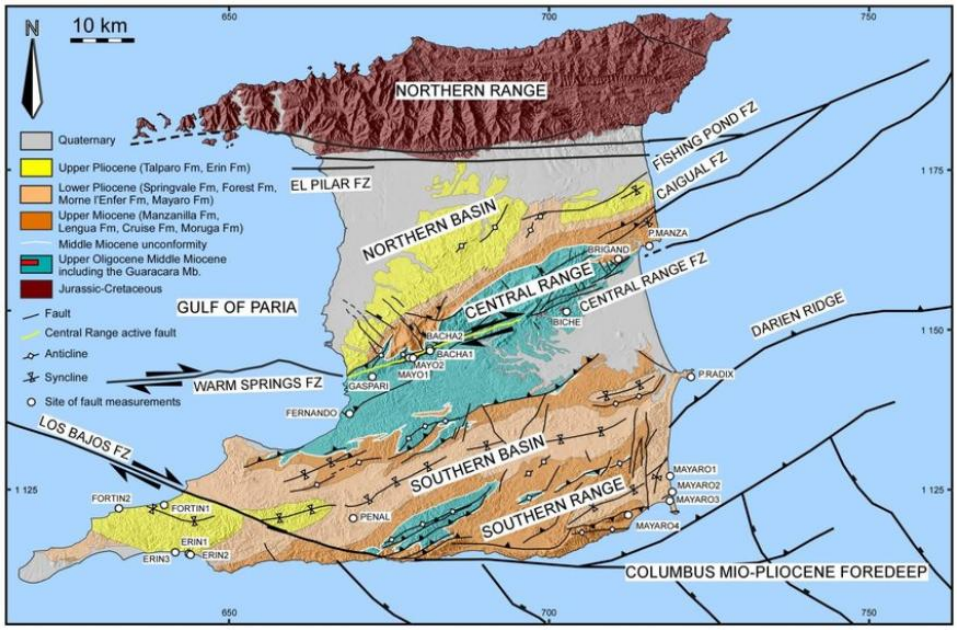


Figure 4-10 Geological Map of Trinidad

4.2.3.1 Acono (Maracas Valley)

Acono lies in the foothills of the Northern Range (Maracas Valley). It is underlain by Northern Range metamorphic rocks: micaceous (talcose) phyllites and small bands of calcareous shale. Colluvial soils have formed on steep slopes.

- **Geology:** Dominantly micaceous phyllites (sericite/talc schists) with some calcareous phyllites and shale beds. These metamorphic bedrocks weather into fine clays and sand. As shown on the map in Figure 4-10, the Northern Range is primarily composed of Cretaceous to early Tertiary metamorphic and igneous rocks, including schists, quartzites, phyllites, and gneisses (HIPPOLYTE & Mann, 2021).
- **Soils:** Acono's soils are chiefly clay loams and silty sands derived from weathered phyllites. Soil surveys list "micaceous river wash" and clay-loam in Acono Village, plus thin gravelly hillwash (sand and silt) on slopes.
- **Land use & erosion:** Acono has suffered intense quarrying for decades. The Coosal quarry stripped vegetation from hillsides, leaving bare rock and generating vast amounts of rock

waste. Wash from the quarry has deposited heavy silt loads into the Acono River. This dumping of sediment has choked the riverbed (raising it many feet) and killed local aquatic life (Nakhid, 2020). Downstream, the extra sediment has aggravated flooding on the Caroni Plain. In summary, anthropogenic disturbance (quarry extraction and development) has greatly increased erosion and sedimentation in the Acono watershed (Nakhid, 2020).

4.2.3.2 Siparia

Siparia is located within the Southern Basin of Trinidad and is underlain predominantly by sedimentary rocks of Cretaceous to Miocene age. The area is characterized by low-relief terrain underlain by marine shale, claystone, marl, siltstone, and minor sandstone formations that were deposited in a shallow marine environment.

- **Geology**: The geology is dominated by fine-grained sedimentary units including the Lizard Springs Formation, Chaudiere Formation, Navet Formation, and younger Cipero Group sediments. These formations consist primarily of shale, claystone, marl, and siltstone, with localized sandstone horizons. Structurally, the area lies within the Siparia Syncline, part of the larger Siparia–Erin Basin, with strata that are generally flat-lying to gently folded.
- **Soils**: Soils in the Siparia area are predominantly clay-rich residual and alluvial soils derived from the weathering of the underlying sedimentary formations. These soils are typically characterized by low permeability, moderate compressibility, and varying drainage conditions depending on topographic position.
- **Land Use & Erosion**: Land use within the Siparia area consists primarily of residential development, agriculture, commercial activities, and associated infrastructure. Due to the generally gentle topography and fine-grained soils, erosion potential is typically low to moderate under natural conditions; however, localized erosion and sediment transport may occur where vegetation is removed, soils are exposed, or drainage patterns are altered by development activities.

4.2.4 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 (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.

4.2.4.1 Step 1: Hazard Exposure

TROPICAL CYCLONES AND HURRICANES

Trinidad lies in a high cyclone hazard zone. There is a greater than 20% chance of damaging winds from tropical storms in any 10-year period. Tropical cyclones bring intense winds, heavy rain and storm surge, all of which can damage infrastructure. Climate change may increase cyclone intensity and rainfall (Water Resources Agency, 2001). For example, Tropical Storm Bret (June 2017) brought severe flooding that forced the shutdown of multiple water treatment plants (Mendes-Franco, 2017). Any future hurricane or tropical storm could similarly inundate intake canals, damage electrical equipment and cut off power to pumps. (Heavy wind-borne debris and floodwaters can significantly impact water system components.

Acono is at the foothills of the Northern Range which functions as a natural buffer to the elements of tropical cyclones, as such, the impact of tropical storms is significantly reduced. With this in mind, the refurbishment works at the Acono Water Treatment Plant is at low risk to tropical Cyclones.

Similarly, Siparia is at low risk of impact from tropical cyclones. There are very few cases of hurricanes making landfall in Trinidad and that is due to the northward change in hurricane path that normally occurs beforehand. The remnants then cause gusts of wind and rain on land. The most affected cities are Scarborough and Petit Valley. Siparia being located in the southwestern region of the island results in very minimal direct exposure to tropical cyclones and as such, a low risk of impact from cyclones. This is further reflected in the hazard exposure map below. Both Siparia and Acono (Tunapuna) are deemed to have negligible exposure to cycle impact.

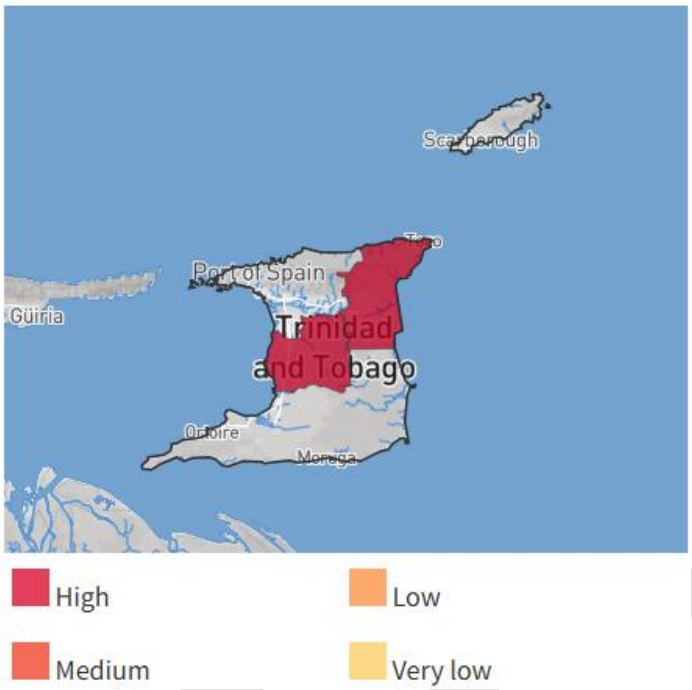


Figure 4-11 Cyclone Exposure Map of Trinidad and Tobago (source: World Bank ThinkHazard Platform

EXTREME HEAT AND DROUGHT

Trinidad's climate features a pronounced dry season. Climate projections indicate hotter, drier conditions. Observations show Trinidad's temperature rising ~0.2–0.3°C per decade, and by mid-century continued greenhouse gas emissions will make heat waves more frequent and intense. Meanwhile, meteorological droughts (prolonged rainfall deficits) are expected to become more common and severe (Inter-American Development Bank, 2014). Higher air temperatures will increase evapotranspiration, reducing surface water availability and river flows (Inter-American Development Bank, 2014). The IDB adaptation study notes that increased temperatures and decreased precipitation will reduce groundwater and aquifer recharge, and available water resources will be reduced. The duration of droughts and extreme heat waves, if extensive, will have considerable negative impact on the supply to both treatment plants, as such, both the Acono and Siparia WTP are deemed to be at medium/moderate risk to the impact of droughts and heat waves.

Acono

As expressed in (Figure 4-12), in the Tunapuna region, extreme heat hazard is classified as **low** based on the information currently available (ThinkHazard.org, 2025). This means that there is between a 5% and 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years. The project planning decisions, design and construction methods should consider this hazard over the lifetime of the project. Acono is therefore considered to be at low exposure to extreme heat. Drought exposure is considered moderate, as the plant relies on surface water resources that may experience reduced flows during prolonged dry periods.

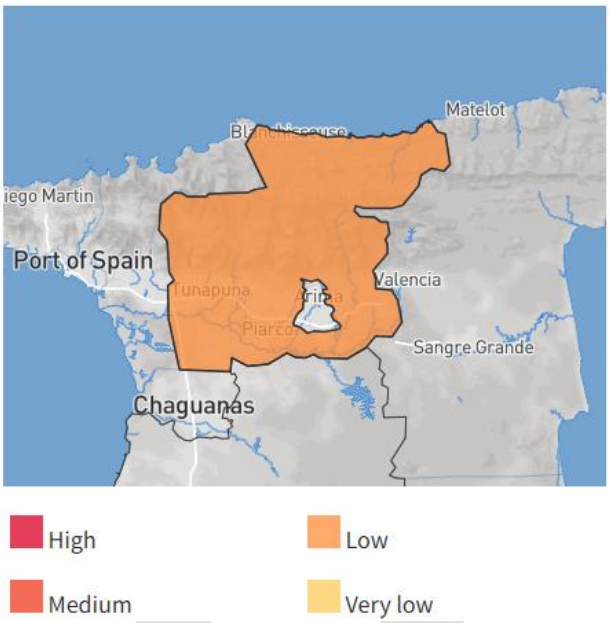


Figure 4-12 Extreme Heat Exposure of Tunapuna/Piarco (source: World Bank ThinkHazard Platform)

Siparia Water Treatment Plant

In Siparia, extreme heat hazard is classified as **medium (**as displayed in Figure 4-12**)** based on the information currently available. This means that there is more than a 25% chance that at least one period of prolonged exposure to extreme heat, resulting in heat stress, will occur in the next five years. Project planning decisions, design and construction methods should take into account the level of hazard. Siparia is therefore considered to be at **moderate exposure** to extreme heat. Drought exposure is also considered **moderate**, as projected increases in temperature and variability in rainfall may reduce water availability and streamflow during extended dry periods.

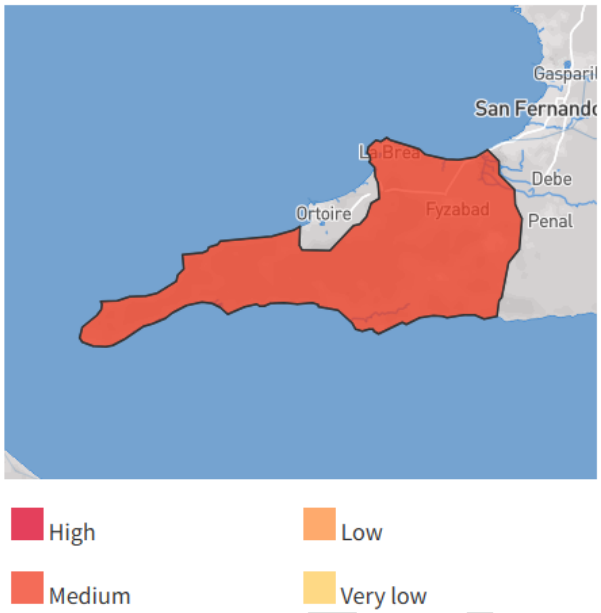


Figure 4-13 Extreme Heat Exposure of Siparia (source: World Bank ThinkHazard Platform)

According to the most recent assessment report of the Intergovernmental panel on Climate Change (Intergovernmental Panel on Climate Change (IPCC), 2019), continued emissions of greenhouse gases will cause further warming, and it is virtually certain that there will be more frequent hot temperature extremes over most land areas during the next fifty years. Warming will not be regionally uniform. In the area you have selected, the temperature increase in the next fifty years will be much lower than the worldwide average, but still significant. It would be prudent to design projects in this area to be robust to global warming in the long-term.

EARTHQUAKES AND LANDSLIDES

Trinidad lies at the complex boundary of the Caribbean and South American plates, making it the second most seismically active region in the eastern Caribbean (UWI Seismic Research Centre, 2025). There are active faults (e.g. Central Range Fault, El Pilar Fault). Historically, the 1766 quake (M≈7.9) devastated northern Trinidad, and an 1888 M7.5 event caused damage across the island (UWI Seismic Research Centre, 2025). Even in the modern era, a 1968 M7.0 tremor caused damage in Port-of-Spain (UWI Seismic Research Centre, 2025). The Rehabilitation sites themselves are inland but are still susceptible to seismically activity. Strong shaking could damage the plant's structures (sedimentation basins, clarifiers, tanks), pipelines and road access.

Acono WTP

In the Tunapuna region, earthquake hazard is classified as **medium** according to the information currently available. This means that there is a 10% chance of potentially damaging earthquake shaking in the project area in the next 50 years. Based on this information, the impact of earthquake should be considered in all phases of the project, particularly during design and construction. Acono is therefore considered to be at **moderate exposure** to earthquakes (Figure 4-14).

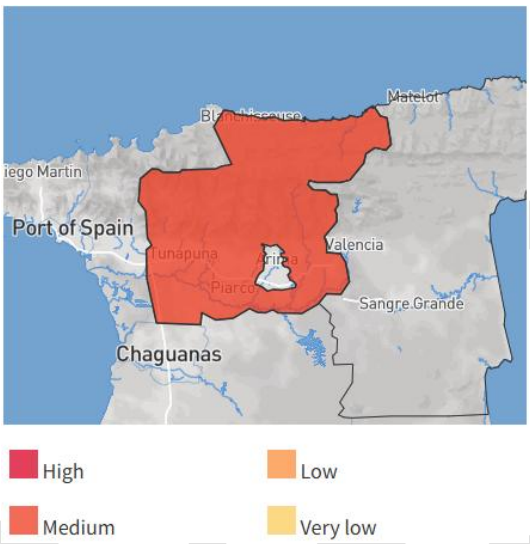


Figure 4-14 Earthquake Exposure map of the Tunapuna Region

Siparia Water Treatment Plant

In the area selected for Siparia, earthquake hazard is classified as **high** according to the information currently available. This means that there is more than a 20% chance of potentially damaging earthquake shaking in the project area in the next 50 years. Based on this information, the impact of earthquake must be considered in all phases of the project, particularly during design and construction. Siparia is therefore considered to be at **high exposure** to earthquakes.

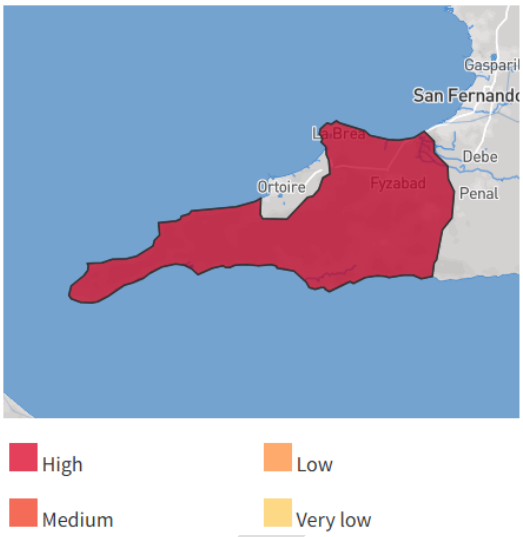


Figure 4-15 Earthquake Exposure Map of Siparia

Landslides represent a secondary hazard associated with intense rainfall and seismic activity. Steep terrain, weathered soils and high rainfall contribute to slope instability, and heavy rainfall events can trigger landslides that block access roads, damage pipelines, increase sediment loads within rivers and negatively affect raw water quality. Climate change is likely to alter slope and bedrock stability through changes in precipitation and temperature, although future locations and timing of large slope failures are difficult to predict.

Acono Water Treatment Plant

In the area selected for Acono, landslide susceptibility is classified as **high** according to the information currently available. This means that rainfall patterns, terrain slope, geology, soil, land cover and potentially earthquakes make localized landslides a frequent hazard phenomenon. Based on this information, planning decisions such as project siting, project design and construction methods must take into account the potential for landslides. Acono is therefore considered to be at **high exposure** to landslides (Figure 4-16).

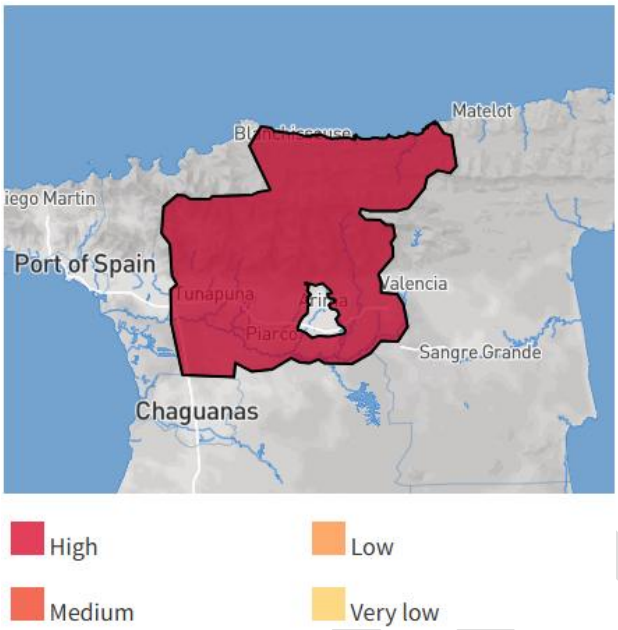


Figure 4-16 landslide Exposure Map of the Tunapuna Region

Siparia Water Treatment Plant

In the area selected for Siparia, landslide susceptibility is classified as **low** according to the information currently available. This means that the area has rainfall patterns, terrain slope, geology, soil, land cover and potentially earthquakes that make localized landslides an uncommon hazard phenomenon. Based on this information, planning decisions such as project siting, project design and construction methods may consider the potential for landslides, although the likelihood is limited. Siparia is therefore considered to be at **low exposure** to landslides (Figure 4-17).

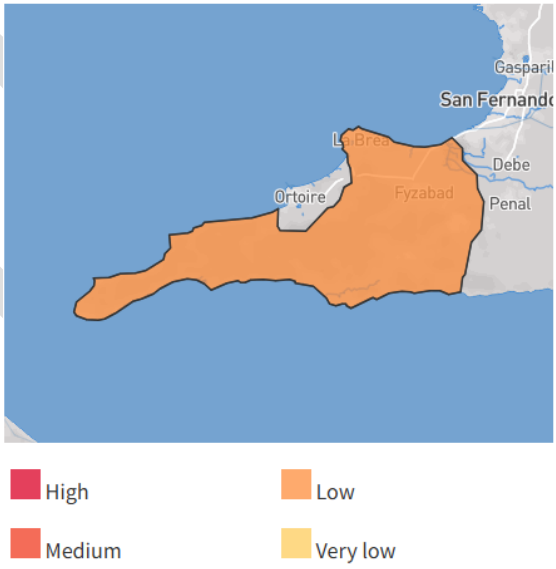


Figure 4-17 Landslide Exposure Map of the Siparia Region

Extreme Rainfall and Flooding

Trinidad's wet seasons now bring intense, erratic rainfall. Between 2017–2018 the country saw five major flood events (Cari-Bois Environmental News Network, 2025), causing widespread damage to infrastructure. Heavy rains can overflow rivers and catchments, inundate low-lying plant sites (e.g. intake areas) and wash sediment/debris into systems. In past storms, WASA has reported that flooded rivers and clogged intake screens disrupted multiple treatment plants (Mendes-Franco, 2017). Landslides in upland watersheds (triggered by heavy rain) also threaten raw-water quality and quantity. Thus, flash floods and sustained heavy rains are an expected hazard that can shut down operations by flooding facilities or causing turbidity spikes.

Acono

The refurbishment plans at the Acono WTP are all internal and fall within the existing footprint of the plant. As such, the level of exposure and risk of impact of heavy rainfall and/or flooding remain the same as they are now. There are no reported incidents of flooding at the plant directly, however, during periods of heavy rainfall, such as the widespread heavy rainfall that occurred on June 4th, 2018 (Rampersad, 2018) and in June 2025 (CNC3 News Trinidad and Tobago, 2025), the Acono supply area has been inundated and recorded disruptions to water supply. This exposure to the impact of different types of flooding is further evident based on the exposure maps displayed in Figure 4-18 and Figure 4-19 below.

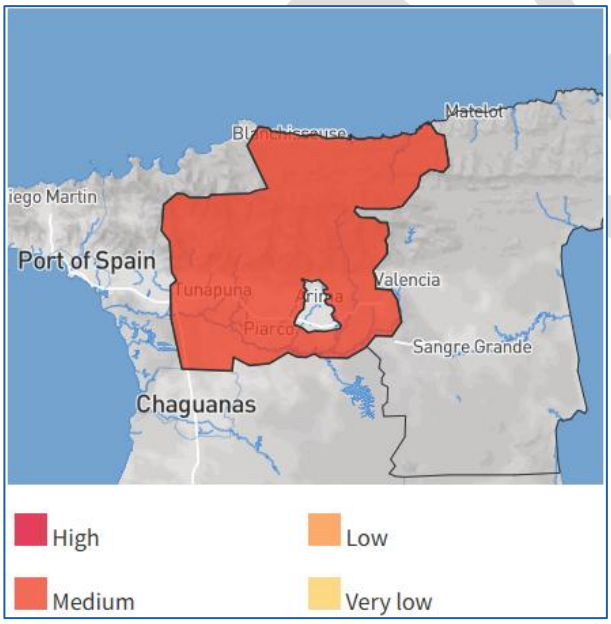


Figure 4-18 Hazard Exposure Map for Riverine Flood in the Tunapuna Region

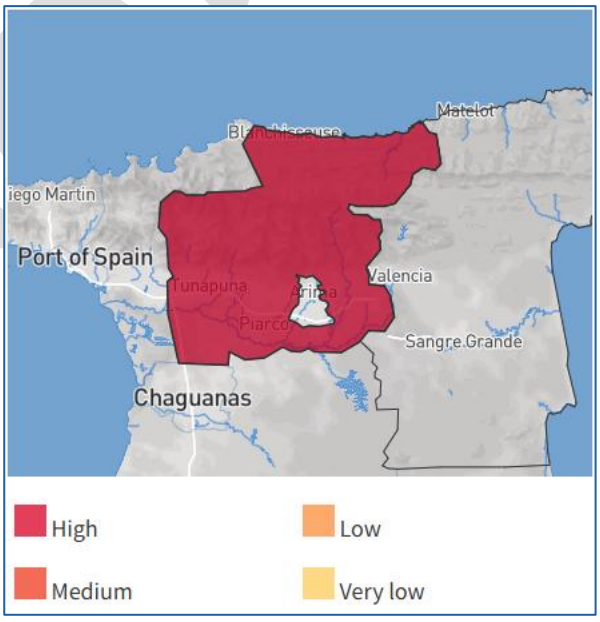


Figure 4-19 Hazard Exposure Map for Urban Flood in the Tunapuna Region

- **River Flooding:** River flood hazard in the Tunapuna/Piarco area is classified as **medium**, indicating a greater than 20% probability of potentially damaging and life-threatening river

flood events occurring within the next ten years. As a result, flood risk management measures should be incorporated into project planning, design and construction, particularly where infrastructure may be affected by nearby watercourses or flood-prone areas. Given the location of the Acono Water Treatment Plant within a watershed draining the Northern Range, periods of intense rainfall may result in elevated river flows, increased sediment loads and temporary operational disruptions. Although future rainfall projections remain uncertain, climate change may increase the frequency and severity of river flooding, and the project should incorporate measures that enhance long-term flood resilience.

- **Urban Flooding:** Urban flood hazard in the Tunapuna/Piarco area is classified as **high**, indicating that potentially damaging and life-threatening urban flood events are expected to occur at least once within the next ten years. Project planning, design and construction should therefore account for the potential for surface water accumulation, drainage exceedance and localized flooding. While no significant flooding has been reported at the Acono Water Treatment Plant itself, flooding has occurred within the wider service area during major rainfall events, resulting in water supply disruptions. Future changes in rainfall patterns associated with climate change may increase urban flood risk, and the project should incorporate adaptive measures to improve long-term resilience to flooding.

Siparia

The southern region of Trinidad has greater exposure to hazards associated with heavy rainfall and flooding due to the movement of the Inter-Tropical Convergence Zone (ITCZ). Since 2019, Southern Trinidad has recorded at least one major flooding event (Williams, 2024; Persad, 2019; The Caribbean Catastrophe Risk Insurance Facility, 2021)

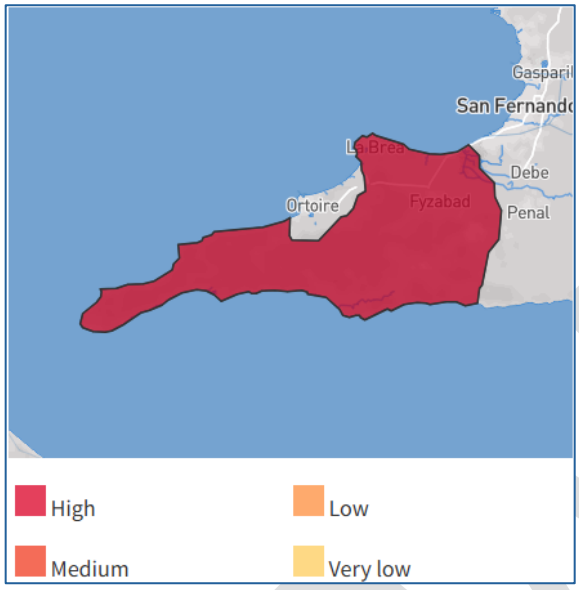


Figure 4-20 Hazard Exposure Map for Urban Flood in the Siparia Region

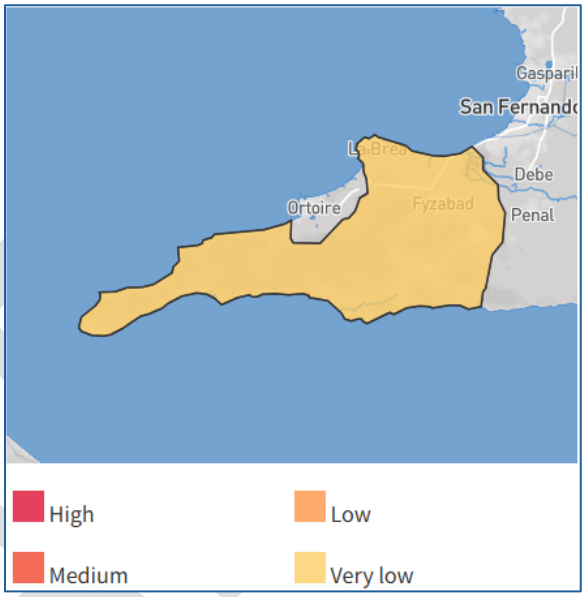


Figure 4-21 Hazard Exposure Map for Riverine Flood in the Siparia Region

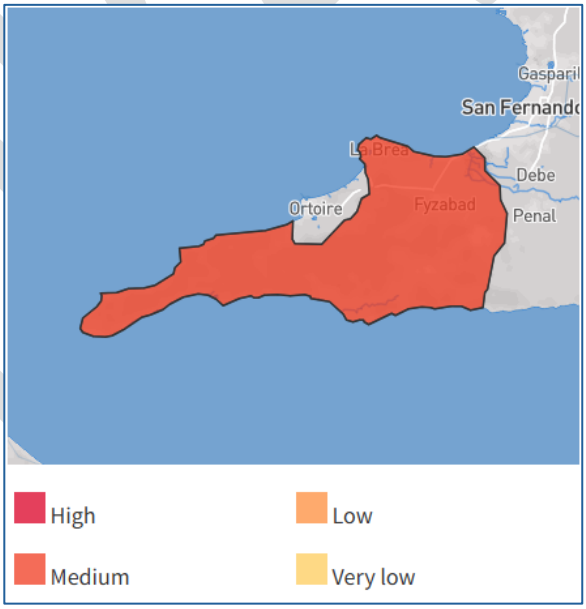


Figure 4-22 Hazard Exposure Map for Coastal Flood in the Siparia Region

- **Urban Flooding:** Urban flood hazard in the Siparia area is classified as **high**, indicating that potentially damaging and life-threatening urban flood events are expected to occur at least

once within the next ten years. Project planning, design and construction should therefore account for the potential for surface water accumulation, drainage exceedance and localized flooding. Given the history of flooding within southern Trinidad and the influence of the Inter-Tropical Convergence Zone (ITCZ), the Siparia Water Treatment Plant is considered to have a high level of exposure to urban flooding. Although future rainfall projections remain uncertain, climate change may increase the frequency and severity of flood events, and the project should incorporate measures that enhance long-term flood resilience.

- **River Flooding:** River flood hazard in the Siparia area is classified as **very low**, indicating that there is less than a 1% probability of a potentially damaging river flood occurring within the next ten years. As such, river flooding is not considered a significant hazard to the project. However, localized flooding associated with drainage deficiencies, blocked watercourses or poorly maintained stormwater infrastructure may still occur and should be considered during project planning. While current exposure is low, future changes in rainfall intensity associated with climate change may increase flood risks over the lifetime of the project.
- **Coastal Flooding:** Coastal flood hazard in the Siparia area is classified as **medium**, indicating a greater than 20% probability of potentially damaging coastal flood events occurring within the next ten years. Although the Water Treatment Plant is not located directly along the coastline, coastal flooding remains a relevant hazard within the wider project area and should be considered during project planning and design. Future sea level rise associated with climate change may increase the frequency and magnitude of coastal flooding, and infrastructure should therefore be designed to accommodate long-term increases in coastal flood risk.

EXPOSURE

The Acono and Siparia Water Treatment Plants are exposed to multiple natural hazards. The proposed rehabilitation works are largely confined to the existing footprints of the plants, which reduces the extent of additional exposure. However, hazards associated with heavy rainfall, flooding and seismicity remain important, and the staggered rehabilitation approach proposed by WASA will help reduce operational disruption during implementation. Based on the hazard screening, both facilities are moderately exposed overall, with site-specific differences in the type and intensity of hazards faced.

Table 4-1 Summary of Hazard Exposure – Acono Water Treatment Plant

Hazard	Exposure Level	Rationale
Tropical Cyclones	Low	The facility is located within the foothills of the Northern Range, which provides a natural barrier against strong winds associated with tropical cyclones. Trinidad also lies south of the primary Atlantic hurricane belt, reducing the likelihood of direct impacts.
Extreme Heat	Low	The Tunapuna/Piarco region is described as having a Low extreme heat hazard, indicating a 5–25% chance of prolonged heat stress events occurring within the next five years.
Drought	Moderate	The facility relies on surface water resources that may experience reduced flows during prolonged dry periods. Climate projections indicate increasing temperatures and potential reductions in dry season rainfall.
Earthquake	Moderate	Medium earthquake exposure, indicating a 10% probability of potentially damaging ground shaking within the next 50 years.
Landslides	High	The facility is located within the Northern Range foothills where steep slopes, intense rainfall, weathered soils, and seismic activity contribute to a high susceptibility to slope instability.
River Flooding	Moderate	River flooding within the Tunapuna/Piarco region is classified as Medium, indicating a greater than 20% probability of damaging river flooding occurring within the next 10 years.
Urban Flooding	High	Urban flooding exposure as High, indicating potentially damaging urban flooding is expected to occur at least once within the next 10 years.
Coastal Flooding	Not Applicable	The facility is located inland and is not exposed to coastal flooding hazards.
Extreme Rainfall	Moderate	The Northern Range watershed experiences periodic heavy rainfall events capable of increasing runoff, turbidity, and localized flooding impacts on water supply infrastructure.

Table 4-2 Summary of Hazard Exposure – Siparia Water Treatment Plant

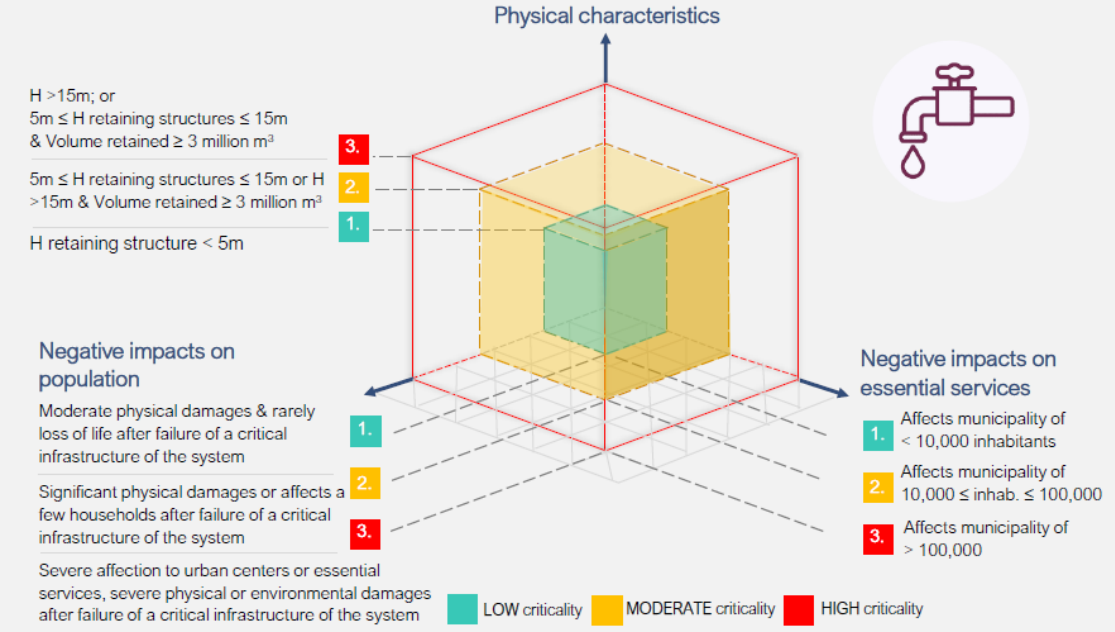
Hazard	Exposure Level	Rationale
Tropical Cyclones	Low	Southwestern Trinidad experiences limited direct exposure to tropical cyclones due to the island's location south of the primary hurricane belt. Impacts are generally restricted to heavy rainfall and localized wind effects associated with tropical storm remnants.
Extreme Heat	Moderate	Medium extreme heat exposure, indicating a greater than 25% probability of prolonged heat stress occurring within the next five years.
Drought	Moderate	Projected increases in temperature and variability in rainfall may reduce water availability and streamflow during extended dry periods, potentially affecting plant operations.
Earthquake	High	High earthquake exposure, indicating a greater than 20% probability of potentially damaging ground shaking occurring within the next 50 years.
Landslides	Low	The area is characterized by relatively gentle topography and is characteristically low susceptibility to landslides
River Flooding	Very Low	Indicates less than a 1% probability of damaging river flooding occurring within the next 10 years.
Urban Flooding	High	Urban flooding is classified as High mainly based on flood history of the region, which is indicative of, indicating damaging flood events are expected to occur at least once within the next 10 years.
Coastal Flooding	Moderate	Medium/Moderate exposure mainly due to location close to the coastline and very limited natural buffer from wave action. A medium/moderate exposure indicates a greater than 20% probability of potentially damaging coastal flood events occurring within the next 10 years.
Extreme Rainfall	High	Southern Trinidad experiences frequent heavy rainfall events associated with the movement of the Inter-Tropical Convergence Zone (ITCZ), increasing exposure to flooding and drainage-related impacts.

SENSITIVITY

These water-treatment systems are moderately sensitive to hazards. Treatment plants and dams have many mechanical, electrical and structural components that can fail under extreme conditions. For instance, flood-borne sediment and debris quickly overload filters and raw-water pumps – in 2017 WASA confirmed that heavy turbidity forced multiple plant shutdowns (Mendes-Franco, 2017). Electrical outages (common in storms/heatwaves) interrupt pumps and controls unless adequately backed up. Even short outages have major impacts: as noted, Arena reservoir

levels fell dangerously low in drought (Douglas, 2024). In sum, the combination of high exposure and intrinsic sensitivity (low redundancy and aging assets) means hazards can quickly cause severe service interruptions.

4.2.4.2 Step 2: Criticality and Vulnerability



- **Acono WTP** – Serves North Central Trinidad. It is the main source for underserved communities. Past operations were hampered by high-turbidity events. The planned addition of a high-rate clarifier, mechanical screens and new dosing systems will reduce sensitivity to storm inflows. Nonetheless, Acono is exposed to tropical rain events in its watershed, and extended outages would leave rural zones without supply.
- **Siparia**

Each of these facilities is highly critical to national water security. Their vulnerabilities stem from age, past maintenance deficits, and locations. The planned project upgrades (new pumps, controls, structures and monitoring) are specifically targeted at reducing these vulnerabilities. For example, automating dosing and installing SCADA will improve operational resilience to hazard events, and dam works will strengthen spillways against overtopping. Nevertheless, until these measures are fully in place, each critical asset remains at substantial risk from the identified hazards.

Table 4-3 Criticality Evaluation

KEY COMPONENT	LOW	MODERATE	HIGH
DIMENSION 1: LOSS OF ESSENTAIL SERVICES			
IMPACTS ON THE SERVICE FUNCTIONALITY		**Acono**: Failure at Acono would interrupt potable supply to approximately **11,300 residents**, placing it in the moderate criticality band. **Siparia** Failure at the Siparia plant during the refurbishment works has the potential to disrupt potable water supply to an approximate 15,000 customers.	
DIMENSION 2: IMPACT ON POPULATION			
IMPACT ON POPULATION	**Acono** Based on the scale and nature of the proposed refurbishment works at the Acono Water Treatment Plant, the potential for the upgraded treatment systems, mechanical equipment, chemical dosing facilities, and associated infrastructure to cause direct physical harm to nearby residents or damage to surrounding properties is considered low. The project primarily involves the rehabilitation and modernization of existing treatment processes within the boundaries of an operational facility and does not		

	introduce new infrastructure that would significantly increase risks to adjacent communities. Any operational failures or equipment malfunctions would be expected to be localized within the plant site and managed through established operational and safety procedures. As such, the potential impact on nearby populations is considered Low. **Siparia:** Based on the scale and nature of the proposed refurbishment and upgrade works at the Siparia Water Treatment Plant, the potential for the upgraded treatment units, chemical handling systems, treated water storage facilities, sludge management infrastructure, and associated electrical and control systems to cause direct physical harm to nearby residents or damage to surrounding properties is considered low. The project consists primarily of the rehabilitation and modernization of existing infrastructure within an operational treatment facility and does not involve works that would create significant off-site safety risks. While		

	localized incidents such as equipment malfunctions or chemical handling failures may occur, any impacts would be expected to remain largely confined to the plant site. Consequently, the potential impact on nearby populations is considered **Low**.		
DIMENSION 3: PHYSICAL CHARACTERISTICS			
PHYSICAL CHARACTERISTICS OF WATER TREATMENT PLANT SYSTEM	**Siparia and Acono** Low: Small-scale facilities with simple treatment processes; short pipeline network; low operating pressures; limited storage capacity; predominantly above-ground assets that are easily accessible for inspection and repair.		
CRITICALITY OF PROJECTS			
Acono – Moderate **Siparia - Low**			

4.2.4.3 Step 3: Diagnostic Narrative

Acono

The project area has notable exposure to the following hazards:

- Drought
- Earthquake
- Landslides
- River Flooding
- Urban Flooding
- Extreme Rainfall

For this operation, Droughts, Earthquakes, River Flooding and Extreme Rainfall are classified as **Moderate/Medium.** Landslides and Urban flooding have been classified as **High**. The criticality and vulnerability of the infrastructure component of the project is classified as **Moderate,** following the criteria shown in the criticality chart: (i) physical characteristics are Low; (ii) the level of Impact on Population is Low; and (iii) level of Impact on the Service Functionality is Moderate. Therefore, the criticality is rated as Moderate. The proposed refurbishment works at the Acono Water Treatment Plant, including the installation of a new high-rate coagulation, flocculation and clarification system, refurbishment of existing filters and clarifiers, upgrades to chemical dosing systems, installation of desilting and sludge management equipment, mechanical screen improvements, and associated civil, electrical and instrumentation upgrades, are not expected to increase the current conditions of natural hazards or vulnerability to surrounding communities or the environment. This is because the proposed interventions are confined to the footprint of the existing operational facility and primarily involve the replacement and modernization of aging infrastructure to improve treatment efficiency, operational reliability, and resilience to variable raw water quality conditions. Furthermore, the project does not involve the construction of new dams, reservoirs, major conveyance infrastructure, or other facilities that could significantly alter existing hazard conditions or increase risks to nearby populations.

Considering the hazard levels identified, the criticality and vulnerability estimated for the infrastructure interventions, and the negligible level of risk exacerbation associated with the proposed refurbishment works, a **Moderate Risk** classification has been determined.

Climate change has been considered as follows: Climate projections for Trinidad and Tobago indicate increasing temperatures, more frequent and intense heat events, greater variability in rainfall patterns, and the potential for more intense rainfall events. These changes may increase the frequency and severity of flooding, landslides, drought conditions, and raw water quality challenges within the Acono watershed. The proposed upgrades are expected to improve the plant's ability to manage increased turbidity, suspended solids, and variable raw water quality associated with future climatic conditions.

The following design considerations aimed at managing the risks were identified: installation of a new high-rate coagulation, flocculation and clarification system; refurbishment of existing filters and clarifiers; optimization of chemical dosing systems; installation of desilting and sludge management equipment; installation of a mechanical trash rack and screen-wash system;

modernization of electrical and instrumentation systems; and implementation of operational and maintenance procedures to improve reliability and resilience during extreme weather events.

The following gaps were identified: while regional hazard screening data are available, site-specific information regarding the future effects of climate change on rainfall intensity, landslide frequency, and watershed hydrology remains limited.

There are also uncertainties that remain regarding the magnitude and timing of future climate change impacts, particularly with respect to changes in extreme rainfall patterns, drought frequency, and associated watershed responses. However, these uncertainties are not considered sufficient to materially alter the overall risk classification.

The narrative concluded that for this Moderate risk operation there is no need to continue to a complete qualitative risk assessment for the operation, Step 4 of the Disaster and Climate Change Risk Assessment Methodology (DCCRAM), as there are no significant gaps, appropriate measures have been identified and documented in a DRMP and it is possible to attain a tolerable risk level from these.

Siparia

The project area has notable exposure to the following hazards:

- Extreme Heat
- Drought
- Earthquake
- Urban Flooding
- Coastal Flooding
- Extreme Rainfall

For this operation, droughts, extreme heat and coastal flooding are classified as **Moderate/Medium**, while earthquakes, urban flooding and extreme rainfall have been classified as **High**.

The criticality and vulnerability of the infrastructure component of the project is classified as **Moderate**, following the criteria shown in the criticality chart. The criticality and vulnerability of the infrastructure component of the project is classified as **Moderate,** following the criteria shown in the criticality chart: (i) physical characteristics are **Low**; (ii) the level of Impact on Population is **Moderate**; and (iii) level of Impact on the Service Functionality is Moderate. Therefore, the criticality is rated as **Moderate**. Therefore, the criticality is rated as **Moderate**.

The proposed refurbishment and upgrade works at the Siparia Water Treatment Plant, including the construction of a new tray-type aerator, installation of new and refurbished lamella clarifiers, reconstruction of rapid gravity filtration units, modernization of chemical dosing and disinfection systems, construction of treated water storage and sludge management facilities, electrical and SCADA upgrades, laboratory modernization, and associated civil, mechanical, electrical and instrumentation works, are not expected to increase the current conditions of natural hazards or

vulnerability to surrounding communities or the environment. This is because the proposed interventions are being undertaken within the footprint of an existing operational water treatment facility and are primarily intended to rehabilitate, modernize, and improve the reliability, efficiency and environmental performance of existing treatment processes.

Although the project includes upgrades to treated water storage, sludge management infrastructure, and plant capacity to better serve surrounding communities, these improvements do not introduce new infrastructure or operational conditions that would significantly increase exposure to natural hazards or create additional risks to nearby populations. Rather, the proposed works are expected to enhance the resilience of the facility through improved treatment processes, upgraded monitoring and control systems, improved chemical handling infrastructure, and modernized electrical and operational equipment.

Considering the hazard levels identified, the criticality and vulnerability estimated for the infrastructure interventions, and the negligible level of risk exacerbation associated with the proposed refurbishment and upgrade works, a **Moderate Risk** classification has been determined.

Climate change has been considered as follows: Climate projections indicate increasing temperatures, more frequent heat extremes, changes in rainfall intensity and distribution, and rising sea levels. These changes may increase the severity of urban flooding, drought conditions, coastal flooding, and operational challenges associated with raw water quality and availability. The proposed upgrades are expected to improve the facility's resilience through enhanced treatment efficiency, improved process control, upgraded monitoring systems, and modernized operational infrastructure.

The following design considerations aimed at managing the risks were identified: installation of a new tray-type aerator; construction and refurbishment of lamella clarifiers; reconstruction of rapid gravity filtration units; modernization of chlorination and chemical dosing systems; construction of treated water storage and sludge management facilities; upgrades to electrical distribution systems and standby power infrastructure; implementation of SCADA and automation systems; and modernization of laboratory facilities to support improved operational monitoring and water quality management.

The following considerations to address exacerbation of risk were identified: the proposed interventions, primarily, rehabilitation and modernization work within the existing treatment plant footprint and are not expected to increase the vulnerability of surrounding communities or environmental receptors to identified natural hazards.

The following gaps were identified: limited site-specific information is available regarding the long-term effects of climate change on local flooding patterns, groundwater availability, and coastal processes within the Siparia area.

There is still uncertainty surrounding the future changes in rainfall patterns, drought frequency, groundwater recharge, and sea-level rise projections. However, these uncertainties are not

considered significant enough to alter the overall risk classification or the effectiveness of the proposed mitigation measures.

The narrative concluded that for this Moderate risk operation there is no need to continue to a complete qualitative risk assessment for the operation, Step 4 of the Disaster and Climate Change Risk Assessment Methodology (DCCRAM), as there are no significant gaps, appropriate measures have been identified and documented in a DRMP and it is possible to attain a tolerable risk level from these.

4.3 Biological Environment Baseline

4.3.1 Acono

Situated in the Maracas–St. Joseph Valley within the Northern Range, this site is surrounded by evergreen, seasonal and montane forests. The area is part of a secondary forest matrix interspersed with cleared slopes, roadways, and residential plots. Vegetation is influenced by historical land use (forestry, small-scale cocoa, and subsistence farming) but retains high ecological value. The proposed project does not involve the construction of new buildings, as all refurbishment activities will be undertaken within existing infrastructure and facility footprints (Figure 4-24). Consequently, significant habitat loss or biodiversity impacts beyond those associated with current operations are not anticipated. Any vegetation disturbance is expected to be minimal and localised, occurring only where necessary to facilitate construction access, equipment installation, or ancillary works.

Potential ecological impacts are therefore expected to be limited primarily to temporary disturbances during the construction phase, including increased noise, human activity, dust generation, and the potential for sediment-laden runoff if not appropriately managed. Although no critical natural habitats have been identified within the immediate project footprint, the facility is situated within the broader Northern Range landscape, which supports an important biodiversity corridor of regional conservation significance. As such, the environmental management measures detailed in the Biodiversity Management Plan should be implemented to prevent indirect impacts on adjacent forested habitats and to maintain the ecological integrity of the surrounding area.

The nearby Acono River supports diverse aquatic species, and the wider Northern Range is a biodiversity hotspot, home to over 200 bird species and several endemic plants. Ecological pressures include deforestation, quarrying, and agricultural runoff.

Figure 4-23: Ecological environment within the Acono Water Treatment Plant property

Figure 4-24: The Acono Water Treatment Plant and surrounding environment

4.3.2 Siparia

The Siparia WTP is situated in the town of Siparia in the south-western region of Trinidad. The surrounding landscape is dominated by agricultural land, human modification from residential development, and remnant patches of seasonal forest and secondary vegetation associated with the southern foothills. The broader regional context is the Southern Range. Given the nature of the proposed refurbishment and upgrade works, all activities are expected to be confined primarily within the existing WASA property boundary (Figure 4-25). Limited use of land immediately adjacent to the site may be required to facilitate construction activities, material storage, equipment access, or other ancillary works, if deemed necessary.

The project site is predominantly characterised by maintained grassy areas interspersed with a small number of trees and ornamental vegetation. As the proposed work will largely occur within an already developed and managed facility, impacts on natural habitats and biodiversity are expected to be minimal. Vegetation clearance is anticipated to be limited, with tree removal undertaken only where necessary to accommodate project infrastructure or ensure safe construction and operational access. Consequently, the overall loss of vegetation and associated ecological impacts is expected to be low.

Figure 4-25: The Siparia Water Treatment Plant and surrounding environment

Figure 4-26: Vegetation on sections of the Siparia Water Treatment Plant

4.4 Socioeconomic Environment Baseline

4.4.1 Social Areas of Influence

The definition of the social area of influence (SAoI) for the refurbishment works on two water treatment plants (WTPs) – Siparia WTP and Acono WTP – is guided by the project scope and geographic footprint described in the project's Conceptual Design Framework and the project brief prepared by WASA. The SAoI represents the social component of the AoI defined for the ESA. It captures the social receptors that may experience direct construction-related effects from the proposed refurbishment and upgrade works, as well as indirect or system-level effects associated with improved water-supply reliability, treatment performance, operational resilience, and public health outcomes.

Both interventions are located at existing water treatment facilities. The Siparia WTP project will finance the comprehensive refurbishment and upgrade of an active 2.0 IMGD facility serving south-western Trinidad, including works within the existing treatment facilities, pumping infrastructure, chemical handling areas, storage tanks, and internal transmission systems within the plant compound. The project is structured to maintain continuity of water production during construction and upgrade activities.

The Acono WTP project will refurbish and modernise the existing facility on Acono Road, Maracas Valley, with the objective of improving potable water supply for over 11,000 residents and businesses in Acono, Maracas, and surrounding areas. Given the nature of the works, direct social effects are expected to be concentrated primarily during the construction and refurbishment phase, while the wider operational benefits are expected to be experienced across the broader service areas.

The Social Direct Area of Influence (S-DAoI) is defined by the physical footprint of the proposed construction and refurbishment activities, together with the nearby receptors that may be directly affected by those activities. For both the Siparia and Acono WTPs, the direct effects are expected to be mainly construction-related because the interventions will be undertaken at existing WTP sites rather than through the development of new greenfield facilities. These effects may include temporary construction disturbance, noise, dust, vibration, movement of workers and materials, localized traffic and access disruption, temporary use of laydown and staging areas, occupational and community health and safety risks, worker-community interaction, and short-term employment or procurement opportunities.

Figure 4-27 Social Indirect and Direct Area of Influence Boundaries for Siparia WTP Refurbishment and Upgrade

For the Siparia WTP, the S-DAoI includes the existing WTP compound, treatment units, pumping and chemical handling areas, storage and internal transmission systems, internal roadways, construction access routes, laydown areas, and directly affected receptors spanning Siparia and Mendez Village. The project scope includes demolition and removal of deteriorated or obsolete treatment units, construction of new reinforced concrete structures for clarifiers, filters, sludge tanks, equipment foundations and support facilities, rehabilitation of existing concrete structures, installation of a new clearwell, provision of access stairways and safety barriers, drainage improvements, internal roadways, fencing, and restoration of disturbed areas. These activities may directly affect nearby residents, road users, land users, businesses, public facilities, WASA staff, contractors, and vulnerable groups located within or immediately adjacent to the construction footprint and access routes.

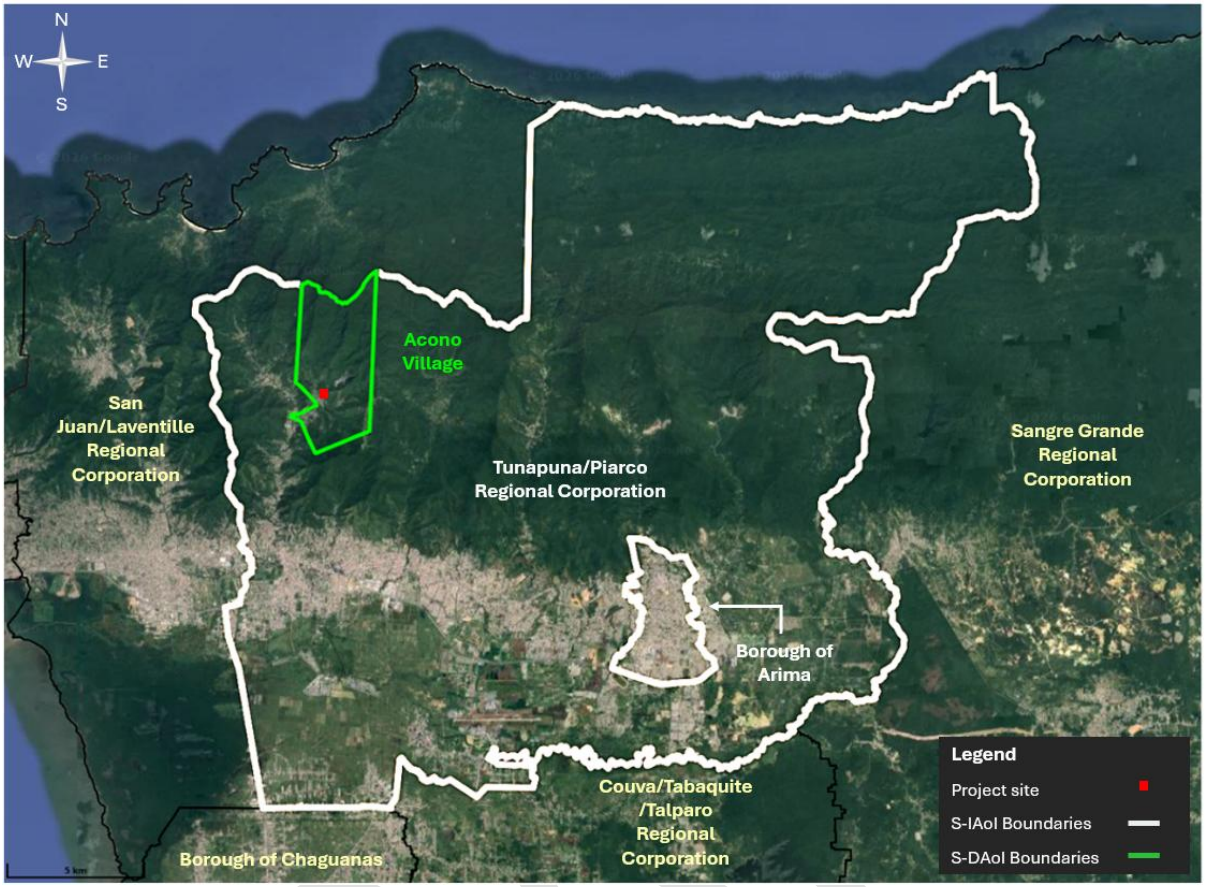


Figure 4-28: Social Indirect and Direct Area of Influence Boundaries for the Acono WTP Refurbishment Project
Map data ©2026 Google.

For the Acono WTP, the S-DAoI includes the existing WTP compound on Acono Road, Maracas Valley; construction access routes; laydown areas; and directly affected receptors in Acono Village. The project scope includes the replacement or refurbishment of clarification and filtration systems; upgrades to chemical treatment, desilting, and sludge removal systems; mechanical and electrical works; SCADA, automation, and water quality monitoring systems; associated civil and instrumentation upgrades; environmental, health and safety, and social considerations; and staff training. Direct effects are therefore expected to be associated mainly with construction access, movement of equipment and materials, temporary nuisance impacts, localised traffic or access constraints, worker-community interaction, and construction-phase health and safety risks.

The Social Indirect Area of Influence (S-IAoI) comprises the wider social receptors that may experience indirect, secondary, or system-level effects from the completed interventions. For the Siparia WTP, the S-IAoI comprises the municipalities of Siparia and Penal/Debe. This reflects the broader municipal and service context in which improved treatment performance, operational redundancy, reduced downtime, and strengthened reliability of the potable water supply are expected. The Siparia WTP project is intended to stabilise and modernise potable water supply services in south-western Trinidad, improve operational resilience, reduce emergency interventions, enhance staff safety, improve energy efficiency, and extend the service life of the facility. The S-IAoI therefore includes beneficiary communities, households, businesses, public institutions, service providers, emergency services, and municipal authorities whose water

security, service continuity, public health conditions, and institutional service delivery may be indirectly affected by improved plant performance.

For the Acono WTP, the S-IAoI is defined as Tunapuna/Piarco. The project brief identifies the wider service coverage as including Acono Road, Belle View, Harmony Drive, Acono Gardens, Sarame Gardens, Green Hill, Caurita, Acono Ridge, Guamal, and Maracas St. Joseph, with a more reliable water supply expected for approximately 11,353 residents. The indirect area, therefore, encompasses communities, households, businesses, public institutions, local service providers, and municipal stakeholders that may benefit from improved production capacity, reduced service disruptions, better turbidity and solids control, more reliable water quality, and more resilient rural water infrastructure. While the physical works are concentrated at the existing Acono WTP, the social benefits and system-level effects are expected to extend across the wider communities served by the facility within the Tunapuna/Piarco municipal context.

Although water-sector planning, financing, development, and regulation are primarily undertaken by national institutions, implementation of both projects will also require coordination with municipal and local stakeholders. Relevant coordination issues may include traffic and access management, drainage, construction waste management, disaster preparedness, public communication, community health and safety, service disruption notices, stakeholder engagement, and grievance management. The SAoI is therefore defined to capture both the direct construction footprint of the proposed refurbishment and upgrade activities and the wider service and administrative areas within which project benefits, risks, and stakeholder interests are likely to be experienced.

4.4.2 Refurbishment and Upgrade of Siparia Water Treatment Plant

4.4.2.1 Demographic and Social Structure

Section 4.4.2.1 summarises the demographic and social characteristics of the population residing within the defined social area of influence for the Siparia WTP Refurbishment and Upgrading Project, drawing primarily on data from the 2011 Population and Housing Census and other relevant secondary sources (Central Statistical Office of Trinidad and Tobago, 2012a). The section describes population size, distribution, density, household composition, age and gender structure, and selected vulnerability characteristics within the directly affected communities of Siparia and Mendez Village (S-DAoI), while also situating these communities within the wider social context of the Borough of Siparia and Penal/Debe Regional Corporation (S-IAoI).

For consistency with the source dataset, statistical tables refer to Siparia as the Siparia Regional Corporation, reflecting the administrative classification used in the 2011 Census. In the narrative, the region will be referred to by its current designation as the Borough of Siparia, with the historical classification noted where relevant. The demographic profile provides a basis for understanding settlement patterns, household dynamics, dependency, and population groups that may be relevant to later assessment of service access, stakeholder engagement, and potential social vulnerability.

Population and Housing Characteristics

The S-IAoI for the Siparia WTP Refurbishment and Upgrading Project comprises the Siparia and Penal/Debe Regional Corporations. Together, these two municipalities recorded a total population of 176,341 persons in 2011, representing 13.3 percent of Trinidad and Tobago's national population. The non-institutional population of the S-IAoI was similar, at 176,240 persons, indicating that the area's population was overwhelmingly resident in private households rather than institutional settings. The S-IAoI population was almost evenly distributed between the two municipalities, with Penal/Debe accounting for 89,392 persons, or 50.7 percent of the S-IAoI population, and Siparia accounting for 86,949 persons, or 49.3 percent. At the national level, Penal/Debe represented 6.7 percent of the population, while Siparia represented 6.5 percent.

Table 4-4 Key 2011 Population and Household Indicators for Siparia WTP Refurbishment and Upgrade S-AoI

Administrative Area	Total Population Count	Population Density
Trinidad and Tobago	1,328,019	259.0
S-IAoI	176,341	238.0
Siparia Regional Corporation	86,949	175.7
Penal/Debe Regional Corporation	89,392	363.4
S-DAoI	7,621	400.4
Siparia	6,170	986.4
Mendez Village	1,451	113.5

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

The two municipalities have broadly comparable population sizes but differ in settlement density and spatial character. Siparia occupies a substantially larger land area, approximately 495 square kilometres, compared with 246 square kilometres in Penal/Debe. As a result, Siparia recorded a lower population density of 175.7 persons per square kilometre, while Penal/Debe recorded a higher density of 363.4 persons per square kilometre. The combined S-IAoI population density was 238.0 persons per square kilometre, slightly below the national density of 259.0 persons per square kilometre. This reflects the mixed rural, peri-urban and small-town character of the wider project setting, particularly in the Borough, which comprises extensive coastal areas, forests, swamps, energy-sector lands, agricultural areas, fishing centres and small urban settlements structured around the arterial road network (Kairi Consultants Limited, 2016a). Penal/Debe, while also containing rural and agricultural communities, is smaller and more compact, and is influenced by its connection between San Fernando and development areas along the south-western peninsula.

The S-DAoI, comprising Siparia and Mendez Village, recorded a combined population of 7,621 persons in 2011. This represented 4.3 percent of the S-IAoI population and 0.6 percent of the national population. Within the S-DAoI, Siparia was the larger settlement, with 6,170 persons, accounting for 81.0 percent of the S-DAoI population. Mendez Village recorded 1,451 persons, or 19.0 percent of the S-DAoI population. These figures indicate that the direct social receptors for the refurbishment and upgrading works are concentrated primarily in Siparia, while Mendez Village forms a smaller but still relevant settlement within the direct area of influence.

Population density differed sharply within the S-DAoI. The combined S-DAoI density was 400.4 persons per square kilometre, higher than both the S-IAoI and national averages. This pattern was driven mainly by Siparia, which recorded a density of 986.4 persons per square kilometre across approximately 6.3 square kilometres, reflecting its more concentrated settlement form and role as the main service centre within the S-DAoI. Mendez Village, by comparison, recorded a much lower density of 113.5 persons per square kilometre across approximately 12.8 square kilometres, consistent with its more dispersed settlement pattern.

Table 4-5: Key 2011 Household Indicators for Siparia WTP Refurbishment and Upgrade S-AoI

Administrative Area	Household Count	Average Household Size
Trinidad and Tobago	401,373	3.3
S-IAoI	52,192	3.4
Borough of Siparia	26,125	3.3
Penal/Debe Regional Corporation	26,067	3.4
S-DAoI	2,376	3.2
Siparia	1,924	3.2
Mendez Village	452	3.2

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

The S-IAoI contained 52,192 households in 2011, representing 13.0 percent of the national household count. Household distribution closely mirrored population distribution across the two municipalities. Borough of Siparia accounted for 26,125 households, or 50.1 percent of S-IAoI

households, while Penal/Debe Regional Corporation accounted for 26,067 households, or 49.9 percent. Average household size was slightly above the national average in the S-IAoI, at 3.4 persons per household compared with 3.3 nationally. Penal/Debe also recorded an average household size of 3.4 persons, while Siparia recorded 3.3 persons per household.

While the S-DAoI is relatively concentrated in terms of population, household sizes are marginally smaller than those in the wider municipal area. Within the S-DAoI, there were 2,376 households in 2011, equivalent to 4.6 percent of S-IAoI households. Siparia accounted for 1,924 households, or 81.0 percent of households in the S-DAoI, while Mendez Village accounted for 452 households, or 19.0 percent. The average household size in the S-DAoI was 3.2 persons, slightly below both the S-IAoI (3.4) and national (3.3) averages. Both Siparia and Mendez Village recorded an average household size of 3.2 persons.

Household composition in the S-DAoI was predominantly characterised by smaller households, although medium-sized households also accounted for a notable share. Single-person households represented 22.9 percent of S-DAoI households, compared with 16.5 percent in the S-IAoI and 19.1 percent nationally. This pattern was more evident in Siparia, where 24.0 percent of households comprised one person, compared with 18.4 percent in Mendez Village. Small households of two to three persons accounted for 37.9 percent of S-DAoI households, while medium-sized households of four to six persons accounted for 33.6 percent. Mendez Village recorded a higher proportion of medium-sized households, at 39.0 percent, compared with 32.3 percent in Siparia. Large households of more than six persons accounted for 5.6 percent of S-DAoI households, broadly comparable to the S-IAoI figure of 5.3 percent and the national figure of 5.7 percent. This distribution is consistent with the slightly lower average household size recorded across the S-DAoI.

Age and Gender Composition

The S-IAoI had a broadly similar age structure to Trinidad and Tobago in 2011, with a slightly larger working-age population and a marginally lower proportion of children and older adults. Children under 15 years accounted for 19.8 percent of the S-IAoI population, compared with 20.6 percent nationally, while the working-age population, aged 15 to 64 years, accounted for 71.5 percent, compared with 70.5 percent nationally. Older adults, aged 65 years and over, represented 8.6 percent of the S-IAoI population, slightly below the national figure of 8.9 percent. The median age of the S-IAoI was 32.8 years, similar to the national median age of 32.6 years.

Table 4-6: Key 2011 Age Indicators for Siparia WTP Refurbishment and Upgrade S-AoI

Administrative Area	Age Distribution (%)			Median Age	Age Dependency
	Child	Working Age	Older Adult		
Trinidad and Tobago	20.6	70.5	8.9	32.6	41.9
S-IAoI	19.8	71.5	8.6	32.8	39.8
Siparia Regional Corporation	20.5	70.4	9.1	32.3	42.1
Penal/Debe Regional Corporation	19.2	72.7	8.1	33.2	37.6
S-DAoI	21.2	68.6	10.1	32.0	45.7
Siparia	21.9	67.6	10.5	31.8	47.9
Mendez Village	18.4	73.1	8.5	32.8	36.9

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

Within the S-IAoI, the two municipalities showed modest differences in age structure. The Siparia administrative area had a slightly younger child profile than Penal/Debe in 2011, with children accounting for 20.5 percent of the population, compared with 19.2 percent in Penal/Debe. Conversely, Penal/Debe had a larger working-age population, at 72.7 percent, compared with 70.4 percent in Siparia. Both regions showed evidence of population ageing between 2000 and 2011, with the proportion of older adults increasing from 7.6 percent to 9.1 percent in Siparia, and from 5.8 percent to 8.1 percent in Penal/Debe.

The S-DAoI had a slightly younger and more dependent age structure than the S-IAoI and the national population. Children accounted for 21.2 percent of the S-DAoI population, while the working-age population represented 68.6 percent. Older adults accounted for 10.1 percent of the S-DAoI population, higher than both the S-IAoI and national figures. The median age of the S-DAoI was 32.0 years, marginally below the national and S-IAoI medians. The S-DAoI includes both a sizeable child population and a relatively higher share of older adults, resulting in a total age dependency ratio of 45.7 dependents per 100 working-age persons, compared with 39.8 in the S-IAoI and 41.9 nationally.

Within the S-DAoI, Siparia had a younger age profile than Mendez Village but also a higher share of older adults. Children accounted for 21.9 percent of Siparia's population, compared with 18.4 percent in Mendez Village. However, older adults represented 10.5 percent of Siparia's population, compared with 8.5 percent in Mendez Village. Mendez Village had the larger working-age share, at 73.1 percent, compared with 67.6 percent in Siparia. This difference is reflected in the dependency ratios: Siparia recorded a total age dependency ratio of 47.9, while Mendez Village recorded a lower ratio of 36.9. The higher dependency ratio in Siparia was driven by both

child dependency and aged dependency, with aged dependency particularly elevated among females.

Table 4-7: Key 2011 Sex Indicators for Siparia WTP Refurbishment and Upgrade S-AoI

Community	Male (%)	Sex Ratio
Trinidad and Tobago	50.1	100.3
S-IAoI	50.9	103.9
Siparia Regional Corporation	51.0	104.2
Penal/Debe Regional Corporation	50.9	103.5
S-DAoI	50.7	103.0
Siparia	50.5	101.8
Mendez Village	52.0	108.2

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

The gender distribution across the S-IAoI was relatively balanced but slightly male-majority. Males represented 50.9 percent of the S-IAoI population, corresponding to a sex ratio of 103.9 males per 100 females. This pattern was similar in both Siparia Regional Corporation and Penal/Debe Regional Corporation, where males accounted for 51.0 percent and 50.9 percent of the population, respectively. The S-DAoI was also slightly male-majority, with males representing 50.7 percent of the population and a sex ratio of 103.0 males per 100 females.

At the community level, the gender distribution differed between Siparia and Mendez Village. Siparia was close to gender parity, with males accounting for 50.5 percent of the population and a sex ratio of 101.8 males per 100 females. Mendez Village had a stronger male majority, with males representing 52.0 percent of the population and a sex ratio of 108.2 males per 100 females. The male majority in Mendez Village was particularly evident among children (53.9%) and the working-age population (51.5%). In comparison, Siparia showed a marked female majority among older adults (59.2%), with a sex ratio of 69.1 males per 100 females in this age group.

Vulnerable Groups

In the context of the Siparia WTP Refurbishment and Upgrading Project, vulnerability refers to the extent to which individuals, households or groups may be more sensitive to service disruptions, face constraints in coping with short-term changes, or experience barriers to accessing information and participating in consultation. Vulnerability is shaped by population characteristics as well as exposure to hazards, dependence on essential services, income security, mobility, health status, access to information and the availability of household or community support systems. Within the S-IAoI and S-DAoI, vulnerability is therefore best understood as the interaction between social and economic conditions, environmental exposure, and the capacity of households and institutions to anticipate, respond to and recover from disruptions (Clarke et al., 2019; Pacific Disaster Center (PDC Global), 2020).

Older persons represent an important vulnerable group within the S-AoI. In 2011, persons aged 65 years and over accounted for 8.6 percent of the S-IAoI population and 10.1 percent of the S-DAoI population. The share was highest in Siparia, where older adults represented 10.5 percent of the population, compared with 8.5 percent in Mendez Village. Ageing was also evident at the

municipal level, with the proportion of older adults increasing from 7.6 percent to 9.1 percent in the Borough of Siparia, and from 5.8 percent to 8.1 percent in Penal/Debe between 2000 and 2011. Older persons may be more sensitive to interruptions in potable water supply, reduced water pressure, temporary access constraints or changes to household routines, particularly where they live alone, have limited mobility, or rely on others for water storage, transport or communication.

Health-related vulnerability is also relevant. Chronic illness was reported among 20.1 percent of the general population in the S-IAoI in 2011, with prevalence at 18.9 percent in the Borough of Siparia and 21.3 percent in Penal/Debe. Among persons aged 60 years and over, prevalence was substantially higher, reaching 57.4 percent across the S-IAoI, 55.2 percent in the Borough of Siparia and 59.8 percent in Penal/Debe. Diabetes and hypertension were among the most common conditions reported among persons aged 64 years and over. Diabetes affected 44.1 percent of older persons in the Borough of Siparia and 47.7 percent in Penal/Debe, while hypertension affected 49.3 percent and 48.2 percent, respectively. These health conditions can increase household sensitivity to water service interruptions, particularly where water is required for hygiene, medication routines, food preparation, cleaning, cooling and care for elderly or chronically ill household members.

The health dimension of vulnerability is reinforced by wider climate and hazard-related risk pathways identified for Trinidad and Tobago. Climate change is expected to affect human health directly through heat, flooding, landslides and extreme weather events, and indirectly through waterborne and vector-borne diseases, food and water insecurity, and stress associated with damage to homes, services and livelihoods. The 2019 Vulnerability and Capacity Assessment identifies the Borough of Siparia and Penal/Debe as areas vulnerable to intense precipitation and flash-flood impacts that can disrupt power supply, routine health service delivery, access, and emergency response (Clarke et al., 2019). Water supply reliability, water quality, and timely communication about service interruptions are therefore particularly relevant for households managing chronic illness, disability, age-related limitations, and caregiving responsibilities.

Persons with disabilities also constitute a key vulnerable group. In 2011, 8,300 persons with disabilities were recorded in the S-IAoI, representing 5.0 percent of the non-institutional population. Disability prevalence was similar in the Borough of Siparia and Penal/Debe, at 5.1 percent and 5.0 percent, respectively. In the S-DAoI, 278 persons with disabilities were recorded, representing 4.0 percent of the non-institutional population. Most persons with disabilities in the S-DAoI were located in Siparia, which accounted for 233 persons, or 84.0 percent of persons with disabilities in the direct influence area. Mendez Village accounted for 44 persons, or 16.0 percent. The prevalence of disability was slightly higher in Siparia (4.1%) than in Mendez Village (3.3%).

The type of disability or ability limitation provides further insight into potential sensitivity. In the S-DAoI, the most commonly reported ability limitations among persons with disabilities were walking (38.9%) and seeing (37.7%), followed by speaking (20.9%), remembering (18.4%), gripping (11.1%) and hearing (8.2%). In Siparia, walking and seeing limitations were also the most common, affecting 40.0 percent and 34.6 percent of persons with disabilities, respectively. In Mendez Village, seeing limitations were particularly prominent, affecting 53.8 percent of persons

with disabilities, although this figure should be interpreted cautiously because of the smaller number of persons with disabilities in that community. These patterns are relevant to how residents may access information, attend meetings, navigate temporary access changes or obtain support during service disruptions.

Participation restrictions among persons with disabilities further highlight accessibility considerations within the S-AoI. In the S-DAoI, 57.0 percent of persons with disabilities reported that their disability had some effect on participation, compared with 51.7 percent in the S-IAoI and 52.0 percent nationally. Restrictions were most commonly associated with working at a job or business (33.2%), going outside the home (25.0%), participating in social activities (24.2%), taking care of self (22.5%), getting around the home (20.1%) and undertaking educational activities (18.9%). In Siparia, restrictions related to working at a job or business (34.6%), going outside the home (27.8%) and participating in social activities (26.8%) were more pronounced than in Mendez Village. These constraints may affect the ability of some residents to attend public meetings, access service information, navigate alternative arrangements during interruptions or use channels that rely heavily on travel or digital communication.

Children and dependent households also form part of the vulnerability profile. Children under 15 years accounted for 21.2 percent of the S-DAoI population, compared with 19.8 percent in the S-IAoI and 20.6 percent nationally. Siparia recorded a higher child share (21.9%) than Mendez Village (18.4%), contributing to a higher child dependency ratio in Siparia. Household composition is relevant in this regard. Single-person households accounted for 22.9 percent of S-DAoI households, while small households of two to three persons accounted for 37.9 percent and medium-sized households of four to six persons accounted for 33.6 percent. Smaller households may have fewer members available to assist with water storage or collection during interruptions, while caregiving households may have higher daily water needs and less flexibility to adjust routines when service is disrupted.

Children's living arrangements provide further context for household vulnerability, although the available data are not disaggregated at the S-DAoI level. Nationally, the share of children living with their mother only increased from 31.5 percent in 2011 to 35.1 percent in 2022, while the share living with their father only increased from 5.0 percent to 7.2 percent (Central Statistical Office, 2023; Ministry of Social Development and Family Services et al., 2017). The share of children living with neither parent remained at 6.1 percent. In the South West region, which provides a relevant proxy for the S-IAoI context, 60.8 percent of children lived with both parents in 2011, compared with 60.3 percent in 2022. Over the same period, the share living with the mother only remained substantial, at 28.0 percent in 2011 and 26.9 percent in 2022, while the share living with neither parent was 5.2 percent in 2011 and 5.3 percent in 2022. Single-parent and non-parental care arrangements may increase sensitivity to temporary service disruptions where caregivers have limited time, transport, income or support to store water, access alternative supplies, or participate in consultation activities.

Socio-economic conditions also shape vulnerability within the S-AoI. The NDPBA municipal risk profiles identify the Borough of Siparia as having high overall vulnerability and low coping capacity, with vulnerability driven primarily by clean water access vulnerability and information

access vulnerability (Pacific Disaster Center (PDC Global), 2020). The Borough recorded a poverty rate of 27.7 percent, 29.7 percent of the population with less than secondary education, 51.6 percent of households with no vehicle, 76.5 percent of households with no internet access, and 10.9 percent of the population with unmet housing need. It also ranked fourth nationally for clean water access vulnerability, with nearly 17 percent of households having inadequate toilet facilities, and fourth for information access vulnerability, largely because of low internet access and lower educational attainment. These conditions may affect how households receive notices, understand technical information, store water during service interruptions, access alternative supply arrangements or participate in grievance processes.

Penal/Debe also presents relevant vulnerability considerations within the wider S-IAoI. It recorded a lower overall vulnerability score than the Borough of Siparia, but very low coping capacity. Environmental stress and gender inequality were identified as key drivers of vulnerability, while communications capacity and economic capacity were among the weaker coping-capacity areas (Pacific Disaster Center (PDC Global), 2020). Household-level environmental issues included drainage problems affecting 32.0 percent of households and flooding affecting 22.4 percent. Penal/Debe also recorded 67.7 percent of households with no internet access, 37.6 percent with no vehicle, a poverty rate of 12.0 percent, and 29.9 percent of the population with less than secondary education. These conditions provide wider context for the Mendez Village portion of the S-DAoI and for households in the broader S-IAoI that may depend on the Siparia water supply system.

The broader vulnerability assessment literature highlights the role of settlement conditions, environmental exposure and infrastructure reliability in shaping household sensitivity. Informal or low-income settlements in Trinidad and Tobago are often associated with limited access to basic amenities, weaker housing conditions, inadequate sanitation and limited risk-transfer mechanisms. Where households are also exposed to flooding, poor drainage, water contamination or infrastructure constraints, these conditions can compound the effects of temporary service disruptions. These background vulnerabilities are relevant to understanding communication access, service continuity, sensitive receptors and the inclusion of poorer or less-connected households in project information flows.

Water-resource vulnerability is particularly relevant to the Siparia WTP project. National vulnerability assessments identify water resources as sensitive to changing rainfall patterns, drought, intense rainfall, sedimentation, pollution and water-quality deterioration (Clarke et al., 2019). Reduced rainfall and longer dry spells can affect freshwater availability, while intense rainfall can increase runoff, sedimentation and contamination risks. These factors have implications for water treatment, supply reliability and household resilience. Improvements in reliability, treatment performance and operational resilience may provide broader social benefits, while temporary interruptions or changes in service may be more difficult for households with low storage capacity, chronic illness, disability, children, older persons or limited access to transport and communication.

Taken together, the vulnerability profile of the S-AoI is shaped by age, health status, disability, household composition, income, transport access, digital access, water and sanitation

conditions, drainage and flood exposure, and wider institutional coping capacity. The vulnerable groups most relevant to the Siparia WTP Refurbishment and Upgrading Project include older persons, persons with chronic illnesses, persons with disabilities, children and caregiving households, single-person households, low-income households, households with limited access to transport or internet, and households already affected by water, sanitation, drainage, flooding or housing constraints. These patterns provide a baseline for later assessment of service interruptions, communication needs, stakeholder engagement, access arrangements and household sensitivity during refurbishment works.

4.4.2.2 Socio-Cultural Context

Section 4.4.2.2 describes the socio-cultural context of the S-AoI, focusing on ethnicity, religious affiliation, and safety and security conditions within Siparia and Mendez Village (S-DAoI) and the wider Borough of Siparia and Penal/Debe Regional Corporation (S-IAoI). The section reflects the plural character of Trinidad and Tobago's population and the ways in which ethnic, religious, cultural and community identities vary across the south-western municipalities and directly affected communities. It draws primarily on the 2011 Population and Housing Census for ethnicity and religious affiliation, and on reported crime data from the Trinidad and Tobago Police Service, supplemented by relevant secondary sources, to describe the wider safety and security context (Central Statistical Office of Trinidad and Tobago, 2012a; Crime and Problem Analysis Branch of the Trinidad and Tobago Police Service, 2023). These socio-cultural patterns provide context for understanding community identity, local networks, information flows, and conditions that may be relevant to later stakeholder engagement and impact assessment.

Ethnic Composition

The ethnic composition of the S-IAoI reflects the historically diverse settlement patterns of south-western Trinidad, with a strong concentration of persons of East Indian descent across the wider municipal area. In 2011, persons of East Indian descent accounted for 60.1 percent of the S-IAoI population, substantially higher than the national figure of 37.8 percent. Persons of African descent represented 22.7 percent of the S-IAoI population, compared with 36.5 percent nationally. Persons of mixed ethnicity accounted for 16.5 percent of the S-IAoI population, comprising 6.2 percent Mixed – African/East Indian and 10.3 percent Mixed – Other. Other ethnic groups, including Caucasian, Chinese, Indigenous, Portuguese, Syrian/Lebanese and other categories, each accounted for less than 1 percent of the S-IAoI population.

There was notable variation between the two municipalities within the S-IAoI. Penal/Debe Regional Corporation had a more pronounced East Indian majority, with persons of East Indian descent accounting for 75.1 percent of the population. Persons of African descent accounted for 12.8 percent, while persons of mixed ethnicity accounted for 11.3 percent. By contrast, the Borough of Siparia had a more ethnically mixed profile. Persons of East Indian descent formed the largest group, at 45.1 percent, followed by persons of African descent at 32.7 percent and persons of mixed ethnicity at 21.6 percent. The higher proportions of African and mixed ethnic groups in Siparia distinguish its population profile from Penal/Debe, although persons of East Indian descent remained the largest single ethnic group across both municipalities.

Within the S-DAoI, the ethnic composition was more evenly distributed across the three largest groups than in the wider S-IAoI. Persons of African descent accounted for the largest share of the S-DAoI population, at 32.5 percent, followed by persons of mixed ethnicity at 39.1 percent when the Mixed – African/East Indian and Mixed – Other categories are combined. Persons of East Indian descent accounted for 27.8 percent. This contrasts with the wider S-IAoI, where persons of East Indian descent formed a clear majority. Other ethnic groups were minimally represented in the S-DAoI, with Chinese persons accounting for 0.3 percent, Indigenous persons for 0.1 percent, and other ethnic groups for 0.1 percent.

Community-level patterns show a marked contrast between Siparia and Mendez Village. Siparia had a predominantly African and mixed ethnic profile, with persons of African descent accounting for 37.0 percent of the population and persons of mixed ethnicity accounting for 45.0 percent, comprising 9.4 percent Mixed – African/East Indian and 35.6 percent Mixed – Other. Persons of East Indian descent represented 17.3 percent of Siparia's population. Mendez Village, by contrast, had a strong East Indian majority, with persons of East Indian descent accounting for 72.6 percent of the population. Persons of African descent accounted for 13.1 percent, while persons of mixed ethnicity accounted for 13.9 percent. The ethnic profile of Mendez Village therefore more closely resembles the wider Penal/Debe pattern, while Siparia reflects a more mixed local settlement profile.

Table 4-8: Siparia WTP Refurbishment and Upgrade S-AoI Ethnic Composition

Ethnic Group	Population (%)						
	Trinidad and Tobago	S-IAoI	Siparia Regional Corp.	Penal/ Debe Regional Corp.	S-DAoI	Siparia	Mendez Village
African	36.5	22.7	32.7	12.8	32.5	37.0	13.1
Caucasian	0.6	0.1	0.0	0.3	0.0	0.0	0.0
Chinese	0.3	0.2	0.2	0.3	0.3	0.4	0.0
East Indian	37.8	60.1	45.1	75.1	27.8	17.3	72.6
Indigenous	0.1	0.2	0.3	0.1	0.1	0.0	0.3
Mixed - African/East Indian	8.2	6.2	7.0	5.3	8.9	9.4	6.9
Mixed - Other	16.2	10.3	14.6	6.0	30.2	35.6	7.0
Portuguese	0.1	0.0	0.0	0.0	0.0	0.0	0.1
Syrian/ Lebanese	0.1	0.0	0.0	0.0	0.0	0.0	0.0
Other ethnic group	0.2	0.1	0.1	0.1	0.1	0.2	0.0

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

The S-DAoI is ethnically diverse, with distinct community-level concentrations. Siparia is characterised by a larger African and mixed ethnic population, while Mendez Village is predominantly East Indian. Ethnicity in Trinidad and Tobago often intersects with settlement history, religious affiliation, cultural practices, festivals, foodways, social networks and

community identity. In the S-DAoI, the contrast between Siparia's predominantly African and mixed-ethnic profile and Mendez Village's predominantly East Indian profile provides context for understanding the distinct cultural and community networks within the directly affected communities.

Religious Composition

Religious affiliation within the S-AoI reflects the pluralistic religious landscape of Trinidad and Tobago and broadly corresponds with the ethnic composition of the wider south-western project setting. Christianity and Hinduism were the dominant religious traditions across both the S-IAoI and S-DAoI, although their relative prominence differed between the wider municipal area and the directly affected communities.

Table 4-9: Siparia WTP Refurbishment and Upgrade S-AoI Religious Composition

Religious Group	Population (%)						
	Trinidad and Tobago	S-IAoI	Siparia Regional Corp.	Penal/ Debe Regional Corp.	S-DAoI	Siparia	Mendez Village
Anglican	6.4	3.7	5.1	2.4	4.6	5.5	0.8
Spiritual Shouter Baptist	6.4	5.5	8.2	2.9	5.1	6.1	0.9
Baptist - Other	1.4	1.2	1.6	0.9	1.1	1.3	0.3
Hinduism	20.4	36.6	25.9	46.9	16.7	7.1	56.4
Islam	5.6	5.8	4.3	7.3	1.9	2.1	0.9
Jehovah's Witness	1.7	1.2	1.4	0.9	1.5	1.6	1.3
Methodist	0.7	0.2	0.2	0.1	0.3	0.3	0.0
Pentecostal/Evangelical/ Full Gospel	17.6	17.2	16.3	18.0	16.6	16.4	17.3
Moravian	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Orisha	1.0	0.5	0.8	0.3	0.2	0.2	0.0
Presbyterian/Congregational	2.8	4.9	4.0	5.8	4.2	4.3	3.6
Rastafarian	0.3	0.3	0.4	0.1	0.3	0.4	0.0
Roman Catholic	24.3	14.7	20.4	9.3	33.8	39.0	12.1
Seventh-day Adventist	4.6	2.5	3.9	1.1	5.9	7.1	1.0
Other	4.1	4.3	5.6	3.0	6.0	6.3	4.8
None	2.5	1.3	1.7	1.0	2.0	2.3	0.8

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

Within the S-IAoI, Christian denominations collectively accounted for 51.1 percent of the population, while Hinduism accounted for 36.6 percent. Islam represented 5.8 percent of the S-IAoI population. Smaller shares of the population were affiliated with other religions, including Orisha (0.5%) and Rastafarianism (0.3%), while 1.3 percent reported no religious affiliation. The religious profile varied between the two municipalities. In the Borough of Siparia, Christian denominations represented 61.2 percent of the population, compared with 41.5 percent in Penal/Debe Regional Corporation. Hinduism was more prominent in Penal/Debe, where it accounted for 46.9 percent of the population, compared with 25.9 percent in the Borough of

Siparia. Islam was also more prevalent in Penal/Debe (7.3%) than in the Borough of Siparia (4.3%).

Within the S-DAoI, Christianity was the most widely reported religious tradition, accounting for 73.0 percent of the population. Hinduism accounted for 16.7 percent, while Islam represented 1.9 percent. Persons reporting other religious affiliations accounted for 6.0 percent, and 2.0 percent reported no religious affiliation. Compared with the wider S-IAoI, the S-DAoI therefore had a stronger Christian profile and a lower proportion of Hindus and Muslims.

Christian affiliation within the S-DAoI was diverse. Roman Catholicism was the largest single denomination, accounting for 33.8 percent of the S-DAoI population, followed by Pentecostal/Evangelical/Full Gospel denominations (16.6%), Seventh Day Adventists (5.9%), Baptists, including Spiritual Shouter Baptists and other Baptists (6.2%), Anglicans (4.6%), Presbyterians/Congregationalists (4.2%), Jehovah's Witnesses (1.5%) and Methodists (0.3%). The S-DAoI had a higher proportion of Roman Catholics than both the S-IAoI (14.7%) and the national population (24.3%). Pentecostal/Evangelical/Full Gospel affiliation was broadly comparable across the S-DAoI (16.6%), S-IAoI (17.2%) and national population (17.6%).

Community-level patterns show a strong contrast between Siparia and Mendez Village. Siparia had a predominantly Christian religious profile, with Christian denominations collectively accounting for 81.6 percent of the population. Roman Catholics formed the largest single group in Siparia, at 39.0 percent, followed by Pentecostal/Evangelical/Full Gospel denominations (16.4%), Seventh Day Adventists (7.1%), Spiritual Shouter Baptists (6.1%), Anglicans (5.5%) and Presbyterians/Congregationalists (4.3%). Hinduism accounted for 7.1 percent of Siparia's population, while Islam accounted for 2.1 percent.

Mendez Village, by contrast, had a predominantly Hindu religious profile, with Hinduism accounting for 56.4 percent of the population. Christian denominations collectively accounted for 37.2 percent, with Pentecostal/Evangelical/Full Gospel denominations representing the largest Christian grouping (17.3%), followed by Roman Catholics (12.1%) and Presbyterians/Congregationalists (3.6%). Islam accounted for 0.9 percent of the Mendez Village population. The religious profile of Mendez Village broadly corresponds with its East Indian ethnic majority, while Siparia's Christian profile is consistent with its higher proportions of African and mixed ethnic groups.

The religious composition of the S-DAoI is characterised by a strong Christian presence in Siparia and a strong Hindu presence in Mendez Village. Religious affiliation in Trinidad and Tobago often intersects with community identity, cultural observances, festivals, family networks, and local institutions. In the S-DAoI, the contrast between Siparia's predominantly Christian profile and Mendez Village's predominantly Hindu profile provides context for understanding community organisation, local observances, and potential channels through which information may circulate.

Safety and Security

Safety and security conditions within the S-AoI for the Siparia WTP Refurbishment and Upgrading Project are shaped primarily by crime dynamics within the South Western Police Division, which

encompasses the project's S-DAoI communities of Siparia and Mendez Village, as well as the wider south-western policing context. Reported crime data for the period January 2015 to December 2025 provide an indication of the main categories of offences recorded in the division and the broad security conditions within which project activities would occur. For 2024 and 2025, individual yearly data were not available; therefore, the most recent period is presented as a combined 2024–2025 total.

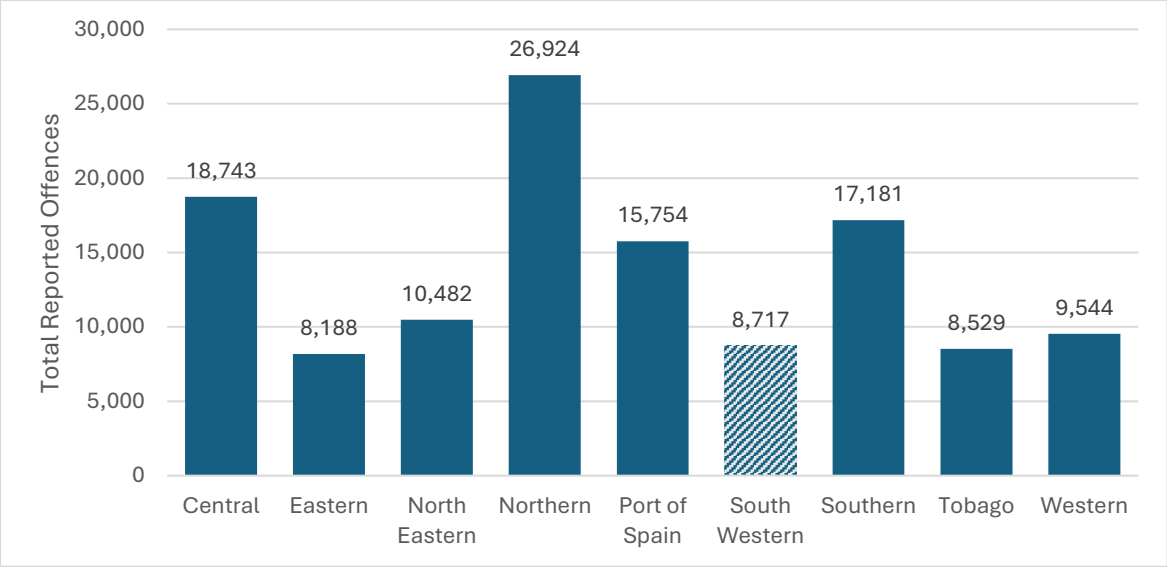


Figure 4-29: January 2015 to December 2025 Total Reported Serious/Major Offences Among Police Divisions
Source: Crime and Problem Analysis Branch of the Trinidad and Tobago Police Service. (2026). Total Crime by Division Report

Between January 2015 and December 2025, the South Western Division recorded 8,717 reported offences, accounting for 7.0 percent of all reported offences nationally. This placed the division below the higher-volume Northern, Central, Southern and Port of Spain Divisions, but broadly comparable with Tobago and the Eastern and Western Divisions in terms of overall reported crime volume. The division's crime profile was dominated by property-related offences and violent offences, which together accounted for the majority of recorded incidents.

Property crime accounted for 3,443 reported offences in the South Western Division, representing 39.5 percent of all offences recorded in the division. Burglaries and break-ins were the largest single offence category, with 1,743 incidents, or 20.0 percent of all divisional offences. General larceny accounted for 1,124 incidents (12.9%), while larceny of dwelling houses and larceny of motor vehicles accounted for smaller shares, at 126 incidents (1.4%) and 207 incidents (2.4%), respectively. The prominence of burglaries and general larceny points to a reported crime profile in which household, commercial and property-security concerns form a central part of the local safety context.

Violence and violent crime accounted for 2,702 reported offences, or 31.0 percent of all offences in the South Western Division. Robberies were the largest component of this category, with 1,754 incidents recorded between 2015 and 2025, representing 20.1 percent of reported offences in the division. Woundings and shootings accounted for 484 incidents (5.6%), while murders

accounted for 339 incidents (3.9%). Serious indecency accounted for 31 reported incidents (0.4%). Firearm-related offences were also present within the divisional profile, with 732 cases of possession of firearms and ammunition, representing 8.4 percent of reported offences. These figures indicate that violent crime, particularly robbery and firearm possession, formed a significant component of reported safety and security conditions in the division.

Sexual offences represented 688 reported incidents in the South Western Division, accounting for 7.9 percent of all reported offences. This included offences recorded under rape, incest and sexual offences. Narcotics offences accounted for 479 incidents, or 5.5 percent of reported offences. Other offences accounted for 673 incidents, representing 7.7 percent. While these categories accounted for smaller proportions than property crime and violent crime, they remain part of the wider social and community safety context in the S-AoI.

In proportional terms, the South Western Division accounted for 7.0 percent of total reported offences nationally during the period. Its share of national burglaries and break-ins was higher, at 8.9 percent, and its share of possession of firearms and ammunition offences was also relatively elevated, at 7.6 percent. The division accounted for 7.5 percent of rape, incest and sexual offences nationally, 6.3 percent of murders, 6.6 percent of robberies, and 7.0 percent of narcotics offences. These figures place the South Western Division within a moderate national crime context, with particular concentration in property-related offences and some firearm-related and sexual offence categories.

Reported offences varied over time. Annual reported crime totals in the South Western Division ranged from 559 offences in 2021 to 1,041 offences in 2018, before the combined 2024–2025 period recorded 1,351 offences. Reported offences declined in 2020 and 2021, with 629 and 559 offences respectively, following higher totals in 2018 (1,041) and 2019 (929). The decline coincided with the COVID-19 pandemic period, when public health restrictions, changes in mobility, altered routine activities, and possible changes in reporting or enforcement patterns may have influenced reported crime levels. Reported offences subsequently increased to 820 in 2022 and 796 in 2023. The combined 2024–2025 total suggests continued reporting of offences in the most recent period, although the absence of separate annual totals limits direct year-to-year comparison with earlier years.

Changes in offence composition were also evident across the period. Burglaries and break-ins declined from 231 incidents in 2015 and 219 in 2016 to 121 in 2023, then rose to 191 incidents for the combined 2024–2025 period. Robberies decreased from 203 incidents in 2016 and 190 in 2019 to 106 in 2021 during the pandemic period, then increased to 151 in 2022, 145 in 2023, and 297 in the combined 2024–2025 period. Possession of firearms and ammunition increased from no recorded cases in 2015 and 2016 to 94 in 2017, 104 in 2018, 98 in 2023 and 169 in the combined 2024–2025 period. Sexual offences also increased in the most recent available period, with 122 incidents in 2023 and 173 incidents in the combined 2024–2025 period, compared with 24 incidents in 2021 and 81 in 2022. These patterns should be interpreted cautiously, as reported offences reflect both underlying crime conditions and factors affecting reporting, policing activity and mobility during and after the pandemic period.

Recent reporting and organised crime assessments provide additional context for interpreting these divisional crime patterns within the South Western Division. Reporting and national organised crime assessments consistently identify the south-western peninsula as an area affected by trafficking activity, firearms movement and transnational criminal networks linked to maritime access routes and proximity to Venezuela. A 2019 intelligence-based media report identified the South Western Division as an area affected by established drug trafficking, firearms trafficking and the smuggling of Latin American women, with references to criminal activity in communities including La Brea, Los Bajos/Santa Flora and Erin(Bassant, 2019). The report described the south-western peninsula as an area where gang activity and trafficking networks intersect with coastal access routes and local recruitment patterns.

Similarly, the 2025 Global Organized Crime Index profile for Trinidad and Tobago identified cocaine trafficking, cannabis trafficking, arms trafficking and human trafficking as significant criminal markets nationally(Global Initiative Against Transnational Organized Crime, 2025). The report highlighted vulnerabilities associated with porous maritime borders, proximity to Venezuela and trafficking routes affecting south-western coastal areas. It also noted that human trafficking involving women and girls from Venezuela and other Latin American countries may be facilitated through maritime access points and informal transport networks, factors considered relevant to the broader south-western security environment.

More recent reporting in 2025 cited senior police officials as identifying increasing Venezuelan involvement in criminal activity affecting the south-western peninsula, particularly in relation to narcotics, firearms and human trafficking (Mc Burnie, 2025). The article noted that police attention had intensified in the South Western Division because of its proximity to Venezuela and concerns regarding the movement of criminal operations into communities within the division. These reports should be interpreted as contextual information regarding broader divisional security dynamics rather than as community-level crime statistics for Siparia or Mendez Village.

Additional reporting from communities within the South Western Division also provides insight into local perceptions of crime and insecurity. A June 2025 Newsday feature focusing on Fyzabad described resident concerns regarding increasing youth involvement in robberies, burglaries, violent offences and sexual assaults (Fraser, 2025). Residents interviewed associated these trends with unemployment, poverty, school disengagement, limited recreational opportunities and family instability. Community members also expressed concerns regarding declining perceptions of safety, reduced social cohesion and fear associated with violent incidents affecting residents and transport operators.

The article further highlighted broader social vulnerability factors identified by residents, educators and community representatives within the South Western Division, including father absenteeism, low literacy levels, limited employment pathways for youth and deterioration of recreational infrastructure. Several interviewees also suggested that some criminal activity involved persons using southwestern communities as temporary bases or transit locations. While these observations are anecdotal and do not constitute official crime statistics, they provide qualitative context regarding perceptions of insecurity and social stressors within communities located in the same policing division as the project area.

Recent reporting on police performance provides additional context regarding law enforcement conditions within the division. A 2024 report on evidence presented to Parliament's National Security Joint Select Committee noted that the South Western Division had one of the higher detection rates nationally, following the Eastern Division and Tobago (Williams, 2024). At the same time, the report acknowledged continuing concerns nationally regarding robberies, burglaries, break-ins and firearm-related offences. These observations align with the broader pattern shown in the South Western Division data, where property crime, robbery and firearm-related offences remain prominent within the reported crime profile.

The safety and security profile of the South Western Division therefore reflects a local context in which property crime, robbery, firearm-related offences, narcotics-related activity, sexual offences and wider trafficking concerns are important features of the baseline environment. Community reporting from areas such as Fyzabad also suggests that perceptions of insecurity are influenced not only by recorded crime but also by broader socio-economic conditions that affect youth engagement, employment opportunities, family structures, and community infrastructure. The S-DAoI communities of Siparia and Mendez Village are situated within a division that does not account for the highest volume of nationally reported crime, but where household and property security, personal safety, movement patterns, and law enforcement attention to south-western trafficking routes remain relevant to the wider social context. The reported crime profile provides context for understanding community perceptions of safety, routine mobility, protection of project materials and equipment, and the local security environment surrounding temporary works and site access.

4.4.2.3 Socio-economic conditions

Section 4.4.2.3 describes the socio-economic conditions of the S-AoI, focusing on education, local economy and livelihoods, business activity, labour market conditions, and poverty within Siparia and Mendez Village (S-DAoI) and the wider Borough of Siparia and Penal/Debe Regional Corporation (S-IAoI). The socio-economic profile reflects a south-western setting shaped by public services, small-scale commerce, agriculture, energy-sector activity, transport links, and rural and semi-rural settlement patterns. Siparia serves as the main service centre within the S-DAoI, while Mendez Village has a smaller, rural residential profile and greater dependence on nearby centres for employment, education, health, and commercial and public services.

The section draws primarily on the 2011 Population and Housing Census, the Municipality of Siparia and Penal/Debe Local Area Economic Profiles, the Siparia Municipal Development Plan, and relevant secondary sources to describe existing livelihood conditions, educational attainment, enterprise patterns, labour force characteristics and poverty-related vulnerability(All-inclusive Project Development Services Limited, 2010; Central Statistical Office of Trinidad and Tobago, 2012a; Central Statistics Office Trinidad and Tobago, 2014; Kairi Consultants Limited, 2016b, 2016a). Where data are not available at the community level, broader municipal, county or ward-level indicators are used cautiously to provide context.

Educational Landscape

Educational attainment within the S-IAoI indicates broad participation in formal schooling, with most residents having attained at least primary or secondary education. In 2011, secondary education was the most commonly reported highest level of educational attainment in the S-IAoI, accounting for 45.4 percent of the applicable non-institutional population. This was slightly higher than the national figure of 44.2 percent. Primary education accounted for 33.0 percent of the S-IAoI population, while 13.5 percent had attained tertiary education, comprising 6.3 percent at the tertiary/non-university level and 7.1 percent at the tertiary/university level. A further 2.4 percent had attained post-secondary education, while 2.2 percent reported no educational attainment.

Table 4-10: Key Education Indicators for Siparia WTP Refurbishment and Upgrade S-AoI

Administrative Area	Educational Attainment		Educational Qualifications	
	Secondary	Tertiary	None	GCE 'O'/CXC Gen/SC
Trinidad and Tobago	62.9	15.8	55.1	21.5
S-IAoI	61.6	13.5	56.6	21.7
Siparia Regional Corporation	61.2	11.9	56.8	22.8
Penal/Debe Regional Corporation	62.0	15.0	56.4	20.7
S-DAoI	62.0	11.9	56.4	22.2
Siparia	62.4	12.3	57.0	23.0
Mendez Village	60.4	10.5	53.8	18.3

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

Educational attainment varied modestly between the two municipalities. In the Borough of Siparia, 46.0 percent of the non-institutional population had attained secondary education, while 33.1 percent had attained primary education and 11.9 percent had attained tertiary education. Penal/Debe Regional Corporation recorded a similar secondary attainment level, at 44.8 percent, but had a higher tertiary attainment rate of 15.0 percent. The S-IAoI as a whole recorded 61.6 percent of the population with at least secondary education and 13.5 percent with tertiary education, compared with 62.9 percent and 15.8 percent nationally. These figures suggest that the wider S-IAoI broadly reflects national patterns in secondary attainment, although tertiary attainment was somewhat lower than the national average.

Gender differences in educational attainment were evident across the S-IAoI. Females were more likely than males to have attained tertiary education, with 14.7 percent of females in the S-IAoI attaining tertiary education compared with 12.3 percent of males. This pattern was also observed in both municipalities. In the Borough of Siparia, 13.3 percent of females had attained tertiary education, compared with 10.5 percent of males. In Penal/Debe, the corresponding figures were 16.0 percent for females and 14.0 percent for males. Secondary attainment was more evenly distributed by sex, with 61.7 percent of males and 61.5 percent of females in the S-IAoI having attained at least secondary education.

Within the S-DAoI, educational attainment was broadly comparable to the wider municipal context at the secondary level, but slightly lower at the tertiary level. Secondary education was the most common highest level attained, accounting for 48.0 percent of the S-DAoI population.

Primary education accounted for 32.4 percent, while tertiary education accounted for 11.9 percent, comprising 5.5 percent at the tertiary/non-university level and 6.2 percent at the tertiary/university level. The S-DAoI recorded 62.0 percent of the population with at least secondary education, similar to the S-IAoI figure of 61.6 percent, but its tertiary attainment rate was lower than both the S-IAoI (13.5%) and national (15.8%) figures.

At the community level, Siparia recorded a slightly stronger secondary and tertiary profile than Mendez Village. In Siparia, 47.8 percent of the non-institutional population had attained secondary education, while 31.3 percent had attained primary education and 12.3 percent had attained tertiary education. In Mendez Village, secondary education accounted for 48.9 percent of the population and primary education for 37.1 percent, while tertiary education accounted for 10.5 percent. Mendez Village therefore had a higher concentration at the primary and secondary levels, while Siparia had a somewhat higher share of residents who had progressed to tertiary education.

The qualification profile shows that formal certification remained limited across the S-IAoI and S-DAoI. In the S-IAoI, 56.6 percent of the population reported no educational qualification, slightly higher than the national figure of 55.1 percent. The most common qualifications were GCE 'O' Level/CXC General/School Certificate passes, held by 21.7 percent of the S-IAoI population, followed by diploma or equivalent certificates of achievement (7.0%), school leaving certificates (3.8%), bachelor's degrees (2.8%), GCE 'A' Level/CAPE/HSC qualifications (2.6%), CXC Basic qualifications (2.1%), associate degrees or higher diplomas (1.8%), master's degrees (0.6%), postgraduate diplomas or professional qualifications (0.3%) and doctorates (0.1%).

Qualification levels differed between the Borough of Siparia and Penal/Debe Regional Corporation. The share of residents with no educational qualifications was similar in both municipalities, at 56.8 percent in the Borough of Siparia and 56.4 percent in Penal/Debe. The Borough of Siparia recorded a slightly higher share of GCE 'O' Level/CXC General/School Certificate qualifications, at 22.8 percent, compared with 20.7 percent in Penal/Debe. Penal/Debe recorded higher proportions of residents with bachelor's degrees (3.5%) and tertiary-level qualifications generally, consistent with its higher tertiary attainment rate.

Within the S-DAoI, 56.4 percent of the population reported no educational qualification, similar to the S-IAoI figure. GCE 'O' Level/CXC General/School Certificate qualifications accounted for 22.2 percent, followed by diploma or equivalent certificates of achievement (5.8%), school leaving certificates (3.7%), CXC Basic qualifications (3.4%), GCE 'A' Level/CAPE/HSC qualifications (2.7%), associate degrees or higher diplomas (2.1%) and bachelor's degrees (2.0%). Higher-level qualifications were less common, with master's degrees, postgraduate diplomas or professional qualifications, and doctorates together accounting for less than 1 percent of the S-DAoI population.

Siparia recorded a higher share of persons with no educational qualifications than Mendez Village, at 57.0 percent compared with 53.8 percent. However, Siparia also recorded a higher proportion of GCE 'O' Level/CXC General/School Certificate qualifications, at 23.0 percent, compared with 18.3 percent in Mendez Village. Mendez Village had higher proportions of school

leaving certificates (6.3%) and CXC Basic qualifications (10.1%), while both communities recorded relatively low levels of advanced qualifications. Bachelor's degrees accounted for 2.0 percent of the population in Siparia and 1.9 percent in Mendez Village.

The education profile of the S-DAoI points to widespread completion of primary and secondary schooling, alongside more modest progression to tertiary education and limited levels of formal certification beyond secondary-level qualifications. The pattern is broadly consistent with the S-IAoI, although tertiary attainment in the directly affected communities was below both the S-IAoI and national levels. Within the S-DAoI, Siparia had a somewhat stronger tertiary and CXC-level qualification profile, while Mendez Village had a larger share of residents concentrated at the primary and secondary levels.

Local Economy and Livelihoods

The local economy within the S-IAoI is shaped by a combination of small-town commercial activity, rural livelihoods, agriculture, energy-linked activity, public services, construction, transport, fishing, and small-scale enterprise. Economic activity is organised around local service centres and surrounding rural communities, with Siparia serving as a key administrative and commercial node within the Borough of Siparia, and Penal and Debe functioning as important settlement and service centres within the Penal/Debe Regional Corporation. The wider S-IAoI is also influenced by its proximity to San Fernando and other larger urban centres, which support commuting, access to higher-order services, and labour mobility beyond municipal boundaries(All-inclusive Project Development Services Limited, 2010; Kairi Consultants Limited, 2016a, 2016b; Parliament of Trinidad and Tobago, 2015a, 2015b)

The Siparia economy is diversified but uneven. The Siparia Municipal Development Plan describes the region as having a mixture of land uses, including settlements of varying sizes, onshore areas and bases for offshore oil production, ports, industrial areas, fishing centres, forests, swamps, agriculture, and beaches extending along the south-western coastline (APDSL, 2010). Economic activity in the wider municipality includes mining and industrial operations at La Brea and Brighton, marine fishing along the south-western and southern coasts, onshore oil production in the Palo Seco and Forest Reserve areas, offshore oil production, and agricultural production dispersed throughout central parts of the region (All-inclusive Project Development Services Limited, 2010). Siparia is identified as the administrative capital and main service centre of the municipality, while San Fernando and Port of Spain provide higher-order regional and national services (All-inclusive Project Development Services Limited, 2010; Parliament of Trinidad and Tobago, 2015b).

Energy and industrial activity are among the main pillars of the wider Siparia economy. Established petroleum, asphalt, industrial and port-related activities contribute directly and indirectly to employment, contracting opportunities, spending on goods and services, transport services, maintenance activities and small business activity. Energy is one of the municipality's strategic sectors for local economic development, alongside agriculture and food production, eco-, heritage and cultural tourism, and commerce and distribution (Kairi Consultants Limited, 2016a). These activities are concentrated in particular parts of the municipality rather than being evenly distributed across all communities.

Agriculture remains an important feature of the Siparia economic landscape, although its role has changed over time. Farming activity is present across several communities, and available lands for pasture, agriculture and related activities are identified as an important regional asset (All-inclusive Project Development Services Limited, 2010). At the same time, the municipal development planning literature identifies constraints such as unemployment, poverty, infrastructure limitations, skills gaps and remoteness from major centres. Evidence presented during the parliamentary review of the Siparia Regional Corporation also noted a decline in farming, partly associated with more young persons moving into clerical and administrative work, as well as a decline in the coconut industry, although discussions had been held with the Ministry of Food Production regarding its revival (Parliament of Trinidad and Tobago, 2015b).

Fishing and coastal livelihoods are also part of the Borough of Siparia's economic profile. The municipality includes an extensive coastline, fishing centres, ports and coastal communities, with economic activity linked to fishing, marine access, beach use, transport and coastal services. Coastal resources also support domestic tourism and recreation, particularly in coastal settlements such as Cedros, Icacos, Erin, Los Iros and other communities along the south-western coastline. The Siparia Municipal Development Plan identifies beaches, wetlands, marshes, forest reserves, wildlife habitats and archaeological sites as resources with tourism potential, while also noting issues such as inadequate maintenance, flooding, drainage problems, coastal erosion, pollution and oil spills as constraints (All-inclusive Project Development Services Limited, 2010).

Tourism and cultural activity provide additional opportunities for economic diversification in Siparia. Cultural events, religious pilgrimages, beaches, forests, wetlands and the municipality's historical and cultural heritage contribute to its tourism potential. Siparia Fete, Easter celebrations associated with La Divina Pastora/Soparee Mai, attractive beaches, forests, wetlands, marshes, remoteness and a strong historical base are among the region's development assets (APDSL, 2010). Eco-, heritage and cultural tourism have also been identified as a strategic sector for local economic development (Kairi Consultants Limited, 2016a). These assets are complemented by local cultural institutions and initiatives, including the Siparia Chamber of Commerce, the Siparia Inter-Religious Group, the Daisy Voisin Hub and efforts to develop a strategic plan for domestic tourism (Parliament of Trinidad and Tobago, 2015b).

Commercial activity in Siparia is concentrated largely in traditional retail, distribution and personal service activities. Commercial business activity in the region has been described as relatively limited in national terms and largely restricted to consumer-type distribution and personal services, which tend to be lower-value activities and do not employ large numbers of persons (All-inclusive Project Development Services Limited, 2010). Business development is therefore an important area for strengthening tourism, agriculture, fisheries, and other primary-sector activities, since local producers and service providers require greater enterprise capacity to capitalise on economic opportunities. MSME development and the creation of a stronger business-enabling environment remain central to local economic development in the municipality (Kairi Consultants Limited, 2016a).

Penal/Debe Regional Corporation has a traditionally agricultural character but has experienced increasing business activity over time. The northern part of the municipality is close to San Fernando and readily accessible to major transportation facilities, with substantial residential communities whose residents commute to job opportunities in larger town centres. Further south, the local economy is more strongly associated with fruit and vegetable production and processing, and with small-scale businesses and industries such as woodworking, carpentry, electrical products, and transportation, while deeper southern areas are more sparsely settled and have more limited accessibility (Parliament of Trinidad and Tobago, 2015a). Agriculture and food, industrial and commercial activity, eco- and cultural tourism, and commerce and distribution are important areas for local economic development in Penal/Debe (Kairi Consultants Limited, 2016b).

Agriculture is central to Penal/Debe's livelihood profile. The municipality's rural areas support crop production, small and medium farming operations, and associated transport and market linkages. Fruit and vegetable production is particularly important in the southern and more rural parts of the municipality, while small-scale businesses and cottage-type industries, including woodworking and carpentry, complement the agricultural base and provide opportunities for employment and self-employment (Kairi Consultants Limited, 2016b; Parliament of Trinidad and Tobago, 2015a). Local economic development in Penal/Debe is also oriented toward strengthening MSMEs and improving collaboration among local government, civil society, private-sector actors and communities (Kairi Consultants Limited, 2016b).

Commercial and service activities are important across both municipalities, although the data available are stronger at the municipal level than at the individual community level. Siparia town, Penal and Debe serve as local centres for retail, transport, public services, small businesses, food outlets, repair services and other commercial functions. These activities support daily household needs and provide employment opportunities in sales, administration, personal services, transport, food preparation, construction and informal enterprise. Local business organisations, community initiatives and enterprise-support programmes provide a basis for strengthening the local business environment, particularly for MSMEs (Kairi Consultants Limited, 2016b, 2016a; Parliament of Trinidad and Tobago, 2015a, 2015b).

Public-sector employment and municipal services also contribute to the S-IAoI economy. Municipal corporations, schools, health services, police, public utilities, social services and other government agencies provide direct employment and support demand for ancillary services. Infrastructural works, drainage maintenance, road works, public health services, waste management, disaster management, maintenance of recreation grounds and short-term employment programmes such as URP and CEPEP also contribute to local employment and income circulation (Parliament of Trinidad and Tobago, 2015a, 2015b). These forms of employment are particularly relevant in rural and semi-rural communities where private-sector opportunities may be more limited.

At the S-DAoI level, the available evidence supports a more cautious interpretation. Siparia is the principal settlement within the S-DAoI and is documented as the administrative capital and main service centre of the wider municipality (All-inclusive Project Development Services Limited,

2010; Parliament of Trinidad and Tobago, 2015b). Its local economy is therefore likely to be more closely associated with retail and distribution, personal services, public administration, transport, construction, small-business activity, and commuting to employment outside the immediate community. Mendez Village forms a smaller settlement within the S-DAoI. In the absence of detailed community-level livelihood data for Mendez Village, it can only be inferred that local livelihoods likely reflect the surrounding rural-residential and commuting hinterland, with possible links to agriculture, construction, services, small-scale enterprises, household-based economic activity, and employment outside the community.

The local economy is influenced by transport connectivity and access to basic infrastructure. Siparia's role as a service centre depends on road access from surrounding communities, while Penal/Debe's northern areas benefit from proximity to San Fernando and major transport corridors. In Siparia, transportation capacity is constrained by road infrastructure affected by flooding, poor drainage and the demands placed on roads by heavy vehicles serving the energy sector (Pacific Disaster Center (PDC Global), 2020). In Penal/Debe, major road corridors such as the SS Erin Road, Penal Rock Road, and Clarke Road support mobility, access to services, and economic activity, while public transport limitations affect night-time travel and access in some areas (Parliament of Trinidad and Tobago, 2015a).

Economic diversification remains an important theme across the S-IAoI. In Siparia, the main diversification opportunities are linked to primary production, tourism, and the development of small and medium-sized businesses (All-inclusive Project Development Services Limited, 2010). Energy, agriculture and food, eco-, heritage and cultural tourism, and commerce and distribution also form strategic sectors for local economic development (Kairi Consultants Limited, 2016a). In Penal/Debe, comparable opportunities exist in agriculture and food, industrial and commercial activities, tourism, commerce and distribution, and are supported by local institutions, enterprise development, and partnerships with agencies involved in MSME support (Kairi Consultants Limited, 2016b). Economic capacity and transportation capacity constraints in the S-IAoI, including low labour force participation and limited financial institution access in both municipalities, may affect household income generation and enterprise development (Pacific Disaster Center (PDC Global), 2020).

The livelihood profile of the S-AoI is mixed, combining documented municipal-level economic activities and inferred community-level livelihood patterns. Siparia's wider municipal economy is shaped by administrative, commercial, coastal, industrial and energy-sector functions, while Penal/Debe combines agricultural livelihoods, small-scale enterprise, commuting and business activity. Within the S-DAoI, Siparia is the more clearly documented service node, while Mendez Village appears to form part of the smaller rural-residential and commuting hinterland. The available planning and economic profile documents describe an area with substantial natural, cultural and enterprise assets, alongside constraints related to infrastructure, skills development, business formation, market access, drainage, transport and uneven diversification.

Business Profile

The business profile of the S-IAoI reflects a local economy dominated by micro and small establishments, with business activity concentrated in the main settlement and service centres. Two data sources are relevant to the profile: the 2018 CSO Business Surveys Establishment Register and the 2011 Population and Housing Census Community Register. These sources are not directly equivalent, as the 2018 dataset records business "establishments," while the 2011 Census records business "places." Firms are also not obligated to inform the CSO when operations commence or cease, and the establishment register is updated mainly from secondary sources. Differences between the two datasets should therefore be interpreted as reflecting timing, definitions, business turnover and possible undercounting of very small, informal or home-based activity, rather than as a direct measure of business growth or decline (Central Statistics Office Trinidad and Tobago, 2018, 2021).

In 2018, there were 26,046 business establishments in Trinidad and Tobago. The S-IAoI accounted for 2,506 establishments, or 9.6 percent of the national total. Penal/Debe accounted for 1,426 establishments, representing 5.5 percent of the national total and 56.9 percent of establishments in the S-IAoI. Siparia accounted for 1,080 establishments, representing 4.1 percent of the national total and 43.1 percent of establishments in the S-IAoI (Central Statistics Office Trinidad and Tobago, 2018).

In 2011, 4,629 business places were recorded across the S-IAoI, comprising 2,593 in Penal/Debe and 2,036 in Siparia. Penal/Debe therefore accounted for 56.0 percent of business places in the S-IAoI, while Siparia accounted for 44.0 percent. This distribution is broadly consistent with the 2018 establishment register, in which Penal/Debe also accounted for a larger share of the two-municipality business base. The 2011 dataset, however, provides a more detailed view of the spatial distribution of business places across communities (Central Statistics Office Trinidad and Tobago, 2021).

Within the Siparia administrative area, business places were widely distributed but concentrated in a limited number of larger settlements and service nodes. Siparia recorded the highest number of business places in the municipality, with 301 business places, equivalent to 14.8 percent of the municipal total. Other notable concentrations were recorded in Fyzabad (135; 6.6%), Aripero Village (94; 4.6%), Dow Village (85; 4.2%) and La Brea (74; 3.6%). Together, these five communities accounted for 33.8 percent of all business places in the municipality. When Pepper Village, Thick Village, Delhi Settlement, San Francique and Oropouche are included, the ten largest business concentrations accounted for 48.3 percent of the municipal total. Siparia's position as the largest individual concentration of business places is consistent with its role as the administrative capital and main service centre of the municipality (All-inclusive Project Development Services Limited, 2010; Central Statistics Office Trinidad and Tobago, 2021).

In Penal/Debe, business places were more strongly concentrated in a smaller number of settlements. Penal recorded the largest number of business places, with 636, representing 24.5 percent of the municipal total. This was followed by Debe Proper (298; 11.5%), La Romain (275; 10.6%), Barrackpore (247; 9.5%) and Duncan Village (226; 8.7%). These five communities accounted for 64.9 percent of all business places recorded in Penal/Debe. The ten largest

concentrations accounted for 79.5 percent of the municipal total, indicating a more concentrated business geography than in Siparia. This pattern corresponds with the municipality's settlement structure, in which Penal, Debe and other larger communities serve as key local commercial and service centres, while more rural and southern communities have smaller documented business bases (Central Statistics Office Trinidad and Tobago, 2021; Kairi Consultants Limited, 2016b; Parliament of Trinidad and Tobago, 2015a).

The S-DAoI accounted for 318 business places in 2011, representing 6.9 percent of all business places recorded across the two S-IAoI municipalities. Siparia accounted for 301 of these business places, or 94.7 percent of the S-DAoI total, while Mendez Village accounted for 17 business places, or 5.3 percent. Within its respective municipality, Siparia accounted for 14.8 percent of all business places in the Siparia administrative area. Mendez Village accounted for 0.7 percent of all business places recorded in Penal/Debe. The S-DAoI business profile is therefore heavily weighted toward Siparia, while Mendez Village has a small documented commercial footprint within the wider Penal/Debe business distribution (Central Statistics Office Trinidad and Tobago, 2021).

The 2018 establishment data show that businesses in both S-IAoI municipalities were predominantly micro and small in scale. In Siparia, 60.8 percent of establishments with available employment-size data were in the 0–1 employee category, followed by 16.0 percent with 2–4 employees, 8.3 percent with 5–9 employees, 7.3 percent with 10–24 employees and 3.1 percent with 25–49 employees. Collectively, establishments with fewer than 50 employees accounted for 95.5 percent of classified establishments in Siparia, while establishments with 50 or more employees accounted for 2.9 percent. In Penal/Debe, 45.7 percent of establishments were in the 0–1 employee category, followed by 23.0 percent with 2–4 employees, 12.3 percent with 5–9 employees, 9.4 percent with 10–24 employees and 3.6 percent with 25–49 employees. Collectively, establishments with fewer than 50 employees accounted for 94.0 percent of classified establishments in Penal/Debe, while establishments with 50 or more employees accounted for 3.0 percent (Central Statistics Office Trinidad and Tobago, 2018).

The distribution of establishments by employment size indicates that the formal business base in both municipalities is heavily weighted toward micro and small enterprises, with relatively few medium- to large-sized employers. Establishments employing 50 or more persons represented only a small share of classified establishments in both Siparia and Penal/Debe, highlighting the dominance of smaller-scale business operations across the S-IAoI municipalities (Central Statistics Office Trinidad and Tobago, 2018).

The business profile of the S-AoI points to a local economy with a meaningful but predominantly small-scale enterprise base. Siparia is the principal documented business concentration within the S-DAoI and the largest single business concentration within the wider Siparia administrative area. Mendez Village has a much smaller recorded business base and appears, based on the available business-place data, to form part of the smaller rural-residential and commuting hinterland within Penal/Debe. The available data do not provide community-level detail on business type, employment, informality or home-based activity in Mendez Village; therefore, any

interpretation of its livelihood base beyond the recorded business-place count should be treated as indicative rather than definitive.

Labour Market Conditions

Labour market conditions within the S-AoI reflect a moderate employment environment, with participation rates below the national average across the wider S-IAoI but somewhat stronger participation within the S-DAoI. The 2011 Population and Housing Census provides the most relevant community-level data for Siparia and Mendez Village, while the 2012–2014 Continuous Sample Survey of Population provides broader administrative context for St. Patrick. The latter should be interpreted as a proxy for wider regional labour market trends rather than as community-level evidence for the S-DAoI.

In 2011, labour force participation in the S-IAoI was 56.1 percent, below the national rate of 60.6 percent. Participation was similar in the two S-IAoI municipalities, at 56.2 percent in the Borough of Siparia and 55.9 percent in Penal/Debe Regional Corporation. The S-DAoI recorded a higher participation rate of 58.6 percent, closer to the national average. Within the S-DAoI, Siparia recorded a participation rate of 59.9 percent, while Mendez Village recorded a lower rate of 53.2 percent. This suggests that labour market engagement was stronger in Siparia than in Mendez Village and in the wider S-IAoI, although it remained marginally below the national level (Central Statistical Office of Trinidad and Tobago, 2012a).

Unemployment in 2011 was higher in the S-IAoI than nationally. The national unemployment rate stood at 5.8 percent, compared with 6.5 percent in the S-IAoI. The Borough of Siparia recorded the higher unemployment rate among the two municipalities, at 7.8 percent, while Penal/Debe recorded a lower rate of 5.2 percent. The S-DAoI unemployment rate was 6.1 percent, slightly above the national rate but below the S-IAoI average. At the community level, Siparia recorded an unemployment rate of 7.2 percent, while Mendez Village recorded a notably lower rate of 1.1 percent. The Mendez Village figure should be interpreted cautiously, given the smaller population base and the sensitivity of community-level unemployment rates to small changes in labour force counts (Central Statistical Office of Trinidad and Tobago, 2012a).

Labour force participation was strongly gendered across all geographies. Nationally, male participation stood at 71.2 percent, compared with 50.0 percent among females. The same pattern was evident in the S-IAoI, where male participation was 70.2 percent and female participation was 41.4 percent. In the Borough of Siparia, male participation was 69.7 percent, compared with 42.3 percent among females, while Penal/Debe recorded male and female participation rates of 70.7 percent and 40.6 percent, respectively. Female participation was therefore more than 28 percentage points lower than male participation across the wider S-IAoI.

Gender differences were also evident within the S-DAoI. Male labour force participation was 71.2 percent, compared with 45.8 percent among females. In Siparia, male participation was 72.1 percent, while female participation was 47.9 percent. Mendez Village recorded a lower female participation rate of 37.6 percent, compared with 68.0 percent among males. The gender gap in participation was therefore particularly pronounced in Mendez Village, where women were less likely to be in the labour force or actively seeking employment than men.

Unemployment also varied by sex. In 2011, female unemployment exceeded male unemployment nationally, at 6.4 percent compared with 5.3 percent. This pattern was replicated in the S-IAoI, where female unemployment was 7.5 percent and male unemployment was 5.9 percent. The gender gap was wider in the Borough of Siparia, where female unemployment was 9.1 percent compared with 7.0 percent among males. Penal/Debe recorded lower unemployment for both sexes, at 5.8 percent among females and 4.9 percent among males. Within the S-DAoI, female unemployment was 7.2 percent compared with 5.4 percent among males. Siparia recorded the higher unemployment rates within the direct area, at 8.2 percent among females and 6.5 percent among males. Mendez Village recorded much lower unemployment, at 1.7 percent among females and 0.9 percent among males, although these values should again be treated cautiously because of the smaller local labour force.

The 2012–2014 CSSP data provide additional context for the early 2010s (Central Statistics Office Trinidad and Tobago, 2014). In St. Patrick, labour force participation remained relatively stable, moving from 58.0 percent in 2012 to 57.0 percent in 2013 and 58.1 percent in 2014. These rates were consistently lower than national participation, which remained above 61 percent across the same period. Unemployment in St. Patrick declined from 4.9 percent in 2012 to 2.9 percent in 2013, before increasing slightly to 3.3 percent in 2014. By 2014, the unemployment rate in St. Patrick was equal to the national rate, although participation remained below the national level.

CSSP data also show persistent gender differences in the broader St. Patrick labour market. Male participation was 74.6 percent in 2012, 71.9 percent in 2013 and 71.1 percent in 2014, while female participation was 40.5 percent, 40.4 percent and 44.5 percent over the same period. Although female participation improved by 2014, it remained substantially below male participation. Female unemployment also exceeded male unemployment in 2012 and 2014, with female unemployment at 7.0 percent in 2012 and 4.9 percent in 2014, compared with male rates of 3.8 percent and 2.3 percent, respectively. In 2013, male and female unemployment were closer, at 2.9 percent and 3.1 percent, respectively.

Employment by occupation in St. Patrick points to a labour market with substantial representation in elementary occupations, craft and related trades, service and sales work, and plant and machine operation. In 2014, elementary occupations accounted for 20.5 percent of employment in St. Patrick, followed by craft and related trades (18.2%), service and sales workers (14.2%), technicians and associate professionals (12.5%), plant and machine operators and assemblers (10.6%), clerks (9.4%), legislators, senior officials and managers (7.5%), professionals (4.3%), and agricultural, forestry and fishery workers (2.9%). Compared with the national occupational profile, St. Patrick had a higher share of craft and related trades and plant and machine operators, while the professional category was smaller than the national average.

The occupational profile was strongly gendered. In 2014, employed men in St. Patrick were concentrated primarily in craft and related trades (26.6%), elementary occupations (22.0%), plant and machine operation and assembly (16.2%), service and sales work (9.7%), technicians and associate professional roles (8.3%), and managerial or senior official categories (7.2%). By contrast, employed women were concentrated mainly in service and sales work (22.0%), clerical occupations (21.6%), technicians and associate professional roles (19.6%), elementary

occupations (18.0%), managerial or senior official categories (8.0%), and professional occupations (5.6%). Women had very low representation in agricultural, forestry and fishery work (0.8%), plant and machine operation and assembly (0.8%), and craft and related trades (3.6%). The corrected occupational distribution therefore points to a labour market in which men were more represented in trades, machine operation and manual occupations, while women were more concentrated in service, clerical, technical and elementary work.

Employment status patterns show the predominance of wage employment alongside a continued role for self-employment. In 2014, paid employment accounted for 77.8 percent of workers in St. Patrick, broadly comparable to the national figure of 77.9 percent. Non-government paid employment was the largest component, accounting for 51.1 percent of workers, followed by public service or statutory board employment at 20.9 percent and state enterprise employment at 5.9 percent. Own-account workers accounted for 16.3 percent, while employers represented 4.6 percent. Unpaid workers and learners or apprentices together accounted for a small share of employment. These patterns suggest that most workers were wage earners, while self-employment and small enterprise remained important secondary livelihood strategies.

Employment status also varied by sex. In 2014, 84.4 percent of employed women in St. Patrick were paid employees, compared with 74.0 percent of employed men. Women were more concentrated in public service or statutory board employment, at 32.4 percent, compared with 14.2 percent among men. Men had higher levels of own-account work, at 19.5 percent compared with 10.8 percent among women, and were also more likely to be employers. These patterns point to a gendered employment structure in which women were more concentrated in paid employment, particularly public-sector-linked employment, while men were more represented in self-employment and employer categories.

Employment by industrial group confirms the importance of services, construction, trade and energy-linked activity in the wider St. Patrick labour market. In 2014, community, social and personal services accounted for 31.2 percent of employment, followed by construction (21.9%), wholesale and retail trade, restaurants and hotels (14.4%), petroleum and gas, including production, refining and service contractors (8.8%), finance, insurance, real estate and business services (7.2%), other manufacturing (5.7%), transport, storage and communication (5.1%), other agriculture, forestry, hunting and fishing (3.8%), and electricity and water (1.8%). This industrial structure is consistent with a regional labour market shaped by services, construction, trade, public and social services, and energy-related activity.

Gender differences were also evident across industries. In 2014, employed men in St. Patrick were concentrated in construction (30.6%), community, social and personal services (22.5%), petroleum and gas-related activity (11.4%), wholesale and retail trade, restaurants and hotels (8.4%), manufacturing (7.2%), transport, storage and communication (6.7%), finance and business services (5.6%), and agriculture, forestry, hunting and fishing (5.3%). Employed women were concentrated mainly in community, social and personal services (46.2%), wholesale and retail trade, restaurants and hotels (24.9%), finance and business services (10.0%), construction (6.8%), petroleum and gas-related activity (4.4%), and manufacturing (3.2%). These patterns reflect a labour market in which men were more represented in construction, energy, transport

and primary-sector-related activities, while women were more concentrated in services, trade and public or social service-linked employment.

The labour market profile of the S-AoI therefore reflects moderate participation, gendered labour force engagement, and a mix of wage employment, self-employment and small enterprise activity. Siparia recorded stronger labour force participation than Mendez Village and the wider S-IAoI, but also higher unemployment. Mendez Village recorded low unemployment, although this should be read cautiously because of its smaller labour force. The broader St. Patrick employment structure points to a labour market shaped by services, construction, trade, energy-related activity, public-sector-linked employment and self-employment, providing the wider employment context for households in the S-DAoI.

Incidence of Poverty

Poverty within the S-AoI reflects a mixed profile of deprivation. Income-based poverty was substantially higher in Siparia than in Penal/Debe, while multidimensional poverty indicators show a more complex pattern, with Penal/Debe recording a higher non-monetary poverty burden. At the community level, poverty scores for the S-DAoI indicate moderate variation between Siparia and Mendez Village, with Mendez Village recording a lower poverty score and, therefore, a relatively higher level of poverty-related vulnerability than Siparia.

Table 4-11: Key Poverty Indicators for Siparia WTP Refurbishment and Upgrade S-IAoI

Administrative Area	Income based	Non-monetary	
	Poverty Rate (%)	MPI	Multi-dimensional Poverty Rate (%)
Trinidad and Tobago	16.7	0.017	6.2
Siparia Regional Corporation	27.7	0.013	5.0
Penal/Debe Regional Corporation	12.0	0.02	7.2

Source: Kairi Consultants Limited. (2007). 2005 Analysis of the Trinidad and Tobago Survey of Living Conditions.

The most recent income-poverty data available at the municipal level show that 16.7 percent of Trinidad and Tobago's population was estimated to be living below the poverty line. Siparia recorded a poverty rate of 27.7 percent, ranking third highest among the country's regional corporations, while Penal/Debe recorded a lower poverty rate of 12.0 percent, ranking tenth. The contrast between the two S-IAoI municipalities is notable. Siparia's poverty rate was more than ten percentage points above the national figure, while Penal/Debe's was below the national average (Kairi Consultants Limited, 2007).

The distribution of the poor population further highlights the weight of poverty in Siparia. Siparia accounted for 15.1 percent of the national poor population, the highest share among the regional corporations, compared with 7.9 percent of the non-poor population. Penal/Debe accounted for 3.7 percent of the national poor population and 5.4 percent of the non-poor population. Together, the two S-IAoI municipalities accounted for 18.8 percent of the national poor population, with most of this share concentrated in Siparia. In relation to the Siparia WTP project, the higher

poverty burden in the wider Siparia administrative area provides important context for household capacity, service affordability, infrastructure access and resilience to temporary disruptions.

Multidimensional poverty indicators provide complementary insight by capturing non-income deprivations in health, education and standard of living. Nationally, the Multidimensional Poverty Index (MPI) was 0.017, with 6.2 percent of the population identified as multidimensionally poor and an overall poverty intensity of 26.9 percent among the multidimensionally poor. Penal/Debe recorded an MPI of 0.020, the third highest nationally, with 7.2 percent of its population classified as multidimensionally poor and an intensity of poverty of 28.1 percent. These figures were above the national profile and point to a comparatively higher non-monetary poverty burden in Penal/Debe (Central Statistical Office of Trinidad and Tobago, 2012b).

Siparia recorded a lower multidimensional poverty burden than Penal/Debe and the national average. Its MPI was 0.013, while 5.0 percent of the population was classified as multidimensionally poor. The intensity of poverty among the multidimensionally poor was 26.5 percent, slightly below the national figure. However, the dimension-specific profile shows that deprivation among the multidimensionally poor in Siparia was concentrated more strongly in education and standard of living than in health. Siparia recorded the highest-ranked education dimension intensity at 8.9 percent and the highest-ranked standard of living dimension intensity at 5.5 percent, while its health dimension intensity was comparatively lower at 12.0 percent. This pattern suggests that, although multidimensional poverty was less widespread in Siparia than in Penal/Debe, affected households experienced important deprivations linked to education and living conditions.

Penal/Debe's multidimensional poverty profile differed from Siparia's. Its health dimension intensity was 20.7 percent, the third highest nationally, while standard of living intensity stood at 3.4 percent and education intensity at 3.9 percent. The higher MPI, higher multidimensional poverty headcount and higher overall intensity in Penal/Debe point to a broader non-income deprivation burden, even though its income-poverty rate was lower than Siparia's. The divergence between income and multidimensional poverty underscores the importance of considering both monetary and non-monetary indicators when assessing social vulnerability across the S-IAoI.

At the S-DAoI level, poverty scores provide the most direct community-level proxy for relative socio-economic conditions, although they are based on 2000 Census data and should be treated as indicative rather than current poverty estimates. Lower poverty scores correspond with higher levels of poverty-related deprivation. Mendez Village recorded a poverty score of 45 and was ranked 153rd poorest among the country's communities. Siparia recorded a higher poverty score of 48 and was ranked 295th poorest. These scores place Mendez Village in a more poverty-vulnerable position than Siparia, while Siparia's ranking suggests a more moderate deprivation profile relative to many other communities nationally (Kairi Consultants Limited, 2007).

The community-level pattern is important because it differs from the wider municipal picture. While Siparia Borough recorded a high municipal poverty rate, the town of Siparia itself had a comparatively better poverty score than Mendez Village. This reflects the importance of distinguishing between municipal-level poverty conditions and community-level variation within

the S-DAoI. Siparia's role as a service centre may be associated with better access to commercial activity, public services and infrastructure relative to smaller surrounding communities, while Mendez Village's lower poverty score points to a higher level of relative deprivation within the direct area of influence. This interpretation is based on the poverty-score ranking and the settlement context, rather than on current household income data for either community.

The poverty profile of the S-AoI is therefore uneven. Siparia carries a high municipal income-poverty burden, while Penal/Debe records a higher multidimensional poverty burden. Within the S-DAoI, Mendez Village appears more poverty-vulnerable than Siparia based on the available community poverty scores. These conditions provide context for understanding differences in household resilience, ability to absorb short-term cost or service shocks, and dependence on reliable access to basic services, including potable water.

4.4.2.4 Cultural Heritage and Archaeological Resources

Trinidad and Tobago's cultural heritage includes tangible and intangible legacies that reflect the country's historical development, settlement patterns, cultural diversity, religious traditions and relationships with the natural landscape. Tangible cultural heritage includes monuments, historic buildings, archaeological sites, cemeteries, landscapes, infrastructure, places of worship, and natural features of historical, scientific or cultural interest. Intangible heritage includes traditions, beliefs, festivals, oral histories, music, foodways, rituals and other practices transmitted across generations and embedded in community identity.

Cultural heritage and archaeological resources are managed within the national heritage framework established under the National Trust of Trinidad and Tobago Act, Chap. 40:53. The framework provides for the identification, recording and formal listing of monuments, sites and places of heritage interest. Formally listed heritage properties are protected under the Act against unauthorised alteration, damage, injury or defacement. In addition to the listed properties, heritage assets may also be recorded in the Heritage Asset Inventory where they have been identified as having heritage interest but have not yet completed the formal listing process.

Within the S-IAoI, recorded heritage assets are more concentrated in the Borough of Siparia than in the Penal/Debe Regional Corporation. Siparia has 33 recorded heritage assets, comprising 26 cultural sites, one mixed site and six natural sites. Penal/Debe has 12 recorded heritage assets, comprising 11 cultural sites and one natural site. This distribution reflects the broader historical, cultural and environmental character of south-western Trinidad, where religious sites, historic buildings, archaeological resources, coastal landscapes, mud volcanoes, cultural traditions and natural features contribute to local identity and place-based heritage.

No recorded heritage sites are located within the S-DAoI communities of Siparia and Mendez Village. The nearest recorded heritage assets are Batiment Crase, the Daisy Voisin Tomb and Erin Bouffe, which are located outside the direct area of influence. Their proximity is part of the municipality's wider cultural heritage setting, but the available inventory information does not identify any known heritage property within the direct project area. Based on the current heritage asset information, the Siparia WTP refurbishment and upgrading works are not expected to directly intersect a recorded heritage site.

The wider Borough of Siparia has a strong cultural heritage profile, shaped by archaeological resources, religious traditions, coastal landscapes, natural heritage, industrial history and cultural events. Heritage and tourism-related assets in the wider municipality include Banwari Trace, the Pitch Lake, La Brea Vieja, industrial heritage associated with oil and asphalt production, the Cedros Peninsula, beaches, forests, wildlife reserves, rivers, swamps and other clusters of cultural and environmental attractions (All-inclusive Project Development Services Limited, 2010; Kairi Consultants Limited, 2016a). Environmental protection and historic preservation are also recognised as part of the wider development direction for Siparia, particularly where development may intersect with sites of biological or archaeological interest (All-inclusive Project Development Services Limited, 2010).

Siparia's intangible cultural heritage is closely linked to religious observance, music, festivals and community identity. Cultural and religious observances associated with La Divina Pastora/Soparee Mai, Siparia Fete, Labour Day celebrations, Carnival and other community events form part of the municipality's identity and visitor economy (All-inclusive Project Development Services Limited, 2010; Kairi Consultants Limited, 2016a). Siparia is also associated with Daisy Voisin, one of Trinidad and Tobago's celebrated parang icons. Community and cultural initiatives, including the Daisy Voisin Hub, the Siparia Inter-Religious Group, the twinning of Cedros and Toco, and domestic tourism planning for Cedros, further reflect the connection between local heritage, cultural expression and community-based development (Parliament of Trinidad and Tobago, 2015b).

Heritage-related development in Siparia is also linked to eco-, heritage and cultural tourism. Opportunities have been identified around tours, visitor facilities and events associated with industrial plants, Banwari Trace, the Pitch Lake, La Brea Vieja, the Cedros Peninsula, forests, wildlife reserves, rivers, swamps, beaches, cultural festivals and religious observances (All-inclusive Project Development Services Limited, 2010; Kairi Consultants Limited, 2016a). These assets provide wider context for the municipality's cultural landscape, although they are located outside the direct footprint of the Siparia WTP project.

Penal/Debe's recorded heritage profile is smaller in number but remains relevant to the wider S-IAoI. Its heritage assets are predominantly cultural, with one recorded natural heritage asset. The municipality's wider cultural and environmental context is associated with agricultural settlement, religious and community institutions, the Oropouche Lagoon, and natural features such as mud volcanoes. Eco and cultural tourism form part of the municipality's local development potential, while the Dignity/Digity Mud Volcano and Bunsee Trace Mud Volcano are among the notable natural and cultural landscape features in the municipality (Kairi Consultants Limited, 2016b; Parliament of Trinidad and Tobago, 2015a).

Archaeological resources are relevant within the broader south-western Trinidad context, particularly because the wider Siparia area includes known archaeological assets such as Banwari Trace and other sites of historical and pre-Columbian significance. However, no recorded archaeological sites were identified within the S-DAoI based on the information provided. The absence of recorded archaeological resources does not preclude the possibility of previously unidentified subsurface material, particularly in areas with long settlement histories,

but the available baseline information places known cultural heritage and archaeological sensitivities outside the direct project area.

The cultural heritage profile of the S-AoI is therefore characterised by a wider municipal setting with a notable concentration of recorded heritage assets in Siparia and a smaller but relevant heritage base in Penal/Debe. Within the S-DAoI, no recorded heritage sites have been identified, and the nearest known assets are outside the directly affected communities. The direct project area has a low known heritage constraint based on available inventory information, while the wider S-IAoI remains culturally and historically significant because of its archaeological resources, religious traditions, cultural festivals, natural heritage assets, industrial history and community-based heritage tourism potential.

4.4.2.5 Natural and Built Resources and Use

Section 4.4.2.5 describes the natural and built resources that shape settlement, service access and everyday resource use within the S-AoI. The section focuses on land ownership and tenure, together with access to key infrastructure and services, including education, health, community and recreational facilities, water and sanitation, electricity, information and communication technology, and transportation. The profile reflects the varied south-western setting of the Borough of Siparia and Penal/Debe Regional Corporation, where established service centres, rural and semi-rural communities, agricultural lands, forested areas, wetlands, drainage systems, coastal resources, energy-sector lands and public infrastructure coexist. Within the S-DAoI, Siparia functions as the more concentrated settlement and service centre, while Mendez Village has a smaller and more dispersed residential-rural profile.

The section draws on the 2011 Population and Housing Census, municipal planning and economic profiles, infrastructure and facility listings, and relevant secondary sources to describe existing land-use and service-access conditions that may be relevant to later assessment of household sensitivity, service disruption, access constraints and community resilience (All-inclusive Project Development Services Limited, 2010; Central Statistical Office of Trinidad and Tobago, 2012a; Kairi Consultants Limited, 2016a, 2016b).

Land Ownership and Tenure

Land ownership and tenure within the S-AoI reflect long-standing patterns of land administration, agricultural landholding, settlement expansion, public land management, environmental protection and informal occupation. In Trinidad and Tobago, tenure is broadly shaped by statutory arrangements governing State lands, private ownership, leasehold occupation, public-sector landholding, family land, and informal settlement regularisation. State and public lands are generally associated with forest reserves, watersheds, wetlands, public infrastructure, strategic industrial areas and other lands held for public or environmental purposes. Private and family-based tenure is more commonly associated with established residential communities, commercial activity, agriculture and small-scale enterprise.

State and Public Land

State land administration is anchored in the State Lands Act, Chap. 57:01, under which the Commissioner of State Lands is responsible for the management, allocation and distribution of State lands. Within the S-IAoI, State and public land interests are relevant because both Siparia and Penal/Debe contain forested areas, wetlands, drainage systems, agricultural lands, public infrastructure, settlement areas and environmentally sensitive landscapes. Public land management is most evident in the wider natural resource and infrastructure setting, while private and family-based tenure is more prominent in the established residential and productive settlement footprint.

Public and State land interests in Siparia are closely connected to forest reserves, wetlands, energy-sector lands, coastal resources and other environmental assets. The municipality includes several forest reserves, including the Southern Watershed, Erin, Cedros, Morne L'Enfer, Siparia and Cap-de-Ville forest areas, as well as mangrove and wetland systems such as the Icacos Basin, Los Blanquizales Lagoon and Rousillac Swamp. These areas form part of a wider landscape in which public land management, environmental protection and resource-use controls influence land-use planning and permissible development (Kairi Consultants Limited, 2016a).

The wider land-use profile of Siparia also reflects significant public and strategic land-use interests associated with infrastructure, energy and environmental management. The municipality includes ports, industrial areas, onshore stations, zones associated with offshore oil production, forested State lands, wetlands and extensive coastal areas. Its relatively low population density is partly associated with forests, swamps and land areas allocated to the energy sector, where resident population is limited (All-inclusive Project Development Services Limited, 2010; Kairi Consultants Limited, 2016a; Parliament of Trinidad and Tobago, 2015b).

In Penal/Debe, public land interests are closely linked to watershed, drainage and environmental management. The municipality includes low-lying areas, hills, wetlands, beaches, agricultural lands, settlement areas and river systems, and approximately 60 percent of the municipality lies within the Oropouche Watershed. Much of this area is subject to frequent flooding, with the Coora, Gucharon, Lengua, Papourie, Trinidad and Oropouche Rivers forming part of the municipality's drainage and environmental setting. Public land management and statutory controls are therefore relevant where river corridors, wetlands, drainage infrastructure, public facilities and watershed functions shape land use (Kairi Consultants Limited, 2016b; Pacific Disaster Center (PDC Global), 2020).

Agricultural landholding data provide additional context for public and institutional land interests in the S-IAoI. In 2004, government and State enterprise holdings accounted for one agricultural parcel in Siparia covering 147.7 ha, and one parcel in Penal/Debe covering 2,740.4 ha. Although these holdings represented only a small number of parcels, the Penal/Debe holding accounted for a substantial share of agricultural parcel area in that municipality. The 2004 data should be interpreted as agricultural landholding context only, given their age and their focus on agricultural parcels rather than residential tenure or project-site ownership (Ministry of Planning & Development, 2004).

Informal occupation is also an important feature of the public land and tenure context within the wider S-IAoI. Available informal settlement data identify sites across both Siparia and Penal/Debe, including settlements with residential and non-residential structures. Based on the available table, 38 informal settlement sites were listed in Siparia, with approximately 2,177 residential structures and 2,873 total structures, for which counts are available. Penal/Debe recorded 34 listed sites, with approximately 1,839 residential structures and 2,729 total structures with available counts. These figures should be treated as indicative, as the table includes some sites with missing structure counts and does not confirm current tenure status, regularisation progress or the legal position of individual occupants (Land Settlement Agency, n.d.).

Informal settlement sites in the wider Siparia area include locations in Palo Seco, La Brea, Gonzales, Siparia, Guapo, Santa Flora, Fyzabad, Los Bajos, Vessigny, San Francique and other communities. Several listed sites are identified by area as Siparia, including Coora Branch Road, Darsan Trace, Gambal Street, La Brea Trace, Lily Trace, Quinam Road and Taylor Avenue/Rito Ville. These sites indicate that informal occupation is present within the broader Siparia service area, although the available data do not confirm whether any listed informal settlement is located within the physical footprint of the Siparia WTP, along project access routes, or within any area that would be directly affected by refurbishment works.

In Penal/Debe, listed informal settlement sites include locations in Barrackpore, Penal, Debe, Penal Rock Road, Rochard Road, La Romain, Lower Barrackpore, Hermitage Village and other communities. Larger concentrations include Digity Trace/Clarke Road, Manohar Road/Rochard Road, Hermitage, Sunress Road/Ramlal Street and Temple Street, Debe. No informal settlement site listed in the provided table is specifically identified as Mendez Village. However, Mendez Village is located within a municipality where informal occupation and tenure complexity occur in several communities, particularly along road corridors, agricultural lands and settlement edges.

Private Land

Private, family-based and leasehold tenure is most closely associated with the settled and productive parts of the S-AoI, including residential communities, agricultural holdings, commercial nodes, small businesses and local service centres. In Siparia, the occupied settlement and agricultural footprint exists alongside extensive State, environmental and energy-sector land uses. Siparia town, as the administrative capital and principal service centre, is likely to have a mixed tenure pattern associated with residential, commercial, institutional and public-service uses. In the absence of parcel-level tenure data for the S-DAoI, the tenure profile of Siparia town should be interpreted as a mixed setting in which private, family, institutional and public land uses coexist within a wider municipality where State lands and environmentally constrained areas remain significant.

Private and family-based land tenure also appears to be prominent across the settled and agricultural parts of Penal/Debe, particularly in residential communities, village settlements, commercial nodes and farming areas. The municipality's development pattern includes agricultural land use, ribbon development, infrastructure constraints and squatter settlements,

creating a varied tenure environment across different communities. Private tenure is likely to be most prominent in established settlements and agricultural areas, while public and State interests are more relevant where drainage, watershed, wetland, river corridor and public infrastructure functions shape land use (Kairi Consultants Limited, 2016b).

Agricultural parcel data show that private holdings dominated the number of agricultural parcels in both S-IAoI municipalities in 2004. Siparia recorded 1,790 agricultural parcels covering 6,006 ha, while Penal/Debe recorded 3,461 parcels covering 7,498.1 ha. Private holdings accounted for 1,776 parcels in Siparia and 3,458 parcels in Penal/Debe. However, private holdings represented a smaller share of total agricultural parcel area than of the total number of parcels. In Siparia, private holdings covered 3,256.5 ha, while co-operative society and private company holdings covered 2,601.8 ha. In Penal/Debe, private holdings covered 4,754.9 ha, alongside a substantial government and State enterprise holding of 2,740.4 ha. These figures point to an agricultural tenure environment in which private landholding is prominent by parcel count, but larger institutional, corporate or public holdings also form part of the agricultural land base (Central Statistical Office, 2004).

The national agricultural tenure profile also shows that agricultural parcels were held under varied arrangements. In 2004, owned land accounted for 34.8 percent of agricultural parcels but 63.1 percent of agricultural parcel area, reflecting the larger average size of owned holdings. Rented or leased lands, family land, rent-free occupation and squatting also formed part of the agricultural tenure landscape. These national patterns provide broader context for the S-IAoI, where agriculture remains an important component of land use and livelihoods, particularly in rural and semi-rural communities.

The 2011 Population and Housing Census provides more direct household-level context for residential land tenure among households that owned their dwelling unit. Across the S-IAoI, most owner-occupier households occupied owned or family land (61.5%). This pattern was stronger in Penal/Debe, where 67.7 percent of owner-occupier households occupied owned or family land, compared with 55.5 percent in the Borough of Siparia. Privately rented land was more common in the Borough of Siparia (25.2%) than in Penal/Debe (14.7%), while government-leased land was slightly more common in Penal/Debe (5.8%) than in Siparia (4.0%). Squatted land accounted for 5.0 percent of owner-occupier households across the S-IAoI, with a higher share in the Borough of Siparia (7.2%) than in Penal/Debe (2.8%).

Within the S-DAoI, 60.6 percent of owner-occupier households occupied owned or family land, while 15.9 percent occupied privately rented land, 3.8 percent occupied government-rented land, 2.7 percent occupied government-leased land, 1.2 percent occupied privately leased land, 3.8 percent occupied land rent-free, and 9.8 percent reported squatted land. The pattern varied sharply between Siparia and Mendez Village. In Siparia, 54.1 percent of owner-occupier households occupied owned or family land, 17.8 percent occupied privately rented land and 12.4 percent reported squatted land. In Mendez Village, 84.9 percent occupied owned or family land, 9.1 percent occupied privately rented land, 3.1 percent occupied government-leased land, and no owner-occupier households reported squatted land. These figures point to a more complex residential tenure profile in Siparia and a stronger pattern of owned or family land occupation in

Mendez Village. The data should be interpreted as household-reported tenure among dwelling owners and not as parcel-level confirmation of land ownership, land title or project-site tenure.

The S-DAoI tenure profile should therefore be interpreted cautiously. Siparia is a larger and more established settlement with commercial, administrative, residential and public-service functions, but it also records a higher share of owner-occupier households on privately rented and squatted land. Mendez Village has a smaller settlement profile and a stronger reported pattern of owned or family land among owner-occupier households. Available data indicate the presence of informal settlements within the wider S-IAoI and in parts of the broader Siparia settlement area, but they do not provide parcel-level tenure information for the WTP site, surrounding properties or households in Mendez Village. Further site-level confirmation would be required to determine whether any land acquisition, access restriction, temporary occupation, encroachment, informal use or tenure-related sensitivity is associated with the project footprint or access arrangements.

Land tenure in the S-AoI is closely linked to the wider use of natural and built resources. In Siparia, the coexistence of settlements, agriculture, forests, wetlands, coastal lands, industrial areas and energy-sector lands creates a varied land-use environment in which private occupation, family landholding, State land management and strategic industrial uses overlap. In Penal/Debe, agricultural land use, watershed conditions, drainage constraints, flooding, ribbon development and informal occupation shape the tenure context. Within the S-DAoI, the available baseline information points to a primarily settled and service-oriented land-use context in Siparia and a smaller residential-rural context in Mendez Village, with no confirmed project-related tenure displacement or direct land acquisition identified from the information currently provided.

4.4.2.5.1 Access to Infrastructure

Education

Trinidad and Tobago's education system is structured across early childhood care and education (ECCE), primary, secondary, vocational/technical, and tertiary levels. Public education services are administered by the Ministry of Education through the national education district system, with provision delivered through government, government-assisted/denominational, private and specialised institutions. The S-DAoI falls within the St. Patrick education district, while parts of the wider Penal/Debe municipality also rely on facilities listed within nearby Victoria and southern education catchments. As a result, access to education in the S-AoI is shaped by both the location of schools in Siparia and Mendez and the ability of households to travel to larger service centres such as Penal, Debe, Point Fortin, Princes Town and San Fernando.

At the ECCE level, facilities are available within or near both S-DAoI communities. In Mendez, Penal Quinam Government ECCE is located along Penal Quinam Road, providing a government early childhood facility within the community. In Siparia, Siparia Hindu SDMS ECCE is located on Seegobin Drive and represents denominational/non-government ECCE provision within the direct area of influence. Other ECCE facilities in the wider St. Patrick district include government centres at Clarke Rochard, Fyzabad, Quarry Village, Rancho Quemado, Santa Flora and Southern Garden, as well as denominational or faith-based centres such as Penal Presbyterian ECCE, Fyzabad SDMS ECCE, St. Anthony's ECCE and Gopie Trace Kindergarten ECCE. The ECCE

network therefore provides early childhood access within the S-DAoI and surrounding communities, although smaller and more dispersed settlements may still depend on road-based travel to neighbouring centres (Ministry of Education, 2025).

Primary education infrastructure is more developed and more widely distributed than secondary or tertiary education. Within Siparia, primary provision includes several government-assisted or denominational schools, including Siparia Boys' RC, Siparia Hindu, Siparia Union Presbyterian, St. Brigid's Girls' RC and Siparia (St. Christopher's) AC. Private or non-government provision is also present in the wider Siparia area, including Siparia SDA. In Mendez, Penal Quinam Government Primary School provides a government primary-level facility within the community. Additional government and government-assisted primary schools in nearby communities include Penal Government, Clarke Rochard Government, Palo Seco Government, Santa Flora Government, South Oropouche Government, Penal Presbyterian, Penal Rock Hindu, Penal Rock Presbyterian, Penal Rock RC, Suchit Trace Hindu and Tulsa Trace Hindu. Special education provision is available in the wider Penal area through Lady Hochoy Penal. The distribution of primary schools suggests that primary-level access is available within both S-DAoI communities, with Siparia offering a wider range of government-assisted and denominational options than Mendez (Ministry of Education, 2022a).

Secondary education is more centralised and concentrated in larger settlements. In Siparia, secondary-level access is provided through Siparia East Secondary and Siparia West Secondary, both government secondary schools located on La Brea Trace. Iere High School, a government-assisted secondary school located at Bayanie Street, De Gannes Village, also serves the wider Siparia area. In Penal/Debe and nearby communities, secondary provision includes government schools such as Penal Secondary and Debe Secondary, and government-assisted schools such as Holy Faith Convent Penal, Shiva Boys Hindu College and Parvati Girls' Hindu College. Barrackpore East Secondary and Barrackpore West Secondary provide additional secondary options in the wider catchment. Secondary education access for Siparia is therefore relatively strong within the S-DAoI, while Mendez Village is more dependent on travel to Penal, Debe, Siparia or nearby centres for a broader range of secondary school options (Ministry of Education, 2022b).

The Schools of Focus initiative provides additional context on targeted educational support needs within the wider S-AoI. In 2022, Cabinet approved targeted interventions for 26 secondary schools, followed by a remediation programme for 80 primary schools and additional support measures for the secondary schools of focus. Selection criteria for primary schools included low SEA performance, leadership and governance support needs, student academic achievement, curriculum completion and delivery challenges, absenteeism and truancy, student indiscipline, critical incidents, socio-economic challenges, and limited parental involvement or supervision. At the secondary level, criteria included the proportion of Form 1 students scoring 30 percent or less, CSEC performance in five or more subjects inclusive of Mathematics and English A, and value-added measures comparing SEA scores with later CSEC outcomes. Within the St. Patrick district, the list includes Siparia (St. Christopher's) AC at the primary level and Siparia East Secondary and Siparia West Secondary at the secondary level. Their inclusion points to the

presence of targeted academic and institutional support needs within parts of the school network serving the wider Siparia area, rather than simply indicating the availability of facilities (Ministry of Education, n.d.).

Post-secondary, tertiary and vocational/technical education opportunities are more limited within the immediate S-DAoI but are accessible in nearby southern centres. San Fernando is the closest major post-secondary service centre, home to the COSTAATT South Campus and the UTT San Fernando Campus. Vocational and technical training opportunities are available through YTEPP facilities in San Fernando and Princes Town, while MIC Institute of Technology has a Penal Technology Centre on Clarke Road. The UWI South Campus at Penal/Debe forms part of the wider tertiary education landscape in south Trinidad; however, its operational status should be described with caution, as available public reporting indicates that restoration and phased operational preparations are underway. These institutions provide important pathways into tertiary, technical and skills-based education for residents of the S-AoI, although access depends on the availability of transport, programme entry requirements, affordability, household income and awareness of available opportunities.

The education infrastructure profile of the S-DAoI is stronger in Siparia than in Mendez Village. Siparia contains ECCE, multiple government-assisted primary schools, government and government-assisted secondary schools, and functions as an education service node for nearby communities. Mendez Village has direct access to a government ECCE centre and a government primary school, but relies more heavily on Penal, Debe, Siparia, San Fernando and other surrounding centres for secondary, tertiary, vocational, special education and specialised training services. The available facility data provide a useful overview of education infrastructure but do not confirm enrolment levels, school capacity, school building conditions, transport costs, attendance patterns, or household-level barriers to access.

Health

Public health services accessed by residents of the S-AoI fall under the South West Regional Health Authority (SWRHA), which is responsible for public health service delivery across the south-western region of Trinidad. The SWRHA service network includes hospitals, district health facilities, health centres, outreach centres and extended care centres distributed across San Fernando, Point Fortin, Siparia, Penal/Debe, Princes Town, Couva and surrounding communities. This structure provides residents of the S-DAoI with access to local primary and district-level services, while more specialised, emergency and inpatient care is concentrated in larger regional facilities outside the immediate project area.

Within the S-DAoI, Siparia has direct access to public health infrastructure through the Siparia District Health Facility on High Street, Siparia. The facility forms part of the district-level health network serving the wider south-western region and provides a closer point of access for residents of Siparia and surrounding communities than the larger hospital facilities in San Fernando or Point Fortin. The availability of a district health facility reinforces Siparia's role as a local service centre, alongside its administrative, commercial and educational functions.

Primary health care in the wider Siparia area is supported by health centres in nearby communities, including Fyzabad, Palo Seco, Santa Flora, Erin, Cedros, Icacos, La Brea, Guapo and South Oropouche. These facilities provide the wider municipal context for access to outpatient, preventative and community-based health services, particularly for residents in smaller or more dispersed communities. Access to these facilities depends on road connectivity, transport availability, service hours, household resources and the nature of care required.

For residents of Mendez Village, the nearest public health facilities are located outside the community, primarily within the Penal/Debe health service network. Relevant facilities include Penal Health Centre on Southern Main Road, Penal; Penal Rock Road Health Centre; Debe Health Centre on Wellington Road; and Rochard Douglas Health Centre. These facilities provide the primary care base for the Penal/Debe side of the S-IAoI, while district-level and higher-order care may require travel to Siparia, Princes Town, Couva, San Fernando or Point Fortin, depending on the service required.

Secondary, emergency and higher-order care are more centralised within the regional health system. The SWRHA administers San Fernando General/Teaching Hospital, Point Fortin Hospital, Princes Town District Health Facility, Couva District Health Facility and Siparia District Health Facility. San Fernando General/Teaching Hospital is the principal regional hospital in the wider southern catchment and provides access to emergency, diagnostic, inpatient and specialist services that are not available at local health centres. Point Fortin Hospital, Princes Town District Health Facility and Couva District Health Facility provide additional emergency and district-level service options within the broader south-western health network.

The spatial pattern of health infrastructure suggests stronger local access to health services in Siparia than in Mendez Village. Siparia contains a district health facility within the S-DAoI and is supported by a wider network of health centres in surrounding Siparia communities. Mendez Village does not appear, based on the available facility listings, to host a major public health facility within the community itself, and residents are more dependent on nearby Penal/Debe facilities and larger service centres for primary, district and hospital care.

The health infrastructure profile of the S-DAoI is therefore relatively stronger in Siparia than in Mendez Village. Siparia has local access to district-level public health services and functions as part of the south-western health service network, while Mendez Village relies more heavily on nearby Penal/Debe facilities and higher-order services in San Fernando, Princes Town, Couva, Point Fortin or Siparia. The available facility data provide a useful overview of the health service network, but do not confirm facility capacity, staffing levels, waiting times, service quality, ambulance response times, transport costs or household-level barriers to accessing care.

Community and Recreational Facilities

Community and recreational facilities provide important spaces for local meetings, social interaction, training, cultural activities, sports, youth development and community-based programming. Within Trinidad and Tobago, these facilities fall partly under the remit of the Ministry of Sport and Community Development, which has responsibility for community

development, community centres, regional complexes, community mediation services, physical education and sport facilities, community swimming pools and indoor sporting arenas.

Within the S-DAoI, both Siparia and Mendez Village have direct access to community centre infrastructure. Siparia Community Centre is located on Grell Street, Siparia, while Mendez Community Centre is located in Mendez Village, via Siparia. These facilities provide local venues for community meetings, training, social programmes, civic activities and other community-level gatherings. Their presence is relevant to the social baseline because they represent established local spaces through which community engagement, information sharing and local coordination may occur.

The wider St. Patrick community centre network is extensive and includes facilities across Siparia, Penal/Debe, Point Fortin, La Brea, Cedros, Erin, Palo Seco, Fyzabad, Santa Flora, Vessigny, Los Bajos, Penal, Clarke Rochard, Lachoos Road, Bunsee Trace, Katwaroo Trace and other communities. Within the broader Siparia side of the S-IAoI, community centres are listed in locations such as Ackbar Trace, Buenos Ayres, Cap-de-Ville, Cedros, Chatham, Erin, Granville, Guapo, La Brea, Los Bajos, Lot 10, Mon Desir, Morne Diablo, Palo Seco, Rancho Quemado, Rousillac, Siparia, South Oropouche, Thick Village, Timital, Vance River and Vessigny. On the Penal/Debe side, relevant community facilities include Bunsee Trace Centre, Clarke Rochard Community Centre, Katwaroo Trace Community Centre, Lachoos Road Community Centre, Mulchan Trace Community Centre, Penal Central Community Centre and Penal Rock Road Community Centre, among others. This distribution suggests a relatively broad community facility network across the S-IAoI, although the available facility list does not provide information on physical condition, frequency of use, accessibility, programming or maintenance status.

Community development services are also supported through district-level administrative infrastructure. The St. Patrick East administrative district office is located at the Siparia Administrative Complex on High Street, Siparia, while St. Patrick West is located in Point Fortin. These district offices provide an administrative base for community development programming and support to community organisations. Wider regional facilities also support community and recreational activity, including Fyzabad Regional Complex, Barrackpore Regional Complex, Point Fortin Civic Centre and other regional complexes located outside the S-DAoI but within the broader south-western service environment.

Sport and recreation infrastructure within the wider S-AoI includes both formal facilities and community-based recreational spaces. The Ministry of Sport and Community Development lists Siparia Community Swimming Pool on Park Street, Siparia, providing a formal recreation and aquatic facility within the direct area of influence. The South Western Regional Indoor Sport Arena, located at Egypt Village in Point Fortin, serves the wider St. Patrick district, while the Southern Regional Indoor Sport Arena in Pleasantville and other facilities in San Fernando provide additional options outside the immediate S-IAoI. These facilities support organised sport, physical activity, youth programmes and community recreation at different scales.

Natural and informal recreation spaces also form part of the wider recreational landscape of the S-IAoI. In the Borough of Siparia, coastal areas, beaches, wetlands, forested areas, rivers,

swamps, and natural heritage sites contribute to recreation, tourism, and cultural use, particularly in areas such as Cedros, Icacos, La Brea, Erin, Palo Seco, and other coastal or rural communities. Penal/Debe's recreational and community-use landscape is more closely associated with village settlements, community grounds, religious and cultural spaces, agricultural landscapes and natural features such as mud volcanoes and wetland environments. These spaces are not necessarily formal recreation infrastructure, but they contribute to place use, community identity and leisure activity across the wider south-western setting.

The community and recreational infrastructure profile of the S-DAoI is therefore relatively strong in terms of basic local facility availability. Siparia contains both a community centre and a community swimming pool, and is supported by nearby regional, civic and sport facilities in Fyzabad, Point Fortin, San Fernando and surrounding communities. Mendez Village has a local community centre and is located within reach of additional community and recreation facilities in Penal, Clarke Rochard, Debe, Siparia and other nearby settlements. The available data provide a useful inventory of facility locations, but do not confirm facility capacity, condition, accessibility for persons with disabilities, opening hours, user levels, programme availability, maintenance needs or the extent to which facilities are actively used by residents.

Water and Sanitation

Access to water and sanitation services across the S-AoI reflects the uneven character of water infrastructure coverage and service reliability in south-western Trinidad. While most households in the wider S-IAoI relied on public pipe-borne water in 2011, the level of direct household connection and the frequency of supply varied considerably between Siparia and Mendez Village. Sanitation arrangements were dominated by on-site systems, particularly water closets connected to septic tanks, while pit latrines remained more common in some communities.

In 2011, public pipe-borne water was the main source of household water supply across the S-IAoI. Most households reported either a public pipe-borne supply to the dwelling (58.2%), public pipe-borne supply to the yard (19.8%), or access through a public standpipe (3.0%). Public pipe-borne water therefore accounted for approximately 81.0 percent of household water supply in the S-IAoI. The pattern was broadly similar in the Borough of Siparia and Penal/Debe Regional Corporation, where public pipe-borne sources accounted for 78.2 percent and 83.9 percent of households, respectively. Private catchments accounted for 7.5 percent of households across the S-IAoI, while truck-borne water, springs, rivers, wells, ponds and other sources accounted for smaller shares (Central Statistical Office of Trinidad and Tobago, 2012a).

Within the S-DAoI, public pipe-borne water also represented the main household water source, but direct household connection was less consistent. Just over half of S-DAoI households reported public pipe-borne water to the dwelling (51.4%), while 30.5 percent relied on a public pipe-borne supply to the yard and 1.6 percent used a public standpipe. Combined, public pipe-borne sources accounted for 83.5 percent of households in the S-DAoI. However, community-level differences were pronounced. In Siparia, 59.7 percent of households reported public pipe-borne water to the dwelling, and 28.8 percent had public pipe-borne water to the yard, while only 4.5 percent relied on private catchments. In Mendez Village, only 16.4 percent of households had public pipe-borne water to the dwelling, while 37.5 percent relied on public pipe-borne water to

the yard and 35.5 percent relied on private catchments. Mendez Village, therefore had a substantially lower level of in-dwelling public water connection and a much higher reliance on catchment water than Siparia.

The frequency of public water supply also varied across the S-AoI. Across the S-IAoI, 18.7 percent of households connected to the public water system reported daily supply, 39.4 percent received water three or more times weekly, and 39.3 percent received water once or twice weekly. Only small shares reported receiving water once every two or three weeks (2.1%) or not at all (0.3%). The Borough of Siparia recorded better daily supply than Penal/Debe, with 25.0 percent of households receiving water every day compared with 12.8 percent in Penal/Debe. Penal/Debe recorded a higher proportion of households receiving water once or twice weekly (42.4%) than the Borough of Siparia (35.9%).

Within the S-DAoI, public water supply was less frequent than the wider S-IAoI average. Only 10.4 percent of households connected to public supply reported receiving water every day, while 24.4 percent received water three or more times weekly and 63.4 percent received water once or twice weekly. In Siparia, 11.8 percent of households reported daily supply, 26.1 percent received water three or more times weekly, and 60.5 percent received water once or twice weekly. In Mendez Village, daily public supply was very limited, at 0.9 percent, while 12.9 percent received water three or more times weekly and 82.6 percent received water once or twice weekly. These figures show that, although public water infrastructure is present, most households in the S-DAoI, particularly in Mendez Village, experienced intermittent rather than daily water supply.

Recent newspaper reporting provides operational context for the intermittent water supply conditions reflected in the 2011 Census data. In November 2022, WASA reported reduced production at the Siparia Water Treatment Plant due to a downhole issue affecting Siparia Well #14. The affected areas included Quinam Road, Mendez, Upper and Lower Coora Road, Coora Extension, Saney Trace, High Street and several surrounding communities. WASA also noted that adverse weather and poor access road conditions had slowed repair works, and that supply restoration could take up to 24 hours in some areas after production resumed (Chan Tack, 2022). This incident is directly relevant to the S-DAoI because it affected both Mendez and central Siparia areas served by the Siparia system.

Water reliability in the S-AoI is also influenced by wider production and transmission arrangements beyond the Siparia WTP. Recent reports of disruptions linked to the DESALCOTT, Caroni and other regional systems show that communities in central and south-west Trinidad, including Siparia and Penal, can experience low pressure or interrupted supply because of plant shutdowns, electrical works, transmission failures or major repairs (Guardian Media Newsroom, 2026; “Water Supply Disruption in Central and Southwest Trinidad,” 2024). These reports reinforce that water access in the S-AoI is shaped by both local plant performance and wider system interdependencies.

Media reports on prolonged repairs and service disruptions also point to the social effects of intermittent supply, including household frustration, reliance on stored water, disruption to daily routines and increased pressure on vulnerable households, small businesses and care activities

(Rodriguez, 2023). Read together with the 2011 Census data, the reports confirm that water reliability remains a material access issue in the S-AoI, particularly where households already depend on intermittent public supply, yard connections, catchments or other supplementary sources.

Sanitation coverage across the S-AoI was largely dependent on on-site systems. Across the S-IAoI, 78.4 percent of households used water closets linked to septic tanks, while 7.6 percent used water closets linked to sewer systems and 14.0 percent relied on pit latrines. The same general pattern was observed in both municipalities. In the Borough of Siparia, 76.9 percent of households used water closets linked to septic tanks, 6.1 percent were connected to sewer systems and 17.0 percent used pit latrines. In Penal/Debe, 80.0 percent used water closets linked to septic tanks, 9.1 percent were connected to sewer systems and 11.0 percent used pit latrines (Central Statistical Office of Trinidad and Tobago, 2012a).

Within the S-DAoI, 76.5 percent of households used water closets linked to septic tanks, 5.0 percent used water closets linked to sewer systems, and 18.6 percent relied on pit latrines. Siparia recorded a slightly higher level of sewer connection (5.9%) and septic tank use (77.5%) than Mendez Village, where only 1.3 percent of households were connected to sewer systems and 72.0 percent used water closets linked to septic tanks. Pit latrine use was also higher in Mendez Village (26.7%) than in Siparia (16.6%). This sanitation profile points to a stronger reliance on on-site sanitation in both communities, with Mendez Village having the higher dependence on pit latrines.

The water and sanitation profile of the S-DAoI reflects two different access conditions. Siparia has a higher level of public pipe-borne water delivered directly to dwellings and a lower reliance on catchment water, but most households connected to the public mains still reported receiving water only once or twice weekly. Mendez Village has a more constrained water access profile, with lower in-dwelling pipe-borne coverage, higher reliance on yard connections and private catchments, and very limited daily public water supply. Sanitation arrangements in both communities remain predominantly on-site, with water closets linked to septic tanks forming the main system, while pit latrines remain more common in Mendez Village.

Where households rely on intermittent public supply, catchments, pit latrines or septic tanks, service conditions may be influenced by storage capacity, household resources, maintenance practices, rainfall variability, drainage conditions and proximity to watercourses. Newspaper reports of recent WASA production constraints, regional plant shutdowns and repair delays reinforce the continued relevance of water reliability in the S-AoI. In this context, reliable water supply and safe sanitation remain important components of household wellbeing, public health and community resilience across the S-DAoI.

Electricity

Electricity access across the S-AoI is high and broadly consistent with national patterns of near-universal household electrification. Electricity is the dominant household light source across both S-IAoI municipalities and the S-DAoI communities, while reliance on kerosene and other lighting sources is limited. This profile suggests that electricity access is not a major

infrastructure deficit for most households in the project area, although small residual gaps remain, particularly where households face affordability constraints, informal tenure conditions, or incomplete service build-out in newer or recently subdivided residential areas.

In 2011, 97.4 percent of households across the S-IAoI used electricity as their main source of lighting. Coverage was slightly higher in Penal/Debe Regional Corporation (98.5%) than in the Borough of Siparia (96.4%). Kerosene was the next most common lighting source, accounting for 2.2 percent of households across the S-IAoI, with higher use in Siparia (3.2%) than in Penal/Debe (1.2%). Other lighting sources accounted for only 0.3 percent, while gas and solar energy were negligible as primary household lighting sources (Central Statistical Office of Trinidad and Tobago, 2012a).

Within the S-DAoI, 96.5 percent of households used electricity as their main lighting source, broadly comparable to the Borough of Siparia and only slightly below the wider S-IAoI average. Electricity use was marginally higher in Siparia (96.7%) than in Mendez Village (95.2%). Kerosene use accounted for 3.2 percent of S-DAoI households, with a higher share in Mendez Village (4.8%) than in Siparia (2.8%). Solar energy was reported by only 0.1 percent of households in the S-DAoI, while other sources accounted for 0.3 percent. These figures indicate that both directly affected communities had high levels of electricity access, but Mendez Village retained a slightly higher reliance on non-electric lighting sources.

Municipal infrastructure assessments similarly describe electricity supply as universal or near universal in both S-IAoI municipalities. In Siparia, the small share of households without electricity has been linked mainly to affordability constraints associated with extreme poverty. In Penal/Debe, remaining access gaps have been linked to both affordability constraints and incomplete service build-out by the Trinidad and Tobago Electricity Commission in recently subdivided residential lands (Kairi Consultants Limited, 2016a, 2016b). These factors help explain why the small proportion of households not using electricity as their main lighting source may persist despite generally extensive network coverage.

The wider electricity context is also relevant because south-western Trinidad contains nationally significant energy infrastructure. Electricity generation assets include facilities in Union Estate, Siparia and Penal/Debe, while the broader south-western industrial and energy landscape includes power generation, petroleum, gas, industrial estates and associated transmission and utility infrastructure. At the municipal planning level, infrastructure upgrading has been identified as part of the wider development agenda for Siparia, including the need to provide adequate capacity and efficient services for electricity, telecommunications, water supply, sewage disposal, drainage and solid waste management (All-inclusive Project Development Services Limited, 2010; Clarke et al., 2019).

For the S-DAoI, the main electricity-related issue is therefore not basic household access, but the small share of households that continue to rely on kerosene or other sources, together with the broader importance of reliable electricity for water supply, household storage, communication, business activity and public services. Reliable electricity is also indirectly linked to water service delivery, as treatment, pumping and distribution systems depend on a stable power supply. In

this context, the refurbishment and upgrading of the Siparia WTP should be understood within a wider infrastructure environment where household electrification is high, but service reliability and the interdependence of utilities remain important to community resilience.

Information and Communication Technology

Information and communication technology (ICT) access is an increasingly important component of household wellbeing, education, employment, business activity, access to public services, emergency communication and social participation. In Trinidad and Tobago, ICT access and use are shaped not only by the availability of telecommunications infrastructure, but also by affordability, household devices, digital skills, trust in online services and the capacity of different population groups to use digital tools effectively. The Digital Inclusion Survey 2021 treats digital inclusion as a broader concept than access alone, incorporating ICT access, participation and usage, trust and confidence, and readiness/digital literacy (Kairi Consultants Limited, 2022).

Nationally, ICT access has improved over the past decade. Trinidad and Tobago recorded an ICT Development Index (IDI) score of 7.86 in 2021, compared with 5.55 in the 2013 Digital Divide Survey. The national Digital Inclusion Index (DII) was 4.24, reflecting a broader assessment of how effectively residents are able to participate in a digital society. Despite improvements in access and subscriptions, the survey identified persistent issues related to ICT skills, use of digital government services, and inclusion of older persons and persons with disabilities (PWDs), who reported lower ICT adoption and use than the wider population (Kairi Consultants Limited, 2022).

At the household level, fixed Internet access is now widespread but not universal. Nationally, 74 percent of households reported a working fixed Internet subscription in 2021, with a slightly lower share in rural areas (71%) than in urban areas (75%). Pay TV subscriptions were less common in rural households (33%) than in urban households (52%), while fixed voice services were used by approximately 26 percent of households nationally. Among households without Internet access, the main reasons were lack of perceived need, cost of service, access to Internet elsewhere, and the cost of equipment (Kairi Consultants Limited, 2022). These barriers remain relevant to the S-AoI, particularly where household income, education levels, age, disability, and rural settlement patterns influence the ability to access and use ICT services.

The municipal digital inclusion profile varies within the S-IAoI. The Borough of Siparia performed comparatively well on digital inclusion, ranking among the three highest municipalities nationally on the DII, with a score of 4.61. Penal/Debe, by contrast, recorded one of the lowest municipal DII scores, at 3.60. The difference between the two municipalities is important for understanding the S-AoI because it suggests stronger digital participation and inclusion conditions in the Siparia side of the S-IAoI than in Penal/Debe, even where basic telecommunications access may be present in both municipalities (Kairi Consultants Limited, 2022).

Community-level estimates show a sharper contrast within the S-DAoI. Siparia recorded an IDI score of 8.32 and a DII score of 5.16, ranking relatively highly among communities nationally. Mendez Village recorded a lower IDI score of 7.27 and DII score of 3.69. Siparia's stronger performance is consistent with its role as a municipal service centre, with greater concentration of public services, businesses, schools, health facilities and transport connections. Mendez

Village's lower scores are more consistent with a smaller rural-residential settlement profile, where access to digital devices, household Internet, mobile and wireless infrastructure, and digital service use may be more constrained.

Municipal resilience data provide additional context for communications capacity. Penal/Debe was identified as having the lowest communications capacity ranking nationally, linked to relatively low mobile and wireless infrastructure density and mobile phone use. The same profile recommended investment in communications infrastructure to support broader use and reliability of mobile and wireless devices, particularly for rural areas and hazard alerting. In Siparia, communications capacity was not identified as the weakest coping-capacity driver, but the municipal profile still records communications indicators as part of its wider resilience context, including mobile phone use and mobile/wireless infrastructure availability (Pacific Disaster Center (PDC Global), 2020).

Earlier municipal economic planning also identified ICT as part of local development infrastructure. In Penal/Debe, a Multi-Purpose Community Based Telecentre was identified as providing access for persons without Internet service at home. The wider planning context also linked expanding cable television, Internet and broadband access to opportunities for distance education, Massive Open Online Courses and other online learning resources. In Siparia, municipal economic planning highlighted the need for universal telecommunications service roll-out, including broadband and other services across communities, and identified Internet access in community centres as part of the infrastructure that could support education, training and enterprise development (Kairi Consultants Limited, 2016a, 2016b).

ICT access is also relevant to local enterprise activity. In Siparia, earlier MSME survey findings recorded routine Internet use among many businesses, with greater use among micro and small businesses than micro-mini enterprises. This points to the growing role of digital tools in business operations, even where smaller or less formal businesses may have lower uptake. For the S-DAoI, reliable Internet and mobile connectivity can support small business communication, customer engagement, access to public services, online banking, training, education, and coordination during utility disruptions or emergencies (Kairi Consultants Limited, 2016a).

Population characteristics influence the extent to which ICT infrastructure translates into digital inclusion. Nationally, Internet use was above 90 percent among persons aged 5 to 44, but declined among older age groups, reaching 36.9 percent among persons aged 75 and over. Persons with disabilities also reported substantially lower use of ICT, with 40.4 percent using the Internet compared with 80.1 percent among persons without disabilities. Mobile phone ownership was high nationally, but lower among PWDs than the wider population. These patterns are relevant to the S-AoI given the presence of older adults, persons with disabilities, residents with chronic illnesses, and households with varied income and education levels (Kairi Consultants Limited, 2022).

The ICT profile of the S-DAoI therefore reflects uneven but generally improving digital access. Siparia has a stronger digital inclusion profile and functions as a local service node with greater capacity to support digital participation. Mendez Village appears more constrained, with lower

community-level IDI and DII scores and greater dependence on nearby service centres. The available data do not confirm household-level Internet subscriptions, mobile coverage quality, network reliability, affordability, or device ownership within the immediate WTP project footprint. However, the available evidence points to ICT access as an important enabling infrastructure for education, livelihoods, business activity, access to public services, emergency communication, and stakeholder engagement across the S-AoI.

Transportation

Transportation access across the S-AoI is primarily road-based and is shaped by the distribution of settlements, the location of service centres, the condition of arterial and local roads, and the availability of public and informal transport. Siparia functions as the main service centre within the S-DAoI and provides access to administrative, commercial, health, education and community facilities. Mendez Village has a smaller residential-rural settlement profile and is more dependent on road connections to Siparia, Penal, Debe and San Fernando for higher-order services, employment, education and health care.

The main road infrastructure serving the S-AoI includes arterial, collector and local roads that connect Siparia and Penal/Debe to San Fernando, Point Fortin, La Brea, Fyzabad, Erin, Debe, Penal and surrounding rural communities. The San Fernando–Siparia–Erin Road, commonly referred to as the S.S. Erin Road, is one of the principal transport corridors in the wider S-AoI, linking San Fernando and South Oropouche to Siparia, Palo Seco, Erin and the south-western peninsula. It supports commuting, public transport movement, access to commercial services, and the movement of goods and construction materials across the wider Siparia service area.

Within and around Siparia, important local and connector roads include High Street, Siparia; La Brea Trace; Siparia Old Road; Coora Branch Road; Quinam Road; Railway Road; and roads serving De Gannes Village, Lower Coora, Coora Hernandez Road, Coora Extension, Saney Trace and nearby communities. These roads connect households to the Siparia town centre, the Siparia District Health Facility, schools, religious institutions, businesses, the community centre, the swimming pool, and the Siparia WTP service area. They also provide links to rural and semi-rural communities that rely on Siparia for administrative and commercial services.

On the Penal/Debe side of the S-AoI, the main road network includes Penal–Quinam Road, Clarke Road, Penal Rock Road, Rochard Road, Southern Main Road, Debe Main Road and other connector roads serving Debe, Penal, Barrackpore, Rochard Douglas, Mendez Village and surrounding settlements. Mendez Village is linked to the wider transport network through Penal–Quinam Road and road connections toward Siparia, Penal and Debe. These routes are important for access to schools, health centres, employment, markets, places of worship and public services.

Common modes of transport in the S-AoI include private vehicles, taxis, maxi-taxis, PTSC buses, informal "PH" taxis, school transport, walking for short local trips, and motorcycles or bicycles in some communities. Public transport in the wider south-western area is mainly road-based, with PTSC services and privately operated route taxis and maxi-taxis providing access along major corridors and between service centres. Parliamentary evidence for Penal/Debe noted PTSC

services along the S.S. Erin Road to Erin, as well as along Penal Rock Road and Clarke Road, while also identifying reliance on private "PH" transport in rural communities where formal public transport is limited or less reliable (Parliament of Trinidad and Tobago, 2015a).

Transport access is generally stronger in Siparia than in smaller rural communities because of its role as a municipal service centre and its position along major road corridors. Residents of Siparia have closer access to schools, the district health facility, community facilities, retail services and public offices. Mendez Village residents have direct access to local roads and nearby primary facilities, but depend more heavily on travel to Penal, Debe, Siparia and San Fernando for secondary, tertiary, specialised health, commercial and employment services. Households without private vehicles are therefore more dependent on the availability, affordability and reliability of taxis, maxi-taxis, PTSC services and informal transport.

Road condition and drainage are key transport access challenges across the S-AoI. Siparia's road infrastructure has been described as inadequately maintained in some areas, affected by flooding and poor drainage, and not always designed to meet the traffic and weight demands associated with heavy vehicles serving the energy sector (Kairi Consultants Limited, 2016a; Pacific Disaster Center (PDC Global), 2020). The municipality was also ranked as having the fourth lowest transportation capacity nationally, driven by low road density and distance to port facilities, with implications for emergency response, access to goods and services, and local economic activity (Pacific Disaster Center (PDC Global), 2020).

Penal/Debe also faces transport constraints linked to settlement pattern, rural access, flooding and congestion. The northern part of the municipality is relatively close to San Fernando and major transport facilities, while deeper southern areas are more sparsely settled and less accessible (Parliament of Trinidad and Tobago, 2015a). Traffic congestion has been noted in Debe, while rural communities have been described as having greater dependence on informal transport. Flooding and drainage constraints in the Oropouche Basin can also affect road usability, commuting, school attendance, emergency response, and access to goods and services, particularly during heavy rainfall events (Kairi Consultants Limited, 2016b; Pacific Disaster Center (PDC Global), 2020).

Transportation access is therefore an important component of vulnerability and service access within the S-AoI. Poor road conditions, intermittent flooding, congestion, limited formal public transport, and dependence on informal transport can increase travel time and cost for households, particularly for students, older persons, persons with disabilities, persons with chronic illnesses, workers, small business operators, and households without private vehicles. These conditions are especially relevant where residents must travel outside their community for secondary education, tertiary training, specialised health services, employment, government services or regular household needs.

For the Siparia WTP Refurbishment and Upgrading Project, the transportation baseline points to a road-based access environment with reasonable connectivity to major service centres, but with localised constraints related to road quality, drainage, rural accessibility and public transport reliability. Siparia has a stronger local service and transport position, while Mendez Village is

more dependent on surrounding road corridors and external service centres. The available data provide useful municipal and institutional context, but do not confirm current traffic volumes, road conditions at the WTP access point, public transport frequency, pedestrian conditions, travel times or household-level transport constraints in the S-DAoI.

4.4.2.6 Institutional Stakeholder Landscape

The institutional stakeholder landscape for the Siparia WTP Refurbishment and Upgrading Project is shaped by central government agencies, local government authorities, statutory service providers, public utilities, community-based organisations, faith-based institutions, private-sector actors and informal resident networks operating within Siparia, Mendez Village and the wider S-IAoI. These institutions are linked to water service delivery, land administration, environmental regulation, public health, road and drainage maintenance, disaster response, community development, public safety and local representation. Their presence and functions form part of the existing social context within which the project will be planned and implemented.

The project involves the refurbishment and upgrading of the Siparia Water Treatment Plant, which serves communities within the wider south-western water supply network. The institutional landscape is therefore closely connected to existing patterns of water supply reliability, WTP operations, public communication on service disruptions, local infrastructure conditions, public health, disaster resilience and community-level service access.

Local and National Government Institutions

At the national level, the Water and Sewerage Authority (WASA) is the principal institutional stakeholder for the project. WASA is responsible for potable water abstraction, treatment, transmission and distribution, and has direct operational responsibility for the Siparia WTP. Its existing role in the S-AoI is particularly important because households in Siparia and Mendez Village experience intermittent water supply, and residents' interactions with WASA are likely to be shaped by previous experiences with water availability, outage notification, restoration timelines, emergency supply arrangements and complaint handling.

Local government oversight is provided by the Borough of Siparia and the Penal/Debe Regional Corporation. Both local government bodies perform similar functions related to local roads and drains, refuse collection, minor infrastructure maintenance, public health support, community facilities, disaster management and community-level coordination. The Borough of Siparia has jurisdiction over Siparia, where the WTP and the main service centre within the S-DAoI are located, making it particularly relevant to local service access, community infrastructure and institutional communication patterns in the Siparia portion of the S-DAoI (All-inclusive Project Development Services Limited, 2010; Parliament of Trinidad and Tobago, 2015b). The Penal/Debe Regional Corporation is relevant because Mendez Village forms part of the S-DAoI. Mendez Village's dependence on road connections to Penal, Debe, Siparia and San Fernando for education, health, employment and other services places the Corporation within the institutional setting relevant to local access, drainage, road condition, disaster response and community communication in the Penal/Debe portion of the S-AoI.

Other central government agencies and statutory bodies have issue-specific relevance. The ministry responsible for public utilities and water-sector policy is relevant to sector oversight and governance. The Environmental Management Authority is relevant to environmental permitting, compliance and monitoring. The Town and Country Planning Division is relevant to land-use planning and development control. The Commissioner of State Lands and the Land Settlement Agency may become relevant where State land, public land, tenure status, encroachment or informal settlement issues intersect with project planning. The South West Regional Health Authority is relevant to public health and health service access, while the Ministry of Health is relevant where water quality, sanitation or public health conditions are raised.

Public safety and emergency response fall within the remit of the Trinidad and Tobago Police Service, municipal police units, the Trinidad and Tobago Fire Service, the Office of Disaster Preparedness and Management and municipal disaster management units. These agencies form part of the wider institutional landscape because the S-AoI is affected by road access constraints, flooding and drainage issues, intermittent water supply and other infrastructure conditions that may influence emergency preparedness and response. Electricity and telecommunications providers are also relevant because water treatment, pumping, distribution, public communication and outage notification depend on reliable power and communication systems.

Existing institutional conditions point to the importance of inter-agency coordination in both municipalities. Earlier reviews of municipal corporations identified staffing, resource and coordination constraints, including overlapping responsibilities among local government and central agencies. In Penal/Debe, the Regional Coordinating Committee was reported as not functioning as intended due to inconsistent attendance by some state-agency representatives, and the Corporation was reported to lack a Communications Unit (Parliament of Trinidad and Tobago, 2015a). These conditions provide context for understanding how information, service requests and institutional responsibilities may move across agencies.

Disaster and resilience institutions are also relevant to the existing stakeholder landscape. Penal/Debe's municipal risk profile identifies environmental stress, flooding, sewerage, wastewater and drainage as key concerns, while also noting communications capacity constraints. Siparia's resilience profile similarly identifies transportation, water and sanitation, and infrastructure-related issues as part of the municipal risk context (Pacific Disaster Center (PDC Global), 2020). These patterns link water supply reliability with household resilience, emergency response, road access, public health and communication systems.

Civil Society Organisations

Civil society stakeholders in the S-AoI include community-based organisations, faith-based institutions, school communities, parent groups, business networks, sports and cultural organisations, informal resident networks and local leaders. These actors contribute to social cohesion, information sharing, local advocacy, community mobilisation and informal support to households. Their role is particularly important in communities where residents may rely on established social networks to obtain information, raise concerns or respond to service disruptions.

Siparia has a comparatively developed civil society and community infrastructure base because it functions as a municipal service centre. Earlier municipal planning identified social and community organisations as resources for poverty alleviation and regional development, including organisations concerned with community development, health and disability, ageing, youth, education and voluntary activity (All-inclusive Project Development Services Limited, 2010). The Siparia Inter-Religious Group and the Siparia Chamber have also been identified as local stakeholder bodies (Parliament of Trinidad and Tobago, 2015b). These institutions point to an existing civic and faith-based network that may influence how information circulates within the community.

Community facilities provide an important physical base for civil society activity. Siparia Community Centre and Mendez Community Centre are located within the S-DAoI and provide local venues for meetings, training, outreach, public information sessions and community-level coordination. The wider St. Patrick community centre network includes facilities across Siparia, Penal, La Brea, Fyzabad, Cedros, Erin, Palo Seco, Los Bajos, Vessigny, Penal Rock Road, Clarke Rochard and other communities, reflecting a broader network of community infrastructure across the S-IAoI.

Faith-based institutions are also important civil society actors. The religious composition of the S-AoI includes Christian, Hindu, Muslim and other faith communities, with differences between Siparia and Mendez Village. Religious institutions may serve as places of worship, but also as centres for social support, charitable activity, information dissemination and informal community coordination. The presence of diverse faith networks is part of the socio-cultural context within which consultation, communication and community-level participation occur.

Private-sector and livelihood stakeholders form part of the broader civil society landscape. The S-AoI includes small businesses, vendors, transport operators, contractors, farmers, agricultural workers, service providers and informal operators. Local economic development planning in both Siparia and Penal/Debe emphasises collaboration among local government, civil society, the private sector and communities, particularly in relation to MSME development, enterprise support and local economic opportunities (Kairi Consultants Limited, 2016b, 2016a). These actors are relevant to the institutional baseline because water supply interruptions, access constraints and road conditions can affect business activity, transport, household livelihoods and service delivery.

Within the S-DAoI, the civil society landscape differs between Siparia and Mendez Village. Siparia's larger population, service-centre function and concentration of schools, health facilities, businesses, religious institutions, public services and community facilities suggest a more institutionally varied stakeholder environment. Mendez Village has a smaller rural-residential profile, with local institutions such as the community centre, schools, places of worship, resident networks and nearby Penal/Debe organisations forming the likely basis for community-level engagement. The activity level, representativeness and current leadership of specific organisations would require field verification.

The vulnerable and service-dependent groups identified in earlier baseline sections are also part of the stakeholder landscape. These include older persons, persons with disabilities, persons with chronic illnesses, low-income households, single-person households, households with limited water storage, households relying on catchments or yard connections, households using pit latrines, children, women-headed households, informal or insecure-tenure households, small business operators and residents without private transport. Their presence is relevant to later assessment because these groups may experience water interruptions, access changes, construction disturbance or communication gaps differently from the wider population.

Community Participation and Consultation Mechanisms

Community participation and consultation within the S-AoI are likely to occur through a combination of formal and informal channels. These include interaction with WASA, engagement with local government representatives, community meetings, community centre activities, faith-based networks, school and health facility channels, local business networks, elected representatives and informal resident communication. Existing patterns of issue-raising in similar semi-rural contexts tend to be linked to service delivery concerns such as water supply reliability, road condition, drainage, waste collection, public health issues and local infrastructure needs.

Previous municipal planning and local economic development processes provide examples of participation mechanisms used in the wider S-IAoI. The Siparia and Penal/Debe local economic development processes used municipal discussions, MSME surveys, focus group discussions with entrepreneurs, interviews with state agencies, private-sector organisations and NGOs, and review of secondary data. This indicates that both municipalities have prior experience with multi-stakeholder planning processes involving public agencies, private actors, civil society and community representatives (Kairi Consultants Limited, 2016a, 2016b). The Siparia Municipal Development Plan also identifies consultation, stakeholder participation, community empowerment and participatory governance as part of the municipal planning context (All-inclusive Project Development Services Limited, 2010).

The existing participation landscape is likely to vary between Siparia and Mendez Village. Siparia has a larger institutional base and more established service-centre functions, which may provide multiple channels for information sharing through local government, schools, health facilities, faith-based bodies, business networks and community facilities. Mendez Village has a smaller institutional footprint and may depend more heavily on local leaders, community centre networks, places of worship, nearby schools, municipal representatives and informal resident communication. These differences are relevant for understanding how information may reach different parts of the S-DAoI.

Digital communication is also part of the participation context, but it is uneven across the S-AoI. Earlier ICT baseline information showed stronger digital inclusion conditions in Siparia than in Mendez Village and wider communications capacity constraints in Penal/Debe. As a result, online notices, email, websites and social media may be useful communication channels for some residents and organisations but may not reach all households equally. Printed notices, in-

person engagement, community-based announcements and direct contact through trusted local institutions remain relevant within the S-AoI participation landscape.

The history of intermittent water supply is likely to influence participation and stakeholder concerns. Residents' existing experience with low-pressure, intermittent supply, water storage, private catchments, truck-borne supply, delayed restoration, and uneven service frequency may shape how they interpret information about WTP refurbishment, planned outages, service continuity, and project benefits. These concerns are baseline conditions rather than project impacts in themselves, but they may influence stakeholder expectations and the types of questions raised during later engagement.

4.4.3 Refurbishment of the Acono Water Treatment Plant

4.4.3.1 Demographic and Social Structure

Section 4.4.3.1 section summarises the demographic and social characteristics of the population residing within the defined social area of influence for the refurbishment of the Acono WTP, drawing primarily on data from the 2011 Population and Housing Census and other relevant secondary sources (Central Statistical Office of Trinidad and Tobago, 2012a). The focus is on describing population size, distribution, density, household composition, age and gender structure, and selected vulnerability characteristics within Acono Village (S-DAoI), and, more broadly, the Tunapuna/Piarco municipality (S-IAoI), which provides the wider municipal context for the project. These indicators establish the existing demographic and social conditions within the S-AoI and identify patterns relevant to later assessment of community sensitivity, stakeholder engagement, and potential project interactions.

Population and Housing Characteristics

The municipality of Tunapuna/Piarco had a total population of 215,119 (including 212,825 non-institutionalised people) according to the 2011 Population and Housing Census, accounting for 16.2 percent of the country's overall population. The region experienced minimal population growth in the decade preceding the last Census, with its annual growth rate between 2000 and 2011 (0.5%) matching the national average (0.5%). However, the municipality is approximately 1.6 times as dense as Trinidad's overall density, with an estimated 421.8 persons per square kilometre (persons/km^2). Most of the Tunapuna/Piarco population is concentrated mostly north of the Churchill Roosevelt Highway in a band along the region's East-West corridor, with high-density areas in Curepe (2,812 persons/km^2), Dinsley (7,845 persons/km^2), Bon Air (5,537 persons/km^2), Maloney (10,876 persons/km$^{2)}$, La Horquetta (3,264 persons/km^2) and Santa Rosa Heights (3,420 persons/km^2).

Table 4-12: Key 2011 Population and Household Indicators for Acono WTP Refurbishment S-AoI

Administrative Area	Population Indicators		Household Indicators	
	Total Population Count	Population Density	Household Count	Average Household Size
Trinidad and Tobago	1,328,019	259.0	401,373	3.3
Tunapuna/Piarco	215,119	421.8	64,174	3.3
Acono Village	2,050	138.0	576	3.6

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

Tunapuna/Piarco also recorded an intercensal increase in the number of households. From 2000 to 2011, the municipality's household growth closely matched that observed at the national level (17.0%), rising by 16.2 percent to reach 64,174 households in 2011. Similarly, the average household size in Tunapuna/Piarco was 3.3 persons, consistent with the national average (3.3 persons per household). Most households in the region contained between two and three individuals (40.0%), and, at 35.4 percent, a comparable proportion of families were medium-sized (4 to 6 persons). Notably, almost one in five households (18.6%) was a single-person household.

Acono Village, the community in which the Acono WTP is located, had a population of 2,050 in 2011, accounting for 1.0 percent of the municipal population of Tunapuna/Piarco. The Village is one of the municipality's low-density communities in the Northern Range. The S-DAoI's population density is roughly a third of the municipal density at 138.0 persons/km^2. Acono Village had 576 households in 2011, with an average of 3.6 individuals per household. Although small households were most common (37.5%) in the community, households with four to six members were almost equally prevalent at 35.6 percent. Notably, larger families (more than six individuals) were more frequent in the S-DAoI at 8.5 percent, compared to 6.0 percent observed regionally.

Age and Gender Composition

The population of Tunapuna/Piarco aged between 2000 and 2011. The municipality's median age increased by almost 5 years over that period, reaching 33.0 years in 2011, up from 28.3 years in 2000. This corresponded to an 8.3 point increase in the proportion of the municipal population over 45 years to 32.9 percent in 2011. The proportion of older adults (over 65 years old) also increased from 5.9 percent in 2000 to 8.7 percent in 2011. Despite the ageing of the population, Tunapuna/Piarco maintained a predominantly youthful demographic. Children, individuals under 15, comprised roughly one-fifth (20.2%) of the S-IAoI population. Just over half (53.2%) of the region's population was under 35 years old in 2011. Notably, at 46.3 percent, the youth constituted a significant segment of the working-age population in 2011, although this figure has decreased from 51.0 percent in 2000.

The 2011 gender distribution in Tunapuna/Piarco was roughly even, with females making up the majority at 50.8 percent of the population. This figure corresponds to a ratio of 1.5 more females than males for every 100 people.

Table 4-13: Key 2011 Age Indicators for Acono WTP Refurbishment S-AoI

Administrative Area	Age Distribution (%)			Median Age	Age Dependency
	Child	Working Age	Older Adult		
Trinidad and Tobago	20.6	70.5	8.9	32.6	41.9
Tunapuna/Piarco	20.2	71.2	8.7	33.0	40.5
Acono Village	24.0	69.4	6.6	31.0	44.2

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

Acono Village had a relatively younger population in 2011 than the Tunapuna/Piarco municipality. Overall, the median age in Acono Village was 31.0 years in 2011, with the under-35 cohort constituting 56.4 percent of the community. Youth accounted for a similar proportion of the working-age population (46.7%) in the S-DAoI as in the municipality, largely because children were a larger share of the S-DAoI population. Individuals under 15 years old made up about a quarter of the population (24.0%), accounting for 42.6 percent of the local youth population, as opposed to 38.0 percent regionally. Notably, 6.6 percent of Acono Village were older adults.

Table 4-14: Key Sex Indicators for Acono WTP Refurbishment S-AoI

Community	Male (%)	Sex Ratio
Trinidad and Tobago	50.1	100.3
Tunapuna/Piarco	49.2	97.0
Acono Village	52.0	108.4

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

In contrast to the sex distribution observed across Tunapuna/Piarco, Acono Village exhibited a male majority. Males represented 52.0 percent of the Village's population, corresponding to 108.4 males per 100 females.

Vulnerable Groups

In the context of the refurbishment of the Acono WTP, vulnerability refers to the extent to which individuals, households or groups may be more sensitive to service disruptions, face constraints in coping with short-term changes, or experience barriers to accessing information and participating in consultation. Vulnerability is shaped by population characteristics as well as exposure to hazards, dependence on essential services, income security, mobility, health status, access to information, and the availability of household or community support systems. National vulnerability literature identifies older persons, persons with disabilities, children, persons with chronic illnesses, low-income households and other special-needs populations as groups that may face additional challenges in anticipating, absorbing, responding to and recovering from hazards, service disruptions or environmental stressors(Clarke et al., 2019; Office of Disaster Preparedness and Management (ODPM), 2014; Pacific Disaster Center (PDC Global), 2020). Within the S-AoI, vulnerability is therefore best understood as the interaction between social and economic conditions, environmental exposure, and household or institutional coping capacity.

Older persons represent an important vulnerable group within Acono Village. In 2011, persons aged 65 years and over accounted for 6.6 percent of the S-DAoI population. Although this was lower than the share recorded in the wider Tunapuna/Piarco municipality, older residents may be more sensitive to interruptions in potable water supply, reduced water pressure, temporary access constraints or changes to household routines, particularly where they live alone, have limited mobility, or rely on others for water storage, transport or communication. This sensitivity is reinforced by the wider health profile of the S-IAoI. In 2011, approximately half of the population aged 60 years and over in Tunapuna/Piarco reported having one or more chronic illnesses. Chronic illness, age-related mobility limitations and dependence on household support may shape how older residents experience temporary service interruptions or access project-related information.

Persons with disabilities constitute a key vulnerable group within the S-AoI. In 2011, 7,436 persons with disabilities were recorded in Tunapuna/Piarco, representing 4.0 percent of the municipal population. Within Acono Village, 56 persons with disabilities were identified, accounting for 3.1 percent of the S-DAoI population. While most persons with disabilities in the municipality were of

working age, disability prevalence was higher among older adults, with 13.8 percent of older persons living with a disability compared with 3.6 percent of working-age adults. In Acono Village, mobility-related impairments were the most commonly reported limitation among persons with disabilities, affecting 61.2 percent, followed by gripping (22.4 percent) and cognitive limitations (20.4 percent). These patterns are relevant to how some residents may access information, attend meetings, move along narrow or uneven local roads, or obtain support during temporary service changes.

Participation restrictions among persons with disabilities provide further insight into accessibility considerations in Acono Village. Among persons with disabilities in the S-DAoI who reported restrictions in daily activities, the most common difficulty was going outside the home, affecting 28.6 percent, compared with 19.8 percent in the wider municipality. This suggests that physical access, mobility support and communication channels are important considerations for understanding how persons with disabilities may receive information or navigate temporary changes in access and services.

Female-headed and single-parent households are also relevant to the vulnerability profile, although female headship was less prevalent in Acono Village than in the wider municipality. In 2011, 24.7 percent of households in Acono Village were headed by women, compared with 35.5 percent in Tunapuna/Piarco. At the regional level, a substantial proportion of female household heads did not have a resident partner, with 71.5 percent reporting that they were in visiting relationships, no longer living with a spouse or common-law partner, or had never been married or in a common-law union. These household arrangements may shape caregiving responsibilities, income security and flexibility in responding to temporary changes in water supply or access.

Children and caregiving households form another dimension of vulnerability in Acono Village. Children under 15 years accounted for 24.0 percent of the S-DAoI population in 2011, a higher share than in the wider municipality. Household size patterns also suggest higher daily water needs, with Acono Village recording an average household size of 3.6 persons and a higher share of large households than the municipal average.

These household patterns are reflected in child-residency arrangements. Nationally, 31.5 percent of children under 17 years were living with their mother only in 2011, increasing to 35.1 percent in 2022, based on MICS findings (Central Statistical Office, 2023; Ministry of Social Development and Family Services et al., 2017). The share is notably higher in the poorest areas, where 39.8 percent of children in 2011 and 44.4 percent in 2022 were living with their mother only. Within the North Central Regional Health Authority region, which includes Tunapuna/Piarco, the proportion of children living with their mother only is somewhat lower than the national average, at 27.7 percent in 2011 and 33.9 percent in 2022. These patterns indicate that a significant proportion of children may reside in households where caregiving responsibilities are concentrated in a single parent, potentially affecting household flexibility and coping capacity during service interruptions. Where households include children, older persons, persons with disabilities or chronically ill members, daily routines may be less flexible,

and household water needs may be more difficult to adjust during periods of interrupted or reduced service.

Youth and younger working-age residents are relevant to the vulnerability profile due to their position in the labour market. Acono Village had a relatively youthful population in 2011, with 56.4 percent of residents under 35 years. The community also recorded a labour force participation rate of 65.0 percent and an unemployment rate of 7.4 percent, higher than both the municipal and national rates. These patterns suggest that some young adults and working-age residents may face constraints in securing stable employment, particularly where educational qualifications, transport access or limited local job opportunities affect labour market entry. Youth vulnerability in this context is therefore linked less to age alone and more to the relationship between skills, employment access, income security and social inclusion.

Socio-economic vulnerability is also shaped by household income, tenure, transport access and digital access. Acono Village was identified in the 2005 Survey of Living Conditions community poverty scoring as falling within the poorer half of communities nationally, despite being located within the generally more affluent Tunapuna/Piarco municipality (Kairi Consultants Limited, 2007). At the S-IAoI level, Tunapuna/Piarco recorded a poverty rate of 10.5 percent, while 24.1 percent of the population had less than secondary education, 48.3 percent of households had no vehicle, 50.6 percent had no internet access, and 10.7 percent experienced unmet housing need (Pacific Disaster Center (PDC Global), 2020). These municipal indicators do not describe Acono Village directly, but they provide useful context for understanding how poorer, less mobile or less digitally connected households may receive notices, access alternative services, participate in consultation or communicate concerns.

Water and sanitation conditions in the S-DAoI suggest that households may exhibit varying levels of sensitivity to temporary service disruptions, particularly where water supply is intermittent or sanitation relies on on-site systems. This sensitivity is heightened by the diversity of water sources used within the community. Acono Village includes households that rely on public supply, standpipes, private abstractions, springs, rainwater harvesting and truck-borne water during dry periods. Dependence on multiple water sources may reflect varying levels of service reliability and household coping capacity, meaning that disruptions or changes in water availability may affect households differently depending on their existing access arrangements and storage capacity.

The wider municipal risk context reinforces the importance of considering environmental exposure and infrastructure reliability. Tunapuna/Piarco was ranked as having very high multi-hazard risk and the highest multi-hazard exposure among municipalities assessed in the NDPBA, although its overall vulnerability was classified as very low and its coping capacity as high. The municipality's exposure profile included flood, landslide, earthquake, tropical cyclone wind and wildfire hazards, while vulnerability was driven primarily by environmental stress and gender inequality (Pacific Disaster Center (PDC Global), 2020). Household-level environmental issues included drainage problems affecting 19.0 percent of households, flooding affecting 14.4 percent, water contamination affecting

2.5 percent and wastewater issues affecting 1.4 percent. These indicators are municipal-level measures and should not be read as direct conditions in Acono Village, but they provide relevant S-IAoI context for understanding how hazard exposure, drainage constraints and water-related stressors may interact with household vulnerability.

Water-resource vulnerability is particularly relevant to the Acono WTP baseline. National vulnerability assessments identify water resources as sensitive to changing rainfall patterns, drought, intense rainfall, sedimentation, pollution and water-quality deterioration. Reduced rainfall and longer dry spells can affect freshwater availability, while intense rainfall can increase runoff, sedimentation and contamination risks (Clarke et al., 2019).

Taken together, the vulnerability profile of the S-AoI is shaped by age, health status, disability, household composition, income, transport access, digital access, water and sanitation conditions, environmental exposure and wider institutional coping capacity. The vulnerable groups most relevant to the Acono WTP baseline include older persons, persons with chronic illnesses, persons with disabilities, children and caregiving households, female-headed or single-parent households, unemployed or underemployed youth, low-income households, households with limited access to transport or internet, and households already dependent on intermittent or alternative water sources. These patterns provide a baseline for later assessment of service interruptions, communication needs, stakeholder engagement, access arrangements and household sensitivity during refurbishment works.

4.4.3.2 Socio-Cultural Context

The socio-cultural context of the S-AoI reflects the plural character of Trinidad and Tobago's population and the intermixing of ethnic, religious and community traditions within the Tunapuna/Piarco municipality and Acono Village. Section 4.4.3.2 describes the ethnic and religious composition of Acono Village (S-DAoI) and the wider Tunapuna/Piarco municipality (S-IAoI), and provides a baseline overview of safety and security conditions relevant to community life, mobility, consultation and service access. The section draws primarily on data from the 2011 Population and Housing Census and reported crime statistics from the Trinidad and Tobago Police Service, with divisional crime data used to contextualise safety and security conditions within the wider police district serving the S-AoI (Central Statistical Office of Trinidad and Tobago, 2012a; Crime and Problem Analysis Branch of the Trinidad and Tobago Police Service, 2023).

Ethnic Composition

Trinidad and Tobago is recognised as a plural society composed of multiple ethnic groups, and the Tunapuna/Piarco municipal population reflects this diversity with all 10 ethnic groups present. Persons of the African (36.9%) and East Indian (32.0%) ancestry represented the most significant ethnic groups, together accounting for 68.9 percent of the population in 2011. The population of Tunapuna/Piarco also included significant multiracial ethnic groups. Specifically, 22.4 percent of residents identified as Mixed-Other ethnicity, while 7.7 percent identified as Mixed-African/East

Indian. Collectively, the proportion of the population of mixed heritage was notably higher in Tunapuna/Piarco (30.1%) compared to the national average (24.3%), reflecting a long history of inter-ethnic interaction and integration in the region.

Table 4-15: Acono WTP Refurbishment S-AoI Ethnic Composition

Ethnic Group	Population (%)		
	Trinidad and Tobago	Tunapuna/ Piarco	Acono Village
African	36.5	36.9	18.7
Caucasian	0.6	0.3	0.3
Chinese	0.3	0.2	0.0
East Indian	37.8	32.0	20.6
Indigenous	0.1	0.1	0.1
Mixed -African/East Indian	8.2	7.7	3.1
Mixed - Other	16.2	22.4	57.3
Portuguese	0.1	0.0	0.0
Syrian/ Lebanese	0.1	0.0	0.0
Other ethnic group	0.2	0.2	0.0

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

The mixed-ancestry population was more prominent in Acono Village. Multiethnic individuals, excluding those of African and East Indian heritage (3.1%), represented the largest ethic group in the S-DAoI, accounting for 57.3 percent of the community. Individuals of East Indian heritage constituted the second-largest ethnic group at 20.6 percent, just ahead of those of African descent at 18.7 percent.

Religious Composition

Religious affiliation within the project's social area of influence reflects Trinidad and Tobago's broader multi-faith demographic, with noteworthy distinctions in the region's dominant faiths in 2011 compared to the national landscape. Christianity is the most prevalent religion nationally (66.1%) and more so in the municipality of Tunapuna/Piarco. Approximately seven in ten persons in the region (70.1%) were Christians. The largest Christian denomination was Roman Catholicism (31.0%), but a significant proportion of Christians followed Protestant faiths (37.3%). Common Protestant branches include Pentecostalism and Evangelicalism (17.9%), Anglicanism (7.1%), Seventh-day Adventism (4.5%), and the Spiritual Shouter Baptist faith (4.4%). Given the higher regional prevalence of Christians, the proportions of followers of Hinduism (17.4%) and Islam (4.9%) were comparatively smaller than observed nationally.

Table 4-16: Acono WTP Refurbishment S-AoI Religious Composition

Religious Group	Population (%)		
	Trinidad and Tobago	Tunapuna/ Piarco	Acono Village
Anglican	6.4	7.1	2.2

Religious Group	Population (%)		
	Trinidad and Tobago	Tunapuna/ Piarco	Acono Village
Spiritual Shouter Baptist	6.4	4.4	2.3
Baptist - Other	1.4	0.5	0.1
Hinduism	20.4	17.4	10.6
Islam	5.6	4.9	1.4
Jehovah's Witness	1.7	1.9	1.6
Methodist	0.7	0.6	0.3
Pentecostal/Evangelical/Full Gospel	17.6	17.9	13.4
Moravian	0.3	0.1	0.0
Orisha	1.0	0.9	0.2
Presbyterian/Congregational	2.8	2.1	1.8
Rastafarian	0.3	0.3	0.3
Roman Catholic	24.3	31.0	49.4
Seventh-day Adventist	4.6	4.5	12.2
Other	4.1	3.7	0.4
None	2.5	2.6	3.9

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

Christianity was even more prominently observed in Acono Village. Approximately 83 percent of the community (83.2%) practised the Christian faith. Notably, Roman Catholicism played a prominent role in the religious landscape, with about half (49.4%) of the population adhering to it. At the same time, Protestantism was less common in the Village (32.3%), with the exception of Seventh-day Adventistism. Approximately 12 percent of Acono Village (12.2%) belonged to the Seventh-Day Adventist faith. Similarly, 11 percent of the S-DAoI population identified as Hindus (10.6%). Notably, around 4 percent of Acono Village were not affiliated with any religion.

Safety and Security

Safety and security conditions within the social area of influence are shaped by broader crime trends across the Tunapuna/Piarco municipality and, more specifically, by the policing context of the Northern Division of the Trinidad and Tobago Police Service, under which Acono Village falls. Crime statistics at the divisional level, therefore, provide the most appropriate baseline for understanding the security environment that influences both the S-DAoI and S-IAoI.

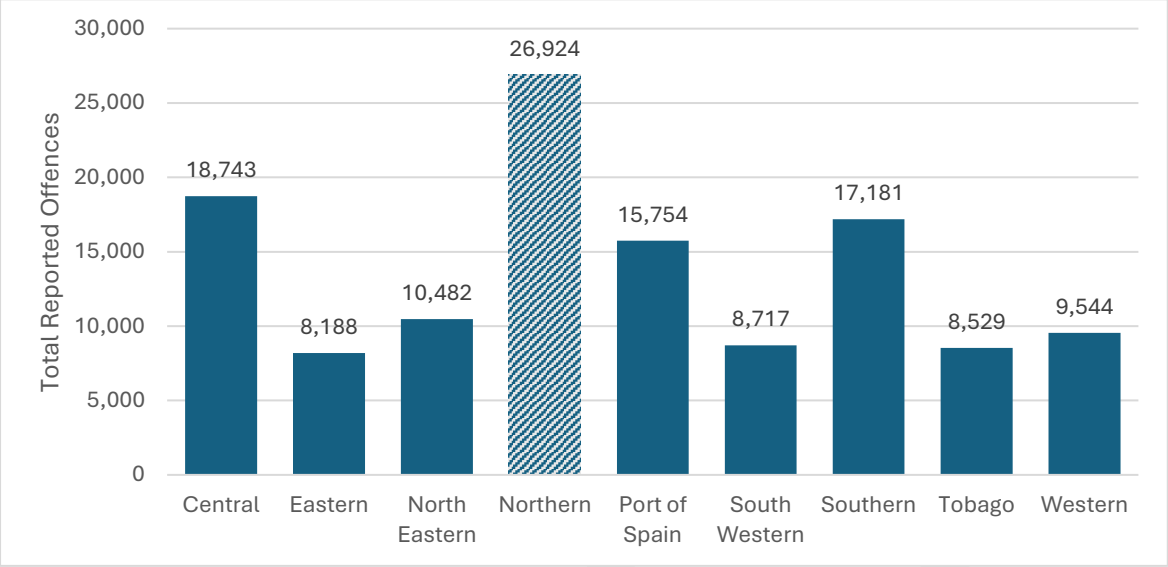


Figure 4-30: January 2015 to December 2025 Total Reported Serious/Major Offences Among Police Divisions
Source: Crime and Problem Analysis Branch of the Trinidad and Tobago Police Service. (2026). Total Crime by Division Report

Between 2015 and 2025, the Northern Division recorded a total of 26,924 reported offences, representing the highest crime volume among all police divisions nationally over the period. This corresponds to an annual average of approximately 2,448 reported offences, reflecting sustained pressure on policing resources in the region. The Northern Division consistently accounted for a disproportionate share of national crime, underscoring its role as a high-demand policing area within Trinidad and Tobago.

Property-related crimes were the most prevalent category during this period, with 12,332 recorded incidents, accounting for nearly half of all reported offences in the division. Within this category, general larceny (4,223 cases) and burglaries and break-ins (3,997 cases) were the most common, followed by larceny of motor vehicles (2,513 cases). The Northern Division also recorded the highest number of motor vehicle thefts nationally over the period, reflecting the division's extensive road networks and connectivity along the East-West Corridor.

Violence and violent crimes constituted a significant proportion of reported offences, with 9,354 incidents recorded between 2015 and 2025. Robberies were the dominant violent offence, accounting for 6,344 cases, or roughly two-thirds of all violent crimes in the division. Other serious offences included woundings and shootings (1,517 cases) and murders (1,241 cases). While murders represented a smaller share of total offences, their persistence contributed significantly to public perceptions of insecurity across the division.

Sexual offences, including rape, incest, and other sexual crimes, accounted for 2,050 reported cases over the eleven-year period. Although these offences comprised a smaller proportion of total crime, their social impact is substantial, particularly for women, children, and other vulnerable groups.

Reported cases fluctuated over time, with notable increases observed in the post-2020 period, consistent with national reporting trends.

Crime trends within the Northern Division showed considerable variability over the decade. Reported offences declined between 2015 and 2016, increased sharply to a peak in 2017 and 2018, and fell again during the COVID-19 pandemic period in 2020, when mobility restrictions were in effect. Following the easing of pandemic controls, reported crime rose steadily, reaching elevated levels in 2022 and 2023 before moderating slightly in 2024 and 2025. Property crimes and robberies accounted for much of the post-pandemic increase, while firearm-related offences and serious violent crimes also rose during this period.

In response to sustained crime pressures, the TTPS restructured the Northern Division into Northern Division North and Northern Division Central, with the latter covering much of the East-West Corridor, including areas proximate to Tunapuna, St. Joseph, and Arouca (Polo, 2023). Policing within this sub-division is challenged by high population density, extensive transportation corridors, and the presence of multiple secondary access routes, including back roads and informal tracks. These factors complicate surveillance, response times, and crime detection, particularly in peri-urban and semi-rural communities.

While divisional-level data indicate elevated crime levels overall, consultations with police officials and secondary sources suggest that Acono Village and similar Northern Range communities experience comparatively lower crime incidence than urbanised East-West Corridor settlements. Recorded offences in these areas are more commonly associated with drug-related activity and opportunistic property crime, with serious violent incidents occurring less frequently. Nevertheless, community perceptions of safety are influenced by wider divisional trends, media reporting, and the proximity of higher-crime districts within Tunapuna/Piarco.

The safety and security context for the S-DAoI is characterised by relatively low localised crime incidence, set within a broader municipal and divisional environment facing persistent challenges in property and violent crime. This wider security context shapes community perceptions of risk, mobility, and engagement and provides an important baseline for understanding social conditions within the project's area of influence.

4.4.3.3 Socio-Economic Conditions

The socio-economic conditions of the S-AoI reflect the contrast between the diversified economy of the wider Tunapuna/Piarco municipality (S-IAoI) and the more rural, residential and livelihood-based character of Acono Village (S-DAoI). At the municipal level, economic activity is supported by commerce and distribution, higher education, manufacturing and food processing, public and professional services, agriculture and tourism, while Acono Village is shaped more directly by small-scale agriculture, quarrying, residential settlement, commuting to employment centres outside the village, and uneven access to formal employment opportunities. Educational attainment, labour market participation, business activity and poverty patterns provide important baseline context for

understanding household resilience, livelihood sensitivity and how residents may engage with or be affected by changes in local services.

This section draws primarily on data from the 2011 Population and Housing Census, the 2012–2014 Continuous Sample Survey of the Population, the Survey of Living Conditions community poverty scoring, and municipal planning and economic sources for Tunapuna/Piarco, including the Final Draft Municipal Development Plan and Local Area Economic Profile (Central Statistical Office of Trinidad and Tobago, 2012a; Central Statistics Office Trinidad and Tobago, 2014; Kairi Consultants Limited, 2010; Kiari Consultants Limited, 2016). Where data are not available at the community level, broader municipal, county or ward-level indicators are used cautiously to provide context.

Educational Landscape

Educational attainment within the social area of influence reflects both the relatively strong access to basic schooling across the Tunapuna/Piarco municipality and the more constrained progression to higher levels of education within Acono Village. Overall patterns are consistent with national trends, but notable differences exist between the S-DAoI and S-IAoI, particularly regarding tertiary participation and formal qualification outcomes.

At the municipal level, educational attainment in Tunapuna/Piarco is comparatively high. Nearly two-thirds of the population (65.6%) had achieved a secondary level of education in 2011, exceeding the national average (62.9%). Approximately one-fifth of residents (19.4%) attained some form of tertiary education, including university and non-university programmes, reflecting the municipality's proximity to secondary schools, tertiary institutions, and the ease of transport along the East–West Corridor. Females consistently outperformed males at higher levels of attainment, with 21.8 percent of women reaching tertiary education compared to 17.4 percent of men, a pattern aligned with national gender trends in educational participation and persistence.

Table 4-17: Key Education Indicators for Acono WTP Refurbishment S-AoI

Administrative Area	Educational Attainment		Educational Qualifications	
	Secondary	Tertiary	None	GCE 'O'/CXC Gen/SC
Trinidad and Tobago	62.9	15.8	55.1	21.5
Tunapuna/Piarco	65.6	19.6	51.8	21.0
Acono Village	53.3	9.8	66.8	9.3

Source: Central Statistical Office of Trinidad and Tobago. (2012). Trinidad and Tobago 2011 Population and Housing Census: Demographic Report.

In contrast, educational attainment in Acono Village was notably lower beyond the compulsory level. While participation in schooling was widespread, progression beyond secondary education was limited. Approximately 53.3 percent of the S-DAoI population attained at least a secondary education, significantly below the municipal (65.6%) and national (62.9%) averages. Primary education remained the most common highest level attained in Acono Village, accounting for 42.2 percent of residents, compared to 28.8 percent in Tunapuna/Piarco. Secondary education

accounted for a similar share in the S-DAoI (42.1%), but post-secondary and tertiary attainment remained comparatively low.

Only 9.8 percent of Acono Village residents attained tertiary-level education, less than half the municipal average. Within this group, attainment was skewed by gender. Females were nearly twice as likely as males to progress to tertiary education, with 12.6 percent of women achieving tertiary qualifications compared to 7.2 percent of men. This gender disparity mirrors broader national patterns but is more pronounced in the S-DAoI, suggesting additional barriers to educational progression among males in the community.

Patterns of formal educational qualifications further highlight disparities between Acono Village and the wider municipality. In Tunapuna/Piarco, just over half of residents (51.8%) reported having no formal educational qualifications, a proportion already lower than the national average (55.1%). By contrast, two-thirds of Acono Village residents (66.8%) reported no formal qualifications, indicating more limited certification despite participation in schooling. This gap is particularly pronounced among males in the S-DAoI, where 70.1 percent reported no qualifications, compared to 63.3 percent of females.

Among those in Acono Village who obtained qualifications, outcomes were concentrated at the lower- to mid-secondary level. Approximately 10.8 percent held CXC Basic qualifications, and 9.3 percent attained GCE 'O'-Level or CXC General/School Certificate passes. Fewer than 5 percent of residents achieved diploma-level or higher credentials, and less than 3 percent held bachelor's degrees or above. Advanced qualifications, including master's degrees and doctorates, were rare in the S-DAoI.

These educational patterns indicate that, while participation in primary and secondary schooling is widespread within Acono Village, progression to post-secondary education and the acquisition of formal qualifications remain constrained. Although a range of secondary, tertiary, and technical training opportunities exists within the wider municipality and neighbouring areas, advancing beyond compulsory schooling typically requires sustained travel, financial resources, and long-term commitment that may not be equally accessible to all households. For many residents, particularly males, these constraints appear to encourage earlier transitions into the labour market or vocational pathways rather than continued academic progression. As a result, the local labour force is characterised by relatively high levels of basic educational attainment but limited formal certification and advanced credentials, shaping employment outcomes and skill profiles within the community.

Local Economy and Livelihoods

The local economy within the S-AoI is shaped by the broader economic structure of the Tunapuna/Piarco municipality, which functions as one of Trinidad and Tobago's most economically diverse regions. Livelihood patterns in Acono Village reflect a more localised and semi-rural expression of this wider economy, influenced by the community's Northern Range setting and its relative distance from the municipality's primary commercial, industrial, and institutional centres.

At the municipal level, Tunapuna/Piarco supports a diversified economic base encompassing commerce and distribution, manufacturing and food processing, higher education services, agriculture, tourism, professional services, and medical services (Kairi Consultants Limited, 2010; Kiari Consultants Limited, 2016). Retail and distribution activities are particularly prominent along major transport corridors such as the Eastern Main Road and other arterial routes, supporting employment in wholesale and retail trade, logistics, vehicle sales, building materials, and fresh produce markets. Large commercial centres, including Trincity Mall, Grand Bazaar, and Valpark Shopping Plaza, serve both municipal residents and a wider national consumer base, reinforcing the area's role as a major commercial hub.

Manufacturing and food processing represent another important component of the municipal economy. Several industrial estates in Tunapuna/Piarco host manufacturing operations that supply domestic and regional markets. Notably, major food and beverage producers such as Nestlé Trinidad & Tobago Ltd. and Coca-Cola Caribbean Bottlers operate within the municipality, supporting direct employment as well as ancillary activities in transport, packaging, and distribution. These operations contribute to relatively stable wage employment opportunities, particularly for skilled and semi-skilled workers.

The higher education services sector is a defining feature of the Tunapuna/Piarco economy and a key driver of local livelihoods. The municipality hosts a concentration of major tertiary institutions, including The University of the West Indies, University of Trinidad and Tobago, University of the Southern Caribbean, Hugh Wooding Law School, School of Accounting and Management, and the Cipriani College of Labour and Cooperative Studies. Collectively, these institutions attract large student, academic, and administrative populations. Their presence is associated with a concentration of small and micro-enterprises providing accommodation, food services, transportation, retail, and personal services, contributing to income-generating opportunities beyond the formal education sector. The development of UTT's facilities at Tamana InTech Park is also associated with longer-term opportunities linked to innovation, research, and technology-based enterprise at the municipal scale.

Agriculture, while historically significant in Tunapuna/Piarco, now plays a more limited role in the municipal economy. Urban expansion and commercial development along the East–West Corridor have reduced the availability of productive agricultural land, with remaining agricultural activity largely confined to Northern Range valleys and more remote communities. In these areas, agriculture is typically small-scale and oriented toward household consumption, local markets, or supplementary income rather than commercial production.

Tourism contributes modestly to local livelihoods, particularly through eco-tourism activities associated with the Northern Range. Attractions such as the Asa Wright Nature Centre, along with forested landscapes, waterfalls, and culturally significant sites in communities such as Blanchisseuse and Lopinot, support income-earning activities related to guiding services, small accommodation providers, food vending, and craft production. Historical and archaeological

features across the municipality further contribute to tourism's role as a supplementary economic activity.

Within Acono Village, livelihood patterns reflect the community's semi-rural character and its position relative to the municipality's main employment centres. In the absence of major commercial, industrial, or institutional employers within the immediate S-DAoI, residents are likely to rely on a combination of wage employment accessed outside the community and smaller-scale economic activities undertaken at the household or community level. Employment opportunities are therefore shaped by commuting to nearby urban areas, engagement in service-based or manual occupations, and participation in informal or seasonal work. Household income strategies may involve multiple earners or mixed income sources rather than stable, single-employer arrangements, consistent with patterns observed in similar Northern Range communities.

Overall, livelihoods within the S-DAoI are closely linked to the broader economic dynamics of the Tunapuna/Piarco municipality, while remaining shaped by local geographic context, settlement scale, and access to external employment opportunities.

Business Profile

The business environment within the social area of influence is shaped primarily by the wider commercial and industrial structure of the Tunapuna/Piarco municipality. As one of Trinidad and Tobago's principal economic centres, the municipality hosts a substantial share of the country's registered business establishments, reflecting its strategic location along the East–West Corridor and the concentration of commercial activity in key urban nodes.

According to the Central Statistical Office's Business Establishment Register, there were 2,882 registered businesses operating in Tunapuna/Piarco in 2018, accounting for 11.1 percent of all registered business establishments nationally (Central Statistics Office Trinidad and Tobago, 2018). This represented a modest decline of approximately 5 percent compared to the 2011 figure of 3,033 businesses, following an earlier period of growth between 2008 and 2017. Registered businesses within the municipality are spatially concentrated in established commercial centres, including Tunapuna, Curepe, Trincity, Valsayn, St. Augustine, and Tacarigua, which function as the primary hubs for retail, services, and formal employment.

The municipal business profile is dominated by micro, small, and medium-sized enterprises (MSMEs). In 2018, MSMEs accounted for 61.5 percent of all registered businesses in Tunapuna/Piarco, with micro-enterprises alone comprising 44.3 percent. A substantial proportion of these micro-businesses operated as one-person ventures, indicating a high prevalence of owner-operated enterprises and self-employment within the formal business register. This structure highlights the importance of small-scale entrepreneurship to local economic activity and income generation.

Sectorally, businesses in Tunapuna/Piarco are concentrated largely in commerce and distribution, which together consistently account for more than half of all registered establishments. Historical 2008 Business Register data indicate that approximately 54–55 percent of businesses operated in retail and distribution activities, including wholesale and retail trade, vehicle sales, building materials, and market-based commerce. Other notable sectors include finance, insurance, real estate, and business services (approximately 10–11 %), personal services (11–14 %), and the construction industry (6–10 %).

Although manufacturing, food processing, chemical production, and construction firms account for a smaller share of total registered businesses, these enterprises tend to be larger in size and employment capacity compared to MSMEs. As a result, they contribute disproportionately to formal employment generation within the municipality. In contrast, MSMEs are predominantly concentrated in retail, distribution, and personal services, sectors typically characterised by smaller workforces, variable income streams, and greater sensitivity to economic fluctuations.

Within the immediate area of direct influence, including Acono Village, formally registered businesses are limited in number, reflecting the community's residential and semi-rural character. Economic activity within the S-DAoI is therefore less visible in national business registers and is more likely to involve small-scale, informal, or home-based enterprises, as well as reliance on employment opportunities located elsewhere in the municipality. This distinction between the formal business concentration at the municipal level and a more limited business presence within the S-DAoI is an important contextual factor for understanding local livelihood strategies and labour market participation.

The business profile of Tunapuna/Piarco is characterised by a strong presence of MSMEs operating primarily in commerce and services, complemented by a smaller number of larger industrial and manufacturing firms with higher employment capacity. This structure underpins the municipality's role as a key centre of economic activity and provides the broader context within which employment and livelihood opportunities for residents of Acono Village are shaped.

Labour Market Conditions

Labour market conditions within the social area of influence reflect both national employment trends and the specific socio-economic characteristics of communities within the Tunapuna/Piarco municipality. Labour force participation, employment structure, and occupational profiles vary across the S-DAoI and S-IAoI, shaped by differences in settlement type, access to employment centres, and gendered participation patterns.

Labour market conditions within the social area of influence are assessed using data from the 2011 Population and Housing Census and the 2012–2014 Continuous Sample Survey of the Population (CSSP) dataset (Central Statistical Office of Trinidad and Tobago, 2012a; Central Statistics Office Trinidad and Tobago, 2014). While the Census provides community-level data for Acono Village, CSSP data are reported at broader administrative levels. Accordingly, St. George County is used as a

proxy for labour market conditions within the Tunapuna/Piarco municipality, and the Tacarigua Ward, within which Acono Village is located, is used as a proxy for more recent labour force trends affecting the S-DAoI.

In 2011, Tunapuna/Piarco recorded an above-average labour force participation rate at 62.5 percent, compared to 60.6 percent nationally, indicating a relatively strong level of labour market engagement within the municipality. As observed nationally, participation was strongly gendered, with male participation (71.5%) substantially exceeding female participation (53.9%). The municipal unemployment rate in 2011 was 5.0 percent, broadly aligned with the national average (5.8%).

Intercensal labour market trends for the municipality, reflected by St. George County CSSP data, indicate that labour force participation remained relatively stable between 2012 and 2014, ranging from 62.3 to 63.8 percent. During this period, unemployment rates in St. George County were consistently lower than the national benchmark, declining from 2.5 percent in 2012 to 1.5 percent in 2013, before increasing slightly to 2.3 percent in 2014. These figures suggest comparatively favourable labour market absorption within the municipal area during the intercensal period.

At the community level, Acono Village exhibited a mixed labour market profile in 2011 relative to the wider municipality. The village recorded a labour force participation rate of 65.0 percent, which was higher than both the Tunapuna/Piarco municipal rate and the national benchmark for the same year. Despite relatively strong participation, unemployment in Acono Village stood at 7.4 percent, exceeding both municipal and national rates. This indicates that while a large share of the working-age population was economically active, a comparatively higher proportion of participants were unable to secure employment, pointing to constraints in local and accessible job opportunities rather than labour supply.

More recent labour market conditions affecting the S-DAoI are inferred from Tacarigua Ward CSSP data. Between 2012 and 2014, labour force participation in the Ward ranged from 61.9 to 63.2 percent, broadly comparable to St. George County trends. Unemployment in the Ward remained low during this period, declining from 1.5 percent in 2012 to 0.9 percent in 2013, before rising modestly to 1.7 percent in 2014. While these ward-level indicators suggest relatively favourable labour market conditions, the higher unemployment observed in Acono Village in 2011 indicates that community-specific constraints, such as limited local employment opportunities and skills mismatches, may not be fully captured by ward-level averages.

Gender disparities persisted across all spatial scales. In Acono Village, female labour force participation remained below 50 percent in 2011, and women were more likely than men to be outside the labour force. However, unemployment in the community was more pronounced among men, reflecting both lower male participation relative to neighbouring communities and greater difficulty securing employment.

Employment status, occupational structure and industrial groups within the social area of influence are assessed using CSSP data for employed persons between 2012 and 2014, reported at the level

of St. George County and Tacarigua Ward, and CSSP 2014 data for household heads in Tunapuna/Piarco. St. George County is used as a proxy for labour market conditions within the Tunapuna/Piarco municipality, while Tacarigua Ward, which contains Acono Village, is used as a proxy for employment characteristics affecting the S-DAoI.

Between 2012 and 2014, paid employment was the dominant employment arrangement among employed persons in St. George County, accounting for 82.4 percent in 2012, 83.1 percent in 2013, and 82.7 percent in 2014 of all employed persons. Employment with central and local government and statutory bodies formed a substantial component of paid employment, particularly among women, who consistently accounted for more than half of public-sector employees during this period.

Own-account work represented a smaller but persistent share of employment in St. George County, accounting for 13.6 percent in 2012, 12.9 percent in 2013, and 13.4 percent in 2014. Men were more likely than women to be engaged in own-account work across all three years. Employment as an employer accounted for less than 2.0 percent of total employment, while unpaid family work remained minimal, consistently below 1.0 percent.

Employment status patterns in Tacarigua Ward closely mirrored those observed at the county level. Paid employment accounted for 81.9 percent of employed persons in 2012, 82.6 percent in 2013, and 82.1 percent in 2014. Own-account work ranged between 14.2 and 15.1 percent, slightly higher than the county average, reflecting a modestly greater reliance on self-employment within the Ward. Employer and unpaid family worker categories together accounted for less than 2.0 percent of employment in each year.

In comparison, CSSP 2014 data for household heads in Tunapuna/Piarco show a more differentiated employment profile. In 2014, 40.0 percent of household heads were employed in private enterprises, while 21.0 percent worked for central or local government agencies. A further 17.0 percent identified as own-account workers, and 10.0 percent were employed by state-owned enterprises. The remaining household heads were employed in other arrangements, including unpaid family work and small-scale enterprises.

Relative to the employed-person data, household heads were more likely to be engaged in own-account work (17.0% vs 12–15%) and public-sector employment (31.0% combined government and state-owned enterprises). This reflects greater employment stability and entrepreneurial activity among household heads compared to the broader employed population.

Between 2012 and 2014, employment in St. George County was concentrated in lower- to mid-skilled occupations. The largest occupational groups were:

- Service and sales workers: ranging from 18.9 percent in 2012 to 19.6 percent in 2014
- Craft and related trades workers: 14.2–15.1 percent
- Plant and machine operators and assemblers: 9.1–9.8 percent

- Elementary occupations: 15.7–16.4 percent
- Community, social, and personal service workers: approximately 10.0 percent

Professional occupations accounted for 11.2–12.0 percent, while technicians and associate professionals represented 13.8–14.5 percent. Managers and senior officials consistently accounted for less than 8.0 percent of employed persons, and skilled agricultural workers remained below 3.0 percent across all three years.

Occupational patterns in Tacarigua Ward were broadly similar but showed slightly higher concentrations in elementary and service-related occupations. Service and sales workers accounted for 20.1 percent in 2012, rising to 21.3 percent in 2014, while elementary occupations ranged between 16.9 and 18.2 percent. Craft and related trades workers accounted for 15.6–16.4 percent, reflecting the importance of construction and manual trades within the Ward. Professional and managerial occupations together accounted for less than 18.0 percent of total employment.

Among household heads in Tunapuna/Piarco in 2014, occupational outcomes show a similar but more stratified pattern (Kairi Consultants Limited, 2016). The largest shares of household heads were employed in:

- Elementary occupations: 18.2 percent
- Technicians and associate professionals: 16.5 percent
- Craft and related trades workers: 14.8 percent
- Service and sales workers: 13.2 percent
- Professionals: 12.4 percent

Smaller proportions were employed as plant and machine operators (9.5%), managers (7.4%), clerical support workers (5.8%), and skilled agricultural workers (2.2%). Compared with employed persons, household heads were more likely to hold professional, technical, and managerial roles, reflecting greater labour market experience and employment stability.

Incidence of Poverty

Poverty within the social area of influence is unevenly distributed and is most appropriately understood at the community level, where conditions in Acono Village contrast with the generally more favourable socio-economic profile of the wider Tunapuna/Piarco municipality. Although the municipality as a whole is among the more affluent in Trinidad and Tobago, Acono Village represents a recognised pocket of relative deprivation within this broader context.

Table 4-18: Key Poverty Indicators for Acono WTP Refurbishment S-IAoI

Administrative Area	Income based	Non-monetary	
	Poverty Rate (%)	MPI	Multi-dimensional Poverty Rate (%)
Trinidad and Tobago	16.7	0.017	6.2

Administrative Area	Income based	Non-monetary	
	Poverty Rate (%)	MPI	Multi-dimensional Poverty Rate (%)
Tunapuna/Piarco	10.5	0.015	5.9

Source: Kairi Consultants Limited. (2007). 2005 Analysis of the Trinidad and Tobago Survey of Living Conditions.

Municipal-level data from the 2005 Survey of Living Conditions (SLC) indicate that Tunapuna/Piarco recorded a comparatively low incidence of monetary poverty, with 10.5 percent of the population living below the poverty line, substantially lower than the national average (16.7%) (Kairi Consultants Limited, 2007). This context is relevant insofar as it underscores that poverty within Acono Village exists within an otherwise relatively prosperous municipality, rather than reflecting widespread municipal deprivation.

Community-level poverty scores derived from the 2000 Population and Housing Census, as analysed in the SLC, provide more direct insight into conditions in Acono Village. Acono Village recorded a poverty score of 47, ranking it 238th out of 585 communities nationally, placing it within the poorer half of communities in Trinidad and Tobago. This ranking indicates that, relative to national conditions, households in Acono Village experience notable levels of unmet basic needs, despite their location within a generally affluent municipal area.

When compared with nearby and socially connected communities, Acono Village's poverty ranking aligns with other settlements in the immediate Maracas Valley area that also fall within the poorer half of national rankings. In contrast, some neighbouring communities within the wider Valley include settlements that rank among the wealthier quartiles nationally. This juxtaposition highlights sharp intra-area disparities, where communities with relatively favourable living standards coexist alongside settlements such as Acono Village that face more persistent socio-economic constraints.

Beyond income-based measures, multidimensional poverty indicators provide additional context for conditions affecting Acono Village. While municipal-level data show that the proportion of persons experiencing multidimensional poverty in Tunapuna/Piarco (5.9%) is comparable to the national average (6.2%), the municipality records a comparatively higher contribution from standards-of-living deprivations (4.0%, 5th highest nationally). These include factors such as housing quality, access to services, and household assets, which are particularly relevant to communities like Acono Village. The presence of these deprivations helps to explain why pockets of poverty persist locally, even where income-based poverty rates are relatively low at the municipal scale.

4.4.3.4 Cultural Heritage and Archaeological Resources

Trinidad and Tobago's cultural heritage reflects the tangible and intangible legacies of its people, encompassing physical monuments, landscapes, and artefacts that embody the nation's history, as well as the traditions, beliefs, and practices passed down through generations. Tangible cultural

heritage includes monuments, sites, fossils, and areas of natural, historical, scientific, or archaeological significance that serve as visible reminders of the country's past.

Cultural heritage and archaeological resources within the social area of influence are governed by the national heritage management framework administered by the National Trust of Trinidad and Tobago, which is responsible for identifying, listing, and protecting monuments, sites, and places of national, historic, scientific, cultural, and archaeological significance. Heritage resources formally listed by the Trust are protected under the National Trust of Trinidad and Tobago Act (1991, as amended) against unauthorised alteration, damage, or defacement. Sites identified as being of heritage interest but not yet formally listed are recorded on the Heritage Asset Register (Inventory) and are afforded interim recognition pending further evaluation.

At the national level, the Heritage Asset Register includes over 460 sites, the majority of which are categorised as cultural heritage assets, with a smaller number identified as natural or mixed cultural–natural sites. Within the Tunapuna/Piarco municipality, a number of heritage assets have been recorded on the Register, reflecting the area's long history of Indigenous occupation, colonial settlement, religious development, and interaction with the Northern Range landscape.

Within and immediately surrounding Acono Village, several heritage resources of cultural and archaeological significance have been identified. Of particular importance are the Caurita Petroglyphs, also known locally as the Caurita Stone, which represent the most significant archaeological resource in the vicinity of the S-DAoI, located in St. Joseph. This site is a listed property of interest recognised as a Grade A cultural heritage asset, reflecting its exceptional national significance. The Petroglyphs consist of a large boulder bearing Pre-Columbian rock art created by the First Peoples of Trinidad and Tobago, including carved petroglyphs and painted pictographs. These images include anthropomorphic and zoomorphic figures, facial motifs rendered as pits and grooves, abstract geometric forms, and symbolic designs consistent with wider Caribbean Indigenous rock art traditions. The Caurita Petroglyphs are unique within Trinidad and Tobago and represent the only known example of such an artefact recorded nationally.

In addition to the Caurita Petroglyphs, Acono Village is associated with the Ortinola Great House, a historic estate property recognised on the Heritage Asset Register. The Ortinola Great House is linked to the colonial-era history of the Maracas Valley and reflects patterns of plantation settlement, land use, and architectural heritage in the Northern Range foothills. While not all structures associated with the estate may remain intact, the site retains cultural and historical significance as part of the area's built heritage landscape.

Other heritage resources located within the wider surrounding area include sites of religious, natural, and mixed heritage significance, such as historic churches and prominent Northern Range landmarks. These resources contribute to the broader cultural setting of Acono Village but are spatially and functionally distinct from the S-DAoI. Their relevance to the project lies primarily in

establishing the heritage-rich character of the area, rather than in indicating direct interaction with the Acono WTP site.

4.4.3.5 Natural and Built Resources and Use

The natural and built resources and use profile of the S-AoI reflects the location of Acono Village within the upper Maracas Valley and the wider Northern Range setting of the Tunapuna/Piarco municipality. The S-DAoI is characterised by a mixed rural-residential landscape shaped by former estate lands, hillside settlement, small-scale agriculture, quarrying, forested areas, water supply infrastructure and access routes linking the community to St. Joseph and the East-West Corridor. At the S-IAoI level, Tunapuna/Piarco contains a wider range of land uses and infrastructure, including protected forested watersheds, agricultural lands, urban settlements, commercial and institutional centres, transport corridors and public service facilities.

This section describes existing land ownership and tenure patterns, as well as access to key infrastructure and services, including education, health, community and recreational facilities, water and sanitation, and transportation. The discussion draws primarily on the 2011 Population and Housing Census, municipal planning sources for Tunapuna/Piarco, and available secondary information on infrastructure and land use in Acono Village and the wider Maracas Valley (Central Statistical Office of Trinidad and Tobago, 2012a; Kairi Consultants Limited, 2010; Kiari Consultants Limited, 2016).

Land Ownership and Tenure

Land ownership and tenure within the social area of influence of the Acono WTP reflect long-standing patterns of land administration and settlement development in the Tunapuna/Piarco municipality. Land tenure describes the legal and customary arrangements through which individuals or households occupy, use, or control land, including the associated rights and obligations. In Trinidad and Tobago, tenure is governed predominantly by statutory frameworks and is broadly categorised into State and public land and private land.

State and Public Land

Land tenure in Trinidad and Tobago is governed by a legal framework that establishes ownership rights and the associated rights of access, possession, occupation, use, control, and transfer. Under the State Lands Act (Chap. 57:01), the Commissioner of State Lands is the landlord of all state lands and is responsible for their management, allocation, and distribution. State lands may also be vested in specific government agencies under the statutes that created them, allowing these authorities to lease or manage lands for defined purposes.

State and public land constitute a significant proportion of land holdings within Tunapuna/Piarco, particularly in the Northern Range and its upper watershed areas. These lands include forest reserves, protected areas, and other environmentally sensitive zones that are subject to statutory restrictions on development and land use. The State also holds land outside protected areas that is

leased for agricultural production, residential purposes, quarrying, industrial activity, and infrastructure development.

Public land management and leasing functions are administered through relevant State agencies, including the Estate Management and Business Development Company, which oversees substantial tracts of State-owned land nationally. Within the Maracas Valley and Acono Village, State land occurs primarily in hillside and upper valley areas, including forest reserves and former estate lands.

According to the 2011 Population and Housing Census, State land rental is a prominent tenure arrangement in Acono Village. Approximately 44.1 percent of households reported renting the land on which they resided, largely from government sources. Smaller proportions of households occupied State land under informal arrangements, including rent-free occupation or squatting. These patterns reflect historical estate-based settlement arrangements, where workers resided on estate lands under permissive or informal tenure that, in many cases, was never formally regularised.

The presence of State land and the legacy of informal occupation contribute to ongoing issues of tenure insecurity in parts of Acono Village. While legal mechanisms such as adverse possession exist to regularise long-term occupation, uptake has historically been limited, leaving some households without a formal title despite extended periods of residence.

Private Land

Private land ownership is also prevalent within Acono Village and surrounding communities, particularly in the foothills of the Northern Range and lower valley areas. Privately owned land includes residential plots, former estate lands, agricultural holdings, and parcels associated with quarrying and other economic activities. Over time, subdivision and sale of large estates, particularly from the mid-20th century onward, enabled newer residents to acquire freehold or leasehold titles, contributing to a more formalised tenure structure in some parts of the community.

In Acono Village, 38.5 percent of households reported occupying land that they owned outright or held as family land in 2011. This proportion is lower than the municipal average, indicating a comparatively weaker prevalence of secure private ownership in the S-DAoI. Private land ownership is often more concentrated in newer residential developments and in areas where estate lands were formally subdivided and transferred.

Private land tenure has generally supported more stable investment in housing and infrastructure; however, it exists alongside informal and semi-formal arrangements, resulting in a fragmented tenure landscape within the village. In some cases, households occupy privately owned land under long-standing but undocumented rental or permissive use arrangements, which can complicate land transactions and access to formal services.

Access to Infrastructure

Education

Educational infrastructure accessible to Acono Village spans early childhood, primary, secondary, tertiary, and vocational training facilities. Within the immediate project-affected area, there are several Early Childhood Care and Education (ECCE) centres, including government-operated facilities located in Maracas Valley and St. Joseph, which fall under the St. George East Education District (Ministry of Education, 2022b, 2022a, 2025). These facilities provide early childhood services to residents of Acono Village and surrounding communities.

At the primary level, residents of Acono Village primarily access schools located within Maracas Valley and St. Joseph. The primary schools closest to Acono Village include the Maracas Presbyterian Primary School along Acono Road and the Maracas Seventh-day Adventist Primary School along the Maracas Royal Road. Additional primary schools serving the area are located in St. Joseph, including government-assisted and private institutions. These schools are generally accessed by road, as no primary school is located directly in Acono Village.

Secondary education facilities accessible to Acono Village residents are concentrated mainly in St. Joseph and its environs. These include long-established denominational and government-assisted secondary schools, as well as a secondary school located on the compound of the University of the Southern Caribbean. While secondary schools are not located within Acono Village itself, their proximity to the wider Maracas Valley and St. Joseph area allows students to commute daily.

Tertiary education options extend beyond the immediate project area and include institutions located in Mount Hope, St. Augustine, and Arima. These facilities are accessed by residents seeking post-secondary education and professional training. In addition, vocational and skills-based training opportunities are available through national programmes such as the Youth Training and Employment Partnership Programme, with the closest training facilities located outside the Valley.

Health

Public health services accessed by residents of Acono Village fall under the jurisdiction of the North Central Regional Health Authority, which serves Tunapuna/Piarco and neighbouring municipalities. Health care infrastructure available to the community includes primary, secondary, and tertiary facilities distributed across the north-central region.

Within the project-affected area, residents of Acono Village have access to primary health care facilities located in Maracas Valley and St. Joseph, including public health centres that provide outpatient and preventative services. A private medical facility is also located in St. Joseph and is accessed by residents seeking private health care services.

For specialised and acute medical care, residents typically access regional and national facilities located outside the immediate project area, including hospitals and specialist centres in Mount

Hope and surrounding areas. These facilities provide secondary and tertiary care, diagnostic services, and emergency treatment, and are accessible by road transport from Acono Village.

Community and Recreational Facilities

Community infrastructure accessible to Acono Village residents includes community centres, recreational grounds, and informal social spaces located within the wider Maracas Valley and St. Joseph area. Community centres in neighbouring communities provide venues for meetings, social programmes, and community-based activities and are commonly used by residents of Acono Village, where no equivalent facility exists locally.

Recreational facilities within the affected communities consist primarily of small parks, basketball courts, and recreation grounds, with the majority located in Maracas/St. Joseph. These facilities support informal recreation and organised sporting activities for residents of the Valley, including those from Acono Village. Larger regional recreational and sporting facilities are located elsewhere in Tunapuna/Piarco and are accessed on a less frequent basis.

The availability of recreational and community facilities is supplemented by natural recreational spaces in the Northern Range, which are used for informal recreation and social activities. However, these spaces are not formally developed or managed as recreational infrastructure for Acono Village.

Water and Sanitation

Households in Acono Village primarily rely on a combination of public pipe-borne water supply and supplementary sources, reflecting the community's location within the upper Maracas Valley and the uneven reach of the formal distribution network. According to the 2011 Population and Housing Census, 63.8 percent of households in Acono Village had water piped directly into their dwellings, while a further 6.3 percent received water piped to their yards. A notable share of households (13.0%) relied on public standpipes as their main water source, indicating continued dependence on communal supply infrastructure in the village.

Private pipe-borne supplies were reported by 5.7 percent of households, while 6.3 percent relied on natural water sources, including rivers, springs, wells, or ponds. A small proportion of households (1.0%) depended on truck-borne water. The diversity of water sources used in Acono Village contrasts with the wider Tunapuna/Piarco municipality, where households were more likely to have water piped directly into dwellings and less likely to rely on standpipes or natural sources.

The frequency of public water supply in Acono Village was markedly intermittent in 2011. Only 24.7 percent of households reported receiving public water on a daily basis. Nearly half (49.2 %) were supplied at least three times per week, while 19.7 percent received water once or twice weekly. Smaller proportions reported receiving water once every two or three weeks (1.9%) or not at all (3.8%). These figures indicate that households in Acono Village were substantially more likely than the municipal average to experience irregular public water supply.

The Acono WTP service area represents a wider beneficiary population than the immediate S-DAoI communities alone. Based on WASA's population forecasting, the estimated population served by the Acono WTP was 1,835 persons in 2011 and is projected to increase to approximately 3,722 persons by 2025 and 3,751 persons by 2042. The projections suggest that, after the initial increase from the 2011 baseline, the served population is expected to remain relatively stable over the long term, with only modest growth between 2025 and 2042. At the household and building level, the forecast indicates a more direct service-expansion effect: the number of buildings associated with the Acono WTP service area is projected to increase from 1,778 in 2011 to 3,674, with WASA anticipating approximately 1,896 new connections as a result of the project. While population growth within the service area is expected to remain modest, demand for water services is likely to increase as additional households and buildings are connected to the network and benefit from expanded coverage and improvements to the Acono water-supply system.

Within the Caurita area of Acono Village, households are served by the Acono Water Treatment Facility, which supplies water through a pipe-borne network to homes and yards and via several public standpipes located along Caurita Road. A communal water storage tank installed and periodically filled by the Water and Sewerage Authority provides an additional source during periods of reduced supply. However, households located beyond the formal distribution network—particularly along upper Caurita Road, Providence Road, Bancal Road, Sambradura Road, and Gaumal Road—depend on private abstractions from tributaries and springs, as well as rainwater harvesting. During dry periods, truck-borne water becomes an important supplementary source, and residents may travel to accessible standpipes to collect water.

Sanitation infrastructure in Acono Village is characterised by a predominance of on-site waste treatment systems, consistent with the limited extent of sewerage infrastructure in the upper Valley. Census data indicate that 62.8 percent of households used water closets connected to septic tanks, while 9.7 percent were connected to a sewerage system. A significant proportion of households (27.3 %) reported the use of pit latrines, a share notably higher than that observed at the municipal level.

The reliance on septic systems and pit latrines reflects the village's semi-rural settlement pattern and the absence of comprehensive sewerage coverage. Unimproved sanitation facilities, such as open pits or pit latrines without slabs, were reported to be rare within the wider north-central region, and there is no indication that such facilities are prevalent in Acono Village. A small proportion of households reported sharing sanitation facilities, consistent with broader municipal patterns.

Electricity

Electricity access across the S-AoI is high and broadly consistent with national patterns of near-universal household electrification. In the 2011 Population and Housing Census, household source of lighting provides a useful proxy for electricity access, although it does not capture service reliability, affordability, outage frequency, legal connection status, or the adequacy of supply to individual properties. On this basis, electricity is the dominant household lighting source in both the S-IAoI and the S-DAoI, while reliance on kerosene, gas, solar energy, and other sources is limited.

In 2011, 98.9 percent of households in Tunapuna/Piarco used electricity as their main source of lighting. Kerosene was the next most common lighting source, but accounted for only 0.7 percent of households, while other sources accounted for 0.2 percent (Central Statistical Office of Trinidad and Tobago, 2012a). Gas and solar energy were negligible as primary household lighting sources, each accounting for less than 0.1 percent of households. These figures indicate that electricity access was not a major household infrastructure deficit at the S-IAoI level, although small residual gaps remained.

Within the S-DAoI, electricity use for lighting was slightly lower than the wider municipal average. In Acono Village, 94.5 percent of households used electricity as their main lighting source in 2011, while 3.6 percent relied on kerosene, 0.6 percent on gas, and 0.4 percent on other sources. No households in Acono Village reported solar energy as their main lighting source, while 1.0 percent did not state their lighting source. The comparatively higher reliance on kerosene in Acono Village suggests that a small proportion of households may have had limited or less secure access to grid electricity, although the underlying reasons would require field verification.

Municipal infrastructure assessments also described electricity coverage in Tunapuna/Piarco as extensive. Electricity supply was reported to be available in almost all communities, and the municipal power network was described as being served by 66 KVA and 33 KVA transmission lines running east from Port of Spain through the Trincity, Piarco, Arima and San Raphael areas. Local distribution from the high-voltage network was provided through substations, poles and transformers, while increasing development activity was associated with rising demand for electrical power in the municipality (Kairi Consultants Limited, 2010, 2016).

For Acono Village, the main electricity-related baseline issue is therefore not basic household access, but the small residual share of households that continued to rely on kerosene, gas or other lighting sources, together with the importance of reliable electricity for domestic water storage, household communication, small business activity, refrigeration, education, and access to digital services. Reliable electricity is also indirectly relevant to water service delivery, as water treatment, pumping, distribution, monitoring and operational systems depend on a stable power supply. These patterns are relevant to later assessment of infrastructure interdependencies and community sensitivity to service disruptions within the S-DAoI.

Information and Communication Technology

Information and communication technology (ICT) access within the S-AoI is relevant to household communication, access to online services, education and training, work-related activities, emergency information, and stakeholder engagement. The available data are primarily drawn from the National Digital Inclusion Survey 2021 and the NDPBA municipal risk profile for Tunapuna/Piarco (Kairi Consultants Limited, 2022; Pacific Disaster Center (PDC Global), 2020). Community-level ICT data for Acono Village are available from the Digital Inclusion Survey; however, they are index-based estimates and should be interpreted as indicative of relative digital access and inclusion rather than as a detailed inventory of telecommunications infrastructure or household service quality.

At the S-IAoI level, Tunapuna/Piarco benefits from its position within the East-West Corridor and its proximity to major urban, educational, institutional and commercial centres. However, ICT access and use are uneven across the municipality, particularly between urban corridor communities and more rural or hillside settlements in the Northern Range. The NDPBA municipal risk profile ranked Tunapuna/Piarco ninth overall for communications capacity, seventh for mobile phone use, and ninth for mobile and wireless infrastructure density. It also recorded that approximately half of the households in the municipality had no internet access. These indicators suggest that, despite the municipality's relatively strong urban and institutional base, digital access constraints remain relevant within parts of the S-IAoI, particularly in less accessible communities.

The National Digital Inclusion Survey 2021 provides more direct insight into Acono Village. The S-DAoI recorded an ICT Development Index (IDI) score of 7.26, ranking 473rd out of 609 communities nationally, and a Digital Inclusion Index (DII) score of 3.79, ranking 415th out of 609 communities. These scores place Acono Village among the lower-ranked communities nationally for ICT development and digital inclusion. The pattern is consistent with the community's rural-residential setting, hillside location, and dependence on road-based access to wider service centres, although the specific conditions, reliability, and affordability of household internet and mobile services would require field verification.

The difference between ICT development and digital inclusion is also relevant to the baseline. The IDI captures infrastructure access, ICT use and skills, while the DII extends the analysis to participation in online services, trust and confidence, and readiness or digital literacy. Acono Village's DII ranking suggests that digital inclusion may be shaped not only by access to devices or internet services, but also by affordability, digital skills, confidence in online systems, and the ability to use digital platforms for government, education, financial, communication and information services.

Digital access conditions may affect how information circulates within Acono Village. Households without reliable internet access, older persons, persons with disabilities, low-income households, and residents in upper or more remote parts of the community may be less able to rely exclusively on digital communication channels. At the same time, mobile phones and messaging platforms are likely to remain important tools for routine communication, subject to service coverage, affordability and user capacity. These patterns are relevant to understanding existing information access, communication pathways, and the use of digital and non-digital channels within the S-DAoI.

Transportation

Transportation access in Acono Village is shaped by its location within the upper Maracas Valley and its reliance on a limited number of primary and secondary road corridors connecting the community to St. Joseph and the wider East–West Corridor. The village is accessed principally via Acono Road, which links to Maracas Royal Road, the main north–south connector serving the Maracas Valley. Maracas Royal Road provides the sole continuous vehicular route between the Valley and the Eastern Main Road (EMR), making it a critical piece of infrastructure for daily commuting, goods movement, and access to services.

The Eastern Main Road functions as the primary east–west arterial route connecting St. Joseph to Tunapuna, Curepe, and Port of Spain to the west, and to Arouca and Sangre Grande to the east. Through this corridor, residents of Acono Village access employment centres, secondary and tertiary education institutions, healthcare facilities, and commercial services located outside the community. While the broader Tunapuna/Piarco municipality benefits from multiple parallel east–west routes, including the Priority Bus Route and the Churchill–Roosevelt Highway, these facilities are accessed indirectly by Acono residents via Maracas Royal Road and feeder streets, increasing travel time and dependence on a single access route.

Within Acono Village, the local road network comprises a mix of paved and partially improved roads and traces, including Caurita Road, Providence Road, Bancal Road, Sambradura Road, and Gaumal Road, which provide access to residential clusters, agricultural plots, and forested areas. Road geometry in these areas is generally narrow, with limited shoulders and constrained sightlines, reflecting incremental development patterns and hillside terrain. In some locations, road conditions are affected by slope instability, surface deterioration, and drainage limitations, particularly during periods of heavy rainfall. Upper sections of Gaumal Road have experienced damage, restricting access and concentrating traffic onto alternative routes.

Public transportation services are available primarily along Maracas Royal Road, where maxi-taxis and route taxis operate between Maracas Valley and St. Joseph. These services provide the main form of public transport for residents without private vehicles, facilitating access to schools, workplaces, markets, and public services. However, service frequency may be irregular during off-peak hours, evenings, and weekends, and residents living along interior roads must often walk considerable distances to reach designated pickup points along the main corridor. As a result, households located further upslope or along secondary roads face greater transport constraints.

Pedestrian infrastructure within Acono Village is limited. Many roads lack continuous sidewalks, adequate pedestrian crossings, or formal drainage separation, increasing safety risks for pedestrians, particularly children, older persons, and individuals walking during low-light conditions. These limitations are more pronounced along narrower village roads and at junctions connecting to Maracas Royal Road.

4.4.3.6 Institutional Stakeholder Landscape

The institutional stakeholder landscape for the Acono WTP project comprises central government agencies, local government authorities, statutory service providers, and community-based organisations operating within Acono Village and the wider Maracas Valley. These institutions play critical roles in service delivery, land administration, environmental management, public health, community development, and local representation and are therefore relevant to both the social baseline and subsequent stakeholder engagement and management planning.

Local and National Government Institutions

At the national level, several central government agencies have statutory responsibilities that intersect with the operation, rehabilitation, and social context of the Acono WTP. Key among these is the Water and Sewerage Authority, which is responsible for the abstraction, treatment, and distribution of potable water to Acono Village and surrounding communities. WASA also plays a role in community-level water management through the operation of standpipes, communal tanks, and emergency water trucking during periods of supply disruption.

Local government oversight is provided by the Tunapuna/Piarco Regional Corporation, which has jurisdiction over Acono Village. The Regional Corporation is responsible for local roads, drains, refuse collection, minor infrastructure maintenance, and community facilities, and serves as a key interface between residents and central government agencies. The Corporation also facilitates community development activities and disaster preparedness at the local level.

Public safety and security within Acono Village fall under the remit of the Trinidad and Tobago Police Service, with operational coverage provided through the Northern Division and stations serving St. Joseph and the Maracas Valley. Emergency response and disaster coordination are supported by the Office of Disaster Preparedness and Management, particularly in relation to flooding, landslides, and other hazard events associated with the Northern Range.

Environmental regulation and oversight relevant to water abstraction, treatment, and environmental protection are provided by national regulatory agencies, including those responsible for environmental management, public health, and occupational safety. These agencies establish compliance requirements and monitoring frameworks that influence both project implementation and operational practices.

Civil Society Organisations

Civil society stakeholders in Acono Village are primarily community-based organisations, religious institutions, and informal resident networks that play important roles in social cohesion, local advocacy, and community mobilisation. While Acono Village does not host a large number of formal non-governmental organisations, community representation is typically facilitated through village-level leadership structures and associations linked to the wider Maracas Valley.

Religious institutions located within or accessed by residents of Acono Village serve not only as places of worship but also as centres for social support, charitable activities, and informal dispute resolution. These institutions often act as trusted intermediaries during periods of social stress or emergency and may provide venues for information dissemination and consultation.

Farming groups and informal agricultural networks are also present within Acono Village, reflecting the continued importance of small-scale and part-time agriculture to local livelihoods. While not always formally registered, these networks influence land use practices, water demand patterns,

and seasonal economic activity, and therefore represent relevant stakeholders for water resource management.

Community Participation and Consultation Mechanisms

Participation and consultation within Acono Village typically occur through community meetings, engagement with local government representatives, and interactions with service providers, rather than through highly formalised consultation structures. Residents commonly raise concerns related to water supply reliability, road conditions, drainage, and land tenure through the Tunapuna/Piarco Regional Corporation, elected local representatives, or directly with service providers such as WASA.

Historically, engagement on infrastructure-related issues has been reactive and issue-driven, often in response to service disruptions, environmental events, or proposed developments. While this reflects broader patterns of community participation in semi-rural areas, it underscores the importance of structured and inclusive stakeholder engagement for the Acono WTP project, particularly to ensure that information is accessible and that concerns from vulnerable or less vocal groups are captured.

The institutional landscape in Acono Village is characterised by clear statutory roles at the national and local government levels, complemented by informal but socially significant community structures. Effective coordination among these actors will be important for managing social risks, maintaining public confidence, and supporting transparent communication throughout the project lifecycle.

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.
Probability	• 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.

5.1.1 The Construction Phase

The construction phase of the rehabilitation and upgrading works across the Water Treatment Plants is expected to generate several meaningful positive impacts for surrounding communities, the national water sector, and the broader economy. One of the most significant benefits during construction will be the improvement of existing facility safety, reliability, and operational performance. Although the full operational benefits will be realised post-construction, many enhancements begin during the construction phase, such as early installation of safer equipment, upgraded electrical systems, improved structural integrity, and better site drainage. These improvements immediately reduce risks of equipment failure, chemical exposure, and on-site hazards for staff and visitors. Construction activities will also stimulate infrastructure renewal and modernisation, replacing aged components that currently pose operational inefficiencies.

A further positive outcome during construction is the creation of local employment opportunities during the construction period. The projects will require skilled and unskilled labour. In addition to direct employment, indirect economic benefits will accrue to businesses supplying construction materials, transportation services, food, equipment, security, and accommodation, resulting in increased local spending and stronger community–contractor linkages.

The projects will also contribute positively to capacity building and skills development among workers. Exposure to enhanced water-treatment processes, safe chemical handling practices, energy-efficient technologies, and modern construction techniques will strengthen the technical competencies of local contractors and labourers.

The presence of contractors and enhanced construction oversight has the potential to strengthen environmental stewardship where the Environmental and Social Management Plan (ESMP) is effectively implemented, and compliance is maintained throughout the construction period. Under these conditions, measures such as erosion and sediment controls, waste management systems, and spill prevention procedures will improve the management of sensitive areas surrounding rivers, reservoirs, and forested watersheds by reducing the likelihood of construction-related environmental degradation. Effective implementation of these measures can also contribute to improved environmental management practices and institutional capacity, with knowledge and procedures established during construction potentially informing future operational practices.

Finally, the construction phase provides an opportunity for enhanced community engagement and information sharing. Through grievance mechanisms, public notifications, consultations, and ongoing communication by WASA, communities gain clearer insight into the improvements being undertaken and how these works will ultimately result in a more reliable, higher-quality water supply. This process has the potential to strengthen trust between communities and the utility and reinforce WASA's commitment to transparency and service improvement.

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								
Soil disturbance and erosion	Likely	Increased sedimentation, slope instability, degradation of riverbanks	Negative	Moderate–High (site dependent)	Short-term (construction phase)	- Install silt fences, sediment traps, phased excavation, slope stabilization, protect riparian buffers, schedule works in dry season	Erosion & Sediment Control Plan	Contractor (implementation); WASA/Engineer (supervision)
Increased turbidity and sedimentation of nearby rivers/streams (Acono)	Unlikely	Degraded water quality, increased treatment demand	Negative	High in sensitive watersheds	Short-term (may have temporary ecological effects)	- Use silt curtains, settle runoff onsite, maintain 15–30 m riparian buffers, no in-stream works during heavy rains	Water Quality Management Plan	Contractor; WASA Environmental Unit
Generation of construction dust	Likely	Local air quality deterioration, nuisance to workers and nearby residents	Negative	Low–Moderate	Temporary (only during active works)	- Water spraying, covering stockpiles, wheel washing, and limiting vehicle speeds	Air Quality and Dust Control Plan	Contractor
Localised Noise and vibration from machinery	Definite	Disturbance to communities and wildlife; worker discomfort	Negative	Low–Moderate	Temporary	- Use mufflers, restrict work to daylight hours, maintain equipment, and locate generators away from receptors	Noise & Vibration Management Plan	Contractor
Solid and construction waste generation	Definite	Littering, blockages of drains, attraction of pests, and pollution	Negative	Moderate	Temporary–short term	- Segregate waste, schedule frequent collection, prohibit dumping, provide labelled bins, contract licensed waste haulers	Waste Management Plan	Contractor
Accidental spills (fuel, oil, chemicals)	Likely	Soil and water contamination, harm to aquatic life, fire hazard	Negative	Moderate–High	Short term but potentially significant	- Use drip trays, designated refueling zones, spill kits onsite, train workers, first aid kits	Emergency Response Plan	Contractor; WASA
Disruption of existing drainage patterns	Unlikely	Local flooding, ponding, increased erosion	Negative	Moderate	Temporary	- Maintain clear drains, install temporary diversion channels, ensure site grading directs water to sediment controls	Drainage Management Plan	Contractor
ECOLOGICAL								
Conversion of green space to hard surfaces (like concrete or tar)	Likely	Reduced permeable spaces; increased erosion	Negative	Low–Moderate	Long-term	- Minimize work to footprint	Biodiversity /Habitat Management Plan	Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
INTRODUCTION OR SPREAD OF INVASIVE SPECIES	Unlikely	Competition with native species; altered habitat structure	Negative	Low–Moderate	Medium term	- Inspect materials; clean equipment before site entry; avoid contaminated fill; remove invasives if found	Biodiversity /Habitat Management Plan	Contractor; WASA Environmental Unit
WILDLIFE-VEHICLE COLLISIONS	Likely	Mortality of mammals, reptiles, amphibians	Negative	Low	Short term	- Enforce speed limits on site; Be vigilant of stray wildlife	Biodiversity Management Plan	Contractor
SOCIAL/ECONOMIC								
TRAFFIC DISRUPTION AND SAFETY RISK ARISING FROM THE TRANSPORT OF CONSTRUCTION VEHICLES, EQUIPMENT AND WORKERS (ALL PROJECTS)	Unlikely to Likely	Heightened safety risks for vulnerable groups – pedestrians, older persons and children	Negative	Moderate	Short term	- Develop safe pedestrian access routes around active construction areas. - Install clear and visible signage to guide pedestrians and road users. - Notify affected communities in advance about traffic impacts, mitigation measures, and the movement of heavy equipment during construction.	CESMP Traffic Management Plan	Contractor
NOISE, DUST, AND VIBRATION FROM CONSTRUCTION ACTIVITIES (ALL PROJECTS)	Unlikely – Likely	Temporary reduction in quality of life; health impacts on sensitive population groups	Negative	Low - Moderate	Short term	- Implement dust suppression measures. - Install barriers near sensitive receptors (e.g. schools, health and outreach centres). - Restrict working hours to minimise disturbance to nearby communities.	CESMP	Contractor
INTERRUPTION OF WATER SERVICE WITH REFURBISHMENT WORKS (ALL PROJECTS)	Likely	Temporary service interruption affecting households, businesses, and local institutions – nurseries, schools, health facilities, elderly care facilities Disproportionate effect on women due to increased domestic and caregiving responsibilities	Negative	Low–Moderate	Short term	- Provide advance notification of disruptions. - Provide temporary (truck-borne) water supply or schedule works during low-demand periods. - Coordinate with Municipal Corporations with the supply of truck-borne water where required - Prioritise sensitive facilities when providing water supplies	CESMP Operational Contingency Plan Stakeholder Engagement Plan	WASA, Contractor

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
LIMITED LOCAL EMPLOYMENT OPPORTUNITIES AND GENDER IMBALANCE (ALL PROJECTS)	Definite	Missed opportunities for local hiring; exclusion of women from employment benefits	Mixed	Low–Moderate	Short term	- Encourage local hiring by including local hiring clause in contractor's contract. - Advertise available positions early within local communities. - Work with communities to establish transparent recruitment procedures. - Integrate gender inclusion measures.	Labour Management Plan	Contractor, WASA
COMMUNITY HEALTH AND SAFETY RISKS (TRANSPORT OF HEAVY EQUIPMENT AND VEHICLES, DAM WORKS) (ALL PROJECTS)	Likely	Increased accident risk, particularly for children and persons with reduced mobility	Negative	Moderate	Short-term	- Install site fencing to secure active work areas. - Erect barriers to prevent unauthorized access. - Provide adequate lighting, particularly for night-time or low-visibility conditions. - Install clear warning signage around construction zones. - Conduct community sensitization activities on construction risks and safety measures.	HSE Plan Stakeholder Engagement Plan	Contractor, WASA
PRESENCE OF MALE-DOMINATED CONSTRUCTION WORKFORCE (ALL PROJECTS)	Likely	Risk of community tension, inappropriate behaviour, and GBVH incidents if unmanaged	Negative	Moderate	Short-term	- Establish a Worker Code of Conduct; - Conduct mandatory worker induction and follow up training on gender-based violence and harassment (GBVH) and response - Establish confidential grievance channels to receive, manage, and resolve GBVH-related complaints.	Labour Management Plan GBVH Prevention and Response Plan	Contractor, WASA
UNSAFE ONSITE WORKING CONDITIONS IF REFURBISHMENT ACTIVITIES ARE NOT ADEQUATELY MANAGED (ALL PROJECTS)	Likely	Occupational health and safety risks to workers, including electrical works, confined-space entry, lifting operations, working at height, chemical handling, and works near water	Negative	Moderate	Short-term	- Implement and enforce site-specific HSE procedures. - Conduct task-specific risk assessments and permit-to-work systems for high-risk activities. - Provide appropriate personal protective equipment (PPE) and safety training. - Provide welfare essentials which are made available to all workers. Eg: Lockers, Male and female toilets, potable water, lunch areas etc. - Ensure supervision by qualified personnel.	HSE Plan Labour Management Plan Emergency Response Plan	Contractor, WASA

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
						- Emergency preparedness and incident reporting procedures.		
INSTITUTIONAL COORDINATION GAPS BETWEEN WASA AND MUNICIPAL CORPORATIONS (ALL PROJECTS)	Likely	Scheduling conflicts, poor communication, community frustration	Negative	High	Medium term	- Establish clear coordination. arrangement between WASA, MOWT and Municipal Corporations. - Joint scheduling of planned activities.	Stakeholder Engagement Plan	WASA, MOWT, Municipal Corporation
INADEQUATE COMMUNICATION WITH AFFECTED COMMUNITIES (ALL PROJECTS)	Likely	Confusion, mistrust, unsafe behaviours, grievances	Negative	Moderate–High	Short to medium term	- Implement community communication plan. - Engage all directly and indirectly affected communities. - Use multiple communication channels to advertise. - Provide mechanisms to provide feedback and address grievances.	Stakeholder Engagement Plan Grievance Redress Plan	Contractor, WASA
IMPROVED ACCESS TO POTABLE WATER AND ENHANCED RELIABILITY (ALL PROJECTS)	Definite	Improved health, quality of life, business operations	Positive	High	Long term	- Maintain ongoing communication with communities on commissioning progress and service improvements. - Complete commissioning activities in a timely manner to sustain service improvements and community trust.	O&M Plan	WASA
INCREASED CLIMATE RESILIENCE AND OPERATIONAL SUSTAINABILITY (ALL PROJECTS)	Likely	Strengthened system reliability	Positive	High	Long term	- Integrate climate adaptation features into the design of refurbishment works, system operations and asset management.	ESMS Implementation Plan	WASA

5.1.2 The Operations Phase

The operation phase of the rehabilitated Water Treatment Plants is expected to generate substantial and wide-ranging positive impacts for Trinidad and Tobago's water sector, local communities, and the environment. Foremost among these benefits is the improved efficiency, reliability, and resilience of water supply services. The upgraded plants will operate with enhanced treatment capacity, more robust filtration and sedimentation systems, modernised mechanical and electrical components, and improved chemical dosing controls. These upgrades will enable WASA to consistently meet national and international water-quality standards (TTBS and WHO), ensuring safer, clearer, and more dependable water for households, businesses, healthcare institutions, and schools.

Enhanced operational systems, such as rehabilitated intakes, improved sludge management, and upgraded backup power supplies, will significantly reduce the frequency and duration of water service interruptions. This improvement is especially important in rural and peri-urban areas where communities have historically experienced inconsistent supply. With stronger operational resilience, the system will be better able to withstand shocks such as intense rainfall events, drought conditions, turbidity spikes, or electrical outages. In this way, the projects will contribute meaningfully to national climate adaptation efforts and long-term water security.

The improved performance of the facilities will also yield positive public health outcomes. By providing higher-quality treated water with lower turbidity, reduced sediment load, and more effective disinfection, the upgraded plants can help to reduce the incidence of waterborne diseases and contribute to improved hygiene and sanitation conditions. Households will experience fewer disruptions in water availability, enabling more reliable sanitation practices and reducing the need for unsafe alternative sources such as untreated streams or stored water.

During operation, the benefits extend to the natural environment, particularly at the Acono site, where watershed conditions and aquatic ecosystems are sensitive to changes in water abstraction and treatment processes. With more efficient systems, the improved plants will likely generate lower levels of residual waste, reduce chemical overuse, and better manage sludge, thereby decreasing the risk of environmental contamination.

At the socio-economic level, the operation phase will bring capacity development for WASA's staff. Operators, technicians, and maintenance personnel will benefit from training on upgraded technologies, process optimisation, and environmental safeguards. This strengthens the skill base of the national water sector workforce and supports long-term institutional capacity. More efficient plants also reduce operational strain and energy consumption, lowering operating costs and improving the financial sustainability of water service delivery.

Based on climate change projections for a drying trend and the already existing decrease in rainfall trend seen in the project areas to date (Figure 4-7), decreases in yield from the wells to be installed at Siparia is a long-term concern to be managed. Furthermore, changes in land use over time within the aquifer recharge areas may reduce groundwater recharge, thereby exacerbating long-term water availability constraints. It is therefore essential that both groundwater quantity and quality from the production wells supplying the Siparia Water Treatment Plant are continuously monitored to support adaptive management of the resource. Groundwater quality monitoring should include, at a minimum, iron concentrations, given the elevated iron levels identified within the Morne L'Enfer and Erin Sands aquifers, as well as hydrocarbons where appropriate, owing to the occurrence of active hydrocarbon reservoirs within the Southwestern Basin and the potential for hydrocarbon migration during drilling. Monitoring should also include groundwater levels, pumping rates, and well yields to detect changes in aquifer performance and potential well interference. Results from these monitoring programmes should be used to optimise abstraction rates, determine the sustainable production capacity of individual wells, identify any deterioration in raw water quality requiring treatment modifications, and inform decisions regarding the development of additional production wells. As recommended in the hydrogeological assessment, detailed hydrogeological investigations, including electric logging, borehole drilling, and pumping tests, are also necessary to confirm aquifer characteristics, refine well design, and determine the location, number, and long-term viability of wells capable of supplying the Siparia Water Treatment 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
MECHANICAL/PHYSICAL								
Failure or malfunction of treatment units	Likely to Unlikely	Reduction in water quality; potential supply interruptions	Negative	Moderate	Short–medium term until repaired	- Preventive maintenance; routine inspections; operator training; redundancy systems	Operations & Maintenance Plan	WASA Operations Division
Chemical leaks/spills during storage or dosing (chlorine, alum, polymers)	Likely	Chemical contamination of soil or drains; worker/public exposure	Negative	Moderate–High (site dependent)	Short term but can be serious	- Secondary containment; automatic shut-off valves; proper PPE; spill kits; staff certification	Emergency Response Plan	WASA (EHS + Operations)
Noise from pumps and mechanical equipment	Likely to Unlikely	Nuisance to nearby communities; worker discomfort	Negative	Low–Moderate	Long term	- Acoustic enclosures; maintenance of bearings/motors; schedule noisy activities for daytime	Noise Management Plan	WASA
Inadequate stormwater drainage around the plant	Unlikely	Local flooding, erosion, damage to infrastructure	Negative	Moderate	Medium–long term	- Maintain drains; clear debris; periodic inspections; upgrade drainage if needed	Operations & Maintenance Plan	WASA
Infrastructure corrosion or structural failure (tanks, pipelines)	Likely	Leaks, water loss, contamination risk, safety hazards	Negative	Moderate–High	Medium–long term	- Routine structural inspections; corrosion control; protective coatings; timely repairs	Operations & Maintenance Plan	WASA Engineering Department
Water quality deterioration due to watershed issues (sediment, agricultural runoff)	Likely (Acono)	Reduced treatment efficiency; increased chemical use; potential breakthrough of contaminants	Negative	Moderate–High	Long term, seasonal	- Water quality monitoring; source water protection partnerships; upstream community engagement	Operations & Maintenance Plan	WASA + Ministry with responsibility for Agriculture/Forestry Division
Fire hazard at chemical storage areas or electrical rooms	Likely to Unlikely	Facility damage; threats to workers; service disruption	Negative	High	Short term	- Fire detection/suppression systems; training; no-smoking policy; proper electrical maintenance	Emergency Response Plan	WASA
Failure of generators or backup systems	Likely to Unlikely	Service outages during power failure	Negative	Moderate	Short term during outage	- Routine testing of generators; fuel management; preventive servicing	Emergency Preparedness & Response Plan	WASA
Pollution from vehicle and machinery operations onsite	Unlikely	Hydrocarbon contamination; air emissions	Negative	Low	Long term	- Designated parking and refuelling areas; spill controls; regular vehicle servicing	Air Quality & Emissions Control Plan	WASA

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
Chemical leaks from storage or dosing systems	Likely to Unlikely	Toxicity to aquatic organisms; soil contamination; vegetation damage	Negative	Moderate–High	Short-term, but can be severe	- Secondary containment; leak detection systems; chemical storage protocols; emergency response	Emergency Response Plan	WASA
Excess chlorine release or discharge of inadequately treated water	Unlikely	Harm to aquatic life; temporary water toxicity; ecological disturbance	Negative	Moderate	Short term	- Process monitoring systems; alarms; fail-safe dosing; regular calibration; operator training	Water Quality Monitoring Plan	WASA
Alteration of natural flow regimes downstream of intakes	Likely to Unlikely (Acono)	Reduced habitat availability; changes to sediment transport; stress to aquatic species	Negative	Low–Moderate	Long term	- Maintain environmental flows; monitor abstraction rates; adjust intake operations seasonally	Biodiversity Management Plan	WASA
Noise/light disturbance from 24-hour operations	Unlikley	Disruption to wildlife behaviour (bats, birds, mammals)	Negative	Low	Long term	- Shielded downward lighting; establish light curfews where feasible; maintain equipment to reduce noise	Biodiversity Management Plan	WASA Operations
Erosion at discharge points or drainage outlets	Likely to Unlikely (Acono)	Bank destabilization; increased sediment delivery; loss of riparian vegetation	Negative	Moderate	Medium term	- Stabilize outlets; vegetate banks; routine inspections; culvert maintenance	Erosion & Sediment Control Plan (Operational Phase)	WASA
Reduction in Yield and water availability over time due to climate change and land use change	Likely (Siparia)	Reduction in yield overtime impacting water availability and water quality over time.	Negative	Moderate to High	Long term	- Hydrogeological tests to inform well drilling activities and yield - Ongoing monitoring of well yield and water quality for each well to inform decision-making - Consider restricting development in the well recharge area and revegetate these areas to foster recharge	Operations and Maintenance (O&M) Plan	WASA Operations
ECOLOGICAL								
Improper disposal of sludge and backwash effluent into the nearby river during operations	Likely	Discharge of high-turbidity effluent impacting river biota if unmanaged.	Negative	Moderate	Long-term (operational)	- Provide lined settling ponds. - Recycle clarified water where feasible. - Dispose of dried sludge at EMA-approved site. - No direct discharge to rivers.	Water quality management plan Waste management plan Biodiversity management plan	WASA

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
Alteration of environmental flows from increased water abstraction	Likely	Reduced downstream flow affecting aquatic ecosystems and riparian vegetation.	Negative	Moderate	Long-term (operational)	- Establish environmental flow thresholds. - Install abstraction meters and automated controls. - Adjust intake rates during the dry season.	Water quality management plan Biodiversity management plan	WASA, Contractor
Chemical spills into nearby river systems (chlorine, alum, caustic soda, etc.) (Acono)	Unlikely	Risk of accidental spills contaminating soil and aquatic ecosystems.	Negative	Moderate to High (if incident occurs).	Episodic (accidental).	- Bund chemical storage areas. - Train operators in HAZMAT response. - Maintain spill kits and emergency protocols. - Routine inspection and containment maintenance.	Worker Health and Safety Management Plan Hazardous materials handling management plan	WASA
Water abstraction impacts on river flow and river fauna	Likely to Unlikely	Continuous abstraction of raw water may reduce downstream flows during low-flow periods, potentially affecting aquatic habitat availability, channel connectivity, water depth, and ecological processes. Reduced flows may also alter sediment transport patterns and water quality characteristics such as dissolved oxygen concentrations and temperature.	Negative	Moderate	Long-term	- Establish environmental flow requirements based on hydrological assessments. - Limit abstraction during drought and low-flow periods. - Install automated flow monitoring systems linked to abstraction controls. - Develop adaptive abstraction protocols based on seasonal river conditions. - Regularly monitor upstream and downstream flow regimes. - Coordinate with the Water Resources Agency and EMA regarding abstraction thresholds.	Water Resources Management Plan Water Quality Management Plan Biodiversity Management Plan Operational Environmental Monitoring Plan	WASA Operations Team
Water abstraction impacts on ecosystem-dependent species	Likely to Unlikely	Reduced flow volumes may affect habitat suitability for freshwater fish, aquatic macroinvertebrates, amphibians, and riparian-dependent species. Changes in flow regimes may disrupt breeding, migration, feeding,	Negative	Moderate	Long-term	- Maintain environmental flows sufficient to support aquatic ecosystem functions. - Conduct periodic ecological monitoring upstream and downstream of the intake.	Biodiversity Management Plan Water Resources Management Plan	WASA Environmental Specialist Forestry Division (oversight)

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
		and refuge habitats, particularly during the dry season.				- Adjust abstraction rates if ecological thresholds are exceeded. - Protect riparian vegetation and aquatic habitats. - Implement ecological flow assessments periodically.	Ecological Monitoring Programme	
SOCIAL								
IMPROVED ACCESS TO POTABLE WATER AND SERVICE RELIABILITY (ALL PROJECTS)	Definite	Improved water supply and scheduling. Improved household health, hygiene and quality of life, and improved conditions for caregiving. Enhanced improved public health outcomes.	Positive	High	Long term	- Ensure operational maintenance and timely service response. - Maintain ongoing public communication.	Operations and Maintenance (O&M) Plan Stakeholder Engagement Plan	WASA
INCREASED CLIMATE RESILIENCE AND WATER SECURITY (ALL PROJECTS)	Definite	Greater reliability during droughts and extreme weather events.	Positive	High	Long term	- Integrate climate adaptation features into the system operations and asset management. - Undertake regular maintenance of climate-adaptive infrastructure. - Update emergency response protocols.	O&M Plan Climate Resilience Strategy	WASA
SERVICE INTERRUPTIONS DUE TO OPERATIONAL MAINTENANCE OR SYSTEM FAILURE (ALL PROJECTS)	Unlikely to Likely	Reduced failure frequency due to refurbishment and upgrade. Shorter and better managed interruptions.	Negative	Low – Moderate	Short term (episodic)	- Provide advance notice for planned maintenance where feasible. - Maintain timely, clear communication with the public regarding system failures and service restoration timelines. - Implement system redundancy, standby equipment, and real-time monitoring to enable rapid fault detection and response.	O&M Plan Contingency and Emergency Response Plan	WASA

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
						- Establish rapid response protocol for failure and emergency response.		
INADEQUATE COMMUNICATION ON SERVICE DISRUPTIONS (ALL PROJECTS)	Likely	Frustration, mistrust, and increased grievances from communities.	Negative	Moderate	Short term	- Implement real-time notification system (e.g., WhatsApp, radio, community boards). - Maintain active grievance redress channel.	Operational Stakeholder Engagement Plan Grievance Redress Plan	WASA
WATER QUALITY DETERIORATION (E.G., DUE TO INADEQUATE TREATMENT (ALL PROJECTS)	Unlikely-Likely (depending on O&M)	Health and safety risks, loss of confidence in utility	Negative	Moderate – High	Medium term	- Conduct continuous water quality monitoring. - Ensure transparent reporting of water quality and operational performance. - Implement prompt corrective actions in response to identified issues.	Water Quality Management Plan O&M Plan	WASA
INCREASED UTILITY BILLS OR TARIFFS (PERCEIVED OR ACTUAL) (ALL PROJECTS)	Likely	Economic burden on vulnerable households; resistance to changes	Negative	Low – Moderate	Medium to long term	- Communicate tariff changes in advance and provide clear justification for any adjustments. - Ensure targeted social support or subsidies.	Stakeholder Engagement Plan Customer Relations Protocol	Regulated Industries Commission, WASA
STRENGTHENED INSTITUTIONAL CAPACITY AND SERVICE EFFICIENCY (ALL PROJECTS)	Likely	Improved operational response, better customer service	Positive	Moderate – High	Long term	- Maintain operator training; regular review of operational procedures	Capacity Development Plan O&M Plan	WASA
UPSTREAM HUMAN ACTIVITIES WITHIN WATER SUPPLY CATCHMENTS AFFECTING PLANT EFFICIENCY (ACONO)	Likely to Definite	Deterioration in raw water quality due to upstream human activities within the catchment, increasing treatment challenges and potentially affecting plant efficiency and service reliability.	Negative	Low – Moderate		- Monitor upstream land use and human activities within the catchment areas influencing raw water quality. - Coordinate with relevant agencies and local authorities on catchment management and enforcement actions.	O&M Plan Water Quality Management Plan Operational Stakeholder Engagement Plan	WASA

RISKS	PROBABILITY OF IMPACT	POTENTIAL IMPACTS	DIRECTION OF IMPACT	MAGNITUDE OF IMPACT	IMPACT DURATION	PROPOSED MITIGATION MEASURES	MANAGEMENT PLANS REQUIRED	RESPONSIBLE PARTY
						- Engage upstream communities on practices that may affect water quality, where appropriate.		

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 primary objective of the Environmental and Social Management Plan (ESMP) is to provide a structured, systematic framework that ensures the rehabilitation and upgrading works are implemented in a manner that prevents, minimises, or otherwise effectively manages adverse environmental and social impacts. In alignment with the IDB Environmental and Social Performance Standards, national regulatory requirements, and international best practice, the ESMP outlines the measures necessary to safeguard environmental resources, protect community wellbeing, and ensure worker health and safety throughout both the construction and operational phases of the projects.

More specifically, the ESMP seeks to translate the findings of the Environmental and Social Assessment (ESA) into actionable management measures by clearly defining mitigation strategies, operational controls, monitoring protocols, and compliance requirements for each identified impact. It establishes roles and responsibilities for WASA, contractors, and supervising entities to ensure accountability, consistent implementation, and effective oversight. The ESMP also seeks to ensure that all contractors and subcontractors adhere to a uniform standard of environmental and social performance across all project sites.

6.3 Roles and Responsibilities

6.3.1 Construction Phase

Prior to the start of the works, WASA will conduct the due diligence with the Environmental Management Authority to obtain certificate of environmental clearance (CEC) for the works.

During the Construction Phase, the Contractor Company will be responsible for preparing and implementing the Construction Environmental and Social Management Plan (C-ESMP) of the project, as well as obtaining the environmental and occupational health and safety qualifications and insurances required according to the national and local regulatory framework.

The Contractor will also need to obtain others applicable permits, which could include tree cutting permits for protected trees according to the Protected Trees Act, easements, excavation permits, construction permits, public road occupancy permits, waste disposal permits, permits for works near or in monuments, etc.

Before the start of the works, the Contractor must submit to the EMA, for its approval, a Construction Environmental and Social Management Program (C-ESMP).

The C-ESMP of the project will contain, as a minimum, the programs described in the following Sections of this ESMP.

Once the C-ESMP is approved, the Contractor Company will be responsible for its compliance, using the necessary means to implement the Programs that are formulated within its framework. The Contractor Company must have an environmental and social representative and a person responsible for hygiene and safety, who will be responsible for conducting the implementation of the C-ESMP. Likewise, the contractor must comply with and make the operators and subcontractors comply with all the provisions contained in said Plan, national and local environmental legislation, appropriate construction codes and best practices and the IDB Environmental and Social Policy Framework, during all stages of the execution of the works.

The Contractor Company will prepare monthly reports to the EMA, detailing the actions and results of the C-ESMP implementation.

The inspection, control, and monitoring activities of the C-ESMPc will be conducted by WASA. WASA may conduct inspection visits, prepare reports for internal use for the Project, and determine and impose corrective measures based on the stipulations of the bidding documents.

The environmental authority may also conduct control audits of the work.

At the finalization of the works, the Contractor must submit a Final Environmental and Social Report, which includes the information corresponding to the implementation of C-ESMP, including records of implementation of plans and programs, and a report on compliance with all environmental and social indicators considered at various stages of the project cycle.

6.3.2 Operation and Maintenance

During the operational stage, WASA will be responsible for the operation and maintenance of the infrastructure built under the Program, in accordance with its current environmental policies and environmental and social management systems, including the ESMP for the operational and maintenance stage of each work.

6.3.3 Role of IDB

The IDB will oversee and supervise the implementation of the environmental and social management system for all projects under the Program. This includes the review and approval of the semi-annual environmental and social compliance reports submitted by WASA, as well as conducting environmental and social supervision missions. This is expected to last throughout project implementation.

The Table below summarizes the environmental and social management responsibilities of the entities involved in the different phases of the projects.

Table 6-1: Environmental and Social Responsibilities for Project Intervention

Project Phase	Activity	Responsibility	Monitoring	Oversight
Design	Grievance Redress Mechanism (for the duration of the Program)	WASA	MPU	IDB
	Final Project Design / Engineering Design	Independent Contractors	WASA	IDB
	Environmental and Social Assessment	Independent Consultants	WASA	IDB
	Public Consultation	WASA	MPU	IDB
	Preparation of E&S Technical Specifications for Bidding Documents	WASA	MPU	IDB
	Environmental Permits (when applicable)	WASA	MPU	WASA
Construction	ESMPc: Preparation and implementation	Contractors	WASA	IDB
	Environmental and Social compliance during construction	Contractor	WASA	IDB
	Monthly E&S Progress Report	Contractor	WASA	MPU
	Semi-annual E&S Progress Reports	WASA	MPU	IDB
	Final E&S Report	Contractor	WASA	MPU
	Final E&S Report	WASA	MPU	IDB
Operation	Operation and maintenance of the new installed infrastructure	Each WASA plant	MPU	IDB (initial period of 3 years after work completion)

Decommissioning	Decommissioning of older water treatment plants being replaced will be application to some project interventions. The Decommissioning Plan developed in the ESMP and ESMPc should be implemented.	Contractor	WASA	MPU

6.4 Scope of the ESMP

Measure	Description	Estimated Cost	Schedule	Responsible
Implementation of Mitigation Measures and Programs of Construction ESMP	Preparation of the ESMP at the construction level and implementation during the construction of the project; environmental and social monitoring of the works	1.5% of the total cost of the project	From beginning of their works until their finalization	Contractor
Implementation of Mitigation Measures of Operational ESMP	Incorporation of mitigation measures for the operational stage within the project activities	Incorporated in WASA operational budget	Throughout the lifecycle of the infrastructure	WSC

This section presents the structure of the ESMP, which follows on from the identification of the potential environmental and social impacts and mitigative actions for the proposed Rehabilitation works.

The ESMP applies to all activities, facilities, and operations associated with the Siparia and Acono Water Treatment Plants.

Its scope covers the following key thematic areas:

1. Environmental Management – addressing impacts on air quality, noise, water quality, soil, biodiversity, landscape, and waste management through targeted mitigation and monitoring programs.
2. Social Management – encompassing worker hiring practices, labour management, community engagement, health and safety, worker behaviour, gender equity, and grievance

handling mechanisms, ensuring that local communities benefit from the project while minimising social risks.

3. Health and Safety Management – ensuring safe working conditions for all employees and contractors, and safeguarding community health and safety throughout construction and operation.
4. Biodiversity Conservation – protecting sensitive terrestrial, riparian, and aquatic ecosystems, with particular attention to the Acono River and the recharge area for the Siparia Wellfield, and ensuring compliance with IDB ESPS 6 on biodiversity conservation and sustainable management of living natural resources.
5. Pollution Prevention and Resource Efficiency – controlling emissions, discharges, and waste generation, and promoting efficient use of energy, water, and raw materials in line with ESPS 3.
6. Stakeholder Engagement and Grievance Management – ensuring continuous consultation and information disclosure to affected communities and other stakeholders, in accordance with ESPS 10.
7. Climate Resilience and Energy Efficiency – integrating climate adaptation measures, energy-efficient technologies, and resilient design standards to strengthen the long-term sustainability of the project.
8. Monitoring, Reporting, and Adaptive Management – establishing procedures for environmental and social performance tracking, periodic audits, and submission of monitoring reports to the EMA, IDB, and other relevant authorities.

The ESMP also defines the institutional arrangements for its implementation, including the designation of a WASA team to oversee compliance, supported by contracted environmental officers, independent monitoring consultants, and regulatory oversight by the EMA.

Furthermore, the ESMP incorporates a capacity-building component to enhance the technical competence of WASA staff and contractors in implementing the prescribed management plans, ensuring that all environmental and social obligations are effectively fulfilled.

PLANS	DESCRIPTION	RELEVANT IDB ESPS
Water Quality Management Plan	This Water Quality Management Plan will focus on the protection and maintenance of water quality within the project areas and the surrounding receiving environment. The plan will contain a series of action items to ensure that rehabilitation and construction activities associated with the water treatment plant have minimal impacts on source water quality, treatment processes, and downstream water resources. The plan will also outline measures to prevent contamination from construction-related activities, maintain compliance with	**ESPS 3** addresses the need to prevent and minimise pollution and promote the sustainable management of resources, including the protection of water quality from contamination arising from project activities. **ESPS 1** underscores the importance of identifying, assessing, and managing environmental and social risks and impacts throughout the project lifecycle, including the implementation of effective

PLANS	DESCRIPTION	RELEVANT IDB ESPS
	applicable water quality standards, protect public health, and ensure the continued delivery of safe and reliable potable water throughout the project lifecycle.	monitoring and mitigation measures for water quality. **ESPS 4** recognises that project activities, equipment, and infrastructure can pose risks to community health and safety, particularly where changes in water quality may affect the safety and reliability of potable water supplies.
Air Quality Management Plan	This Air Quality Management Plan will focus on the control and minimisation of air emissions associated with the rehabilitation and operation of the water treatment plants. The plan will include a series of mitigation measures and action items to reduce dust generation from earthworks, prevent and control emissions from construction equipment and machinery, and manage odours and other air pollutants that may arise during construction, installation, and commissioning activities. It will also establish monitoring requirements and good housekeeping practices to ensure compliance with applicable air quality standards, protect worker and community health, and maintain acceptable ambient air conditions throughout the project lifecycle.	**ESPS 3** addresses the need to prevent and minimise pollution to air from project-related activities, including dust, emissions from machinery, and other airborne pollutants. **ESPS 1** underscores the importance of identifying, assessing, and managing environmental and social risks and impacts throughout the project lifecycle, including the implementation of mitigation and monitoring measures for air quality. **ESPS 4** recognises that emissions such as dust, exhaust fumes, and other air pollutants from construction and operational activities can increase risks to community health and safety.
Noise and Vibration Management Plan	This Noise and Vibration Management Plan will focus on the control and minimisation of noise and vibration impacts associated with the rehabilitation and operation of the water treatment plants. The plan will include a series of mitigation measures and action items to reduce noise generated from construction activities, heavy machinery, transport movements, and equipment installation, as well as to manage vibration impacts that may affect nearby structures and sensitive receptors. It will also establish monitoring requirements, work scheduling controls, and good practice construction methods to ensure compliance with applicable noise standards.	**ESPS 3** addresses the need to prevent and minimise noise and vibration pollution arising from project activities, including construction equipment operation and associated works. **ESPS 1** underscores the importance of identifying, assessing, and managing environmental and social risks and impacts throughout the project lifecycle, including the implementation of mitigation measures and monitoring programmes for noise and vibration. **ESPS 4** recognises that elevated noise levels and vibration from project activities can increase risks to community health, well-being, and

PLANS	DESCRIPTION	RELEVANT IDB ESPS
		safety, particularly for nearby sensitive receptors.
Waste Management Plan (WMP)	This Waste Management Plan will focus on the proper management, handling, storage, transport, treatment, and disposal of solid, liquid, and hazardous wastes generated during the rehabilitation and operation of the water treatment plant. The plan will include a series of mitigation measures and action items to minimise waste generation at source, promote reuse and recycling where feasible, and ensure the safe segregation, storage, transportation, treatment, and disposal of construction and operational wastes, including general waste, hazardous waste, packaging materials, excavated spoil, used oils and lubricants, chemical containers, contaminated materials, sludge, and other process-related residues. The plan will also establish procedures to ensure compliance with applicable environmental regulations and best practices for hazardous waste management, thereby protecting human health and the surrounding environment throughout the project lifecycle.	**ESPS 3** addresses the need to prevent and minimise pollution through the effective management of solid and liquid wastes, including reduction, reuse, recycling, and safe disposal practices. **ESPS 1** underscores the importance of identifying, assessing, and managing environmental and social risks and impacts throughout the project lifecycle, including waste generation and the implementation of appropriate mitigation and monitoring measures. **ESPS 4** recognises that improper waste handling and disposal can create risks to community health and safety, including exposure to contaminants, pests, and pollution of water and surrounding environments.
Disaster management Plan	This Disaster Management Plan will focus on establishing a comprehensive framework for preparedness, mitigation, response, and recovery in relation to natural and human-induced disasters that may affect the water treatment plant during its rehabilitation and operation. The plan will include a series of measures and action items to address hazards such as hurricanes, floods, earthquakes, landslides, and other extreme weather events, as well as secondary impacts including infrastructure damage, service disruption, and contamination risks. It will also define institutional roles and responsibilities, early warning systems, communication protocols, evacuation and shutdown procedures, and coordination mechanisms with national disaster management authorities to ensure	**ESPS 1** underscores the importance of identifying, assessing, and managing environmental and social risks and impacts throughout the project lifecycle, including disaster and climate-related risks, and ensuring the implementation of appropriate management and response systems. **ESPS 4** recognises that project infrastructure and operations may be vulnerable to natural hazards and disaster events, which can pose significant risks to community health, safety, and continuity of essential services such as potable water supply. **ESPS 3** addresses the need to prevent and manage environmental contamination and pollution that may

PLANS	DESCRIPTION	RELEVANT IDB ESPS
	effective response, minimise losses, and support the rapid restoration of critical water supply services throughout the project lifecycle.	occur as a result of disaster events, including the release of hazardous materials or deterioration of water quality following extreme weather impacts.
Social Impact Management Plan (SIMP)		Performance Standard 1 underscores the importance of managing environmental and social performance throughout the life of a project.
Biodiversity Management Plan (BMP)	This Biodiversity Management Plan will focus on the protection, conservation, and restoration of biodiversity within and surrounding the water treatment plant during its rehabilitation and operation. The plan will include a series of mitigation measures and action items to avoid and minimise habitat disturbance, protect any remaining flora and fauna, and prevent indirect impacts such as pollution, noise, dust, and altered drainage patterns from affecting sensitive ecosystems. It will also outline requirements for vegetation protection, invasive species management, site rehabilitation, and ecological monitoring to ensure compliance with applicable environmental standards, maintain ecosystem integrity, and enhance opportunities for biodiversity recovery where feasible throughout the project lifecycle.	**ESPS 6** recognises the importance of protecting and conserving biodiversity, including habitats and species potentially affected by project activities, and promoting the sustainable management and restoration of natural ecosystems. **ESPS 1** underscores the importance of identifying, assessing, and managing environmental and social risks and impacts throughout the project lifecycle, including impacts on biodiversity and the implementation of appropriate mitigation and monitoring measures. **ESPS 3** addresses the need to prevent and minimise pollution and environmental degradation, including impacts on air, water, and soil that may indirectly affect biodiversity and ecosystem health.
Local Employment and Gender Inclusion Management Plan (LEGIMP)	This Local Employment and Gender Inclusion Management Plan will focus on promoting fair, transparent, and inclusive access to project-related employment opportunities. The plan will outline measures to prioritise local hiring where feasible, support gender-inclusive recruitment, prevent discrimination, promote safe and respectful working conditions, and ensure that women and vulnerable groups are not excluded from employment or training opportunities associated with the	ESPS 2 addresses labour and working conditions, including fair recruitment, non-discrimination, equal opportunity, worker protection, and access to grievance mechanisms. ESPS 9 recognises the need to address gender-related risks and promote gender equality, including measures to reduce barriers to women's participation. ESPS 1 supports the management of social risks

PLANS	DESCRIPTION	RELEVANT IDB ESPS
	rehabilitation and operation of the water treatment plants.	and impacts through structured planning, monitoring, and corrective actions.
Workers' Health and Safety Management Plan	This Workers' Health and Safety Management Plan will focus on protecting the health, safety, rights, and welfare of all workers involved in the project, including contractors, subcontractors, and temporary workers. The plan will include measures for occupational health and safety, labour management, worker induction and training, safe work procedures, provision and use of PPE, incident reporting, emergency preparedness, worker welfare, and access to a dedicated worker grievance mechanism.	ESPS 2 requires safe and healthy working conditions, protection of workers' rights, fair labour practices, and access to worker grievance mechanisms. ESPS 4 is relevant where worker activities may create health and safety risks for nearby communities. ESPS 1 requires the identification, assessment, mitigation, monitoring, and reporting of environmental and social risks, including occupational health and safety risks.
Stakeholder Engagement Plan	This Stakeholder Engagement Plan will focus on the identification, consultation, information disclosure, and continuous engagement of stakeholders affected by or interested in the project. The plan will establish mechanisms for timely communication on project activities, service interruptions, construction schedules, traffic disruptions, environmental and social risks, and mitigation measures. It will also ensure that vulnerable groups are meaningfully included and that stakeholder feedback is incorporated into project implementation and monitoring.	ESPS 10 requires meaningful stakeholder engagement, timely disclosure of project information, inclusive consultation, and accessible communication throughout the project lifecycle. ESPS 1 requires stakeholder engagement to support the identification and management of environmental and social risks. ESPS 4 is relevant where engagement supports community awareness of health, safety, emergency, and service-disruption risks.
Grievance Redress Plan	This Grievance Redress Plan will establish a transparent, accessible, and responsive mechanism through which affected communities, workers, and other stakeholders can raise concerns or complaints related to project activities. The plan will outline procedures for receiving, recording, assessing, resolving, and reporting grievances, including provisions for anonymous and gender-sensitive reporting, timely response, escalation, and corrective action.	ESPS 10 requires the establishment of accessible and effective grievance mechanisms for project-affected people. ESPS 1 requires grievance management as part of the overall environmental and social risk management system. ESPS 2 is relevant for worker-related grievances, while ESPS 4 is relevant for complaints concerning community health, safety, access, and service disruption.

PLANS	DESCRIPTION	RELEVANT IDB ESPS
Workers' Behaviour and Anti-Harassment Plan	This Workers' Behaviour and Anti-Harassment Plan will focus on establishing expected standards of conduct for all project workers, contractors, and subcontractors. The plan will include requirements for respectful interaction with communities and fellow workers, prevention of sexual harassment, gender-based violence and harassment, discrimination, intimidation, exploitation, and other forms of misconduct. It will also define reporting procedures, disciplinary actions, training requirements, and links to the worker and community grievance mechanisms.	ESPS 2 requires fair treatment, non-discrimination, safe working conditions, and protection from harassment and abuse in the workplace. ESPS 9 addresses gender equality and the prevention of gender-based violence, harassment, exploitation, and abuse. ESPS 4 is relevant where worker behaviour may affect community health, safety, security, or wellbeing. ESPS 10 supports accessible grievance channels for affected persons.
Emergency Management Plan	This Emergency Management Plan will focus on preparedness, response, and recovery procedures for emergencies that may occur during construction and operation of the water treatment plants. The plan will address events such as fires, chemical spills, chlorine leaks, accidents, extreme weather, floods, earthquakes, service disruptions, and other incidents that may affect workers, communities, infrastructure, or the environment. It will define emergency roles and responsibilities, communication procedures, evacuation protocols, emergency equipment, training, drills, and coordination with relevant emergency response agencies.	ESPS 4 requires measures to protect community health, safety, and security, including emergency preparedness and response. ESPS 2 requires emergency arrangements to protect workers from occupational risks and accidents. ESPS 3 is relevant where emergencies could result in pollution, hazardous material releases, or contamination of water resources. ESPS 1 requires emergency risks to be identified, managed, monitored, and incorporated into the project's environmental and social management system.

6.5 Water Quality Management Plan

The proposed rehabilitation and upgrading of the water treatment plant will involve extensive construction activities, including the decommissioning and replacement of aging treatment units, pipelines, storage facilities, chemical handling systems, and associated infrastructure. These activities have the potential to adversely affect both source water and treated water quality through the mobilization of sediments, corrosion products, residual treatment chemicals, construction debris, fuels, lubricants, and other contaminants. The decommissioning of existing pipelines, and sludge management facilities may also result in the release of accumulated sediments and deposits that have built up over years of operation, posing a risk to nearby watercourses, groundwater resources, and the operational integrity of the treatment system.

The parameters to be monitored during land preparation and operation to ensure the protection of the aquatic environment will be stipulated by EMA National standards. Full list of standards for ambient water quality of freshwater sources is attached. Table 6-2 below is the parameters deemed to have the highest potential to contaminate water sources and deteriorate the quality of treated water.

Table 6-2 Trinidad and Tobago National Ambient Water Quality Standards – Freshwater (EMA)

Parameters (units)	Standard Range
Total Dissolved Solids (mg/L)	≤ 600
pH (pH units)	6.5-8.5
Total Alkalinity	≤ 20
Conductivity (µS)	≤2500
Chloride (mg /L)	≤ 250
Magnesium (mg Mg/L)	3.6 - 27.0
Nitrate (mg NO_3^-/L)	≤ 10
Sodium (mg /L)	≤ 200
Sulphate (mg SO_4^{2-}/L)	3.0 – 10.0
Hardness (mg $CaCO_3$/L)	As Ca: 100-300; As $CaCO_3$: 200-300
Silica (mg SiO_2/L)	≤ 80
Turbidity (NTU)	≤ 5
Metals: 1. Iron (µg/L) 2. Manganese (mg/L) 3. Lead (µg/L) 4. Copper (µg/L) 5. Zinc (µg/L) 6. Cadmium (µg/L) 7. Arsenic (µg/L) 8. Mercury (µg/L)	 1. ≤300 2. ≤0.5 3. ≤10 4. ≤1000 5. ≤5000 6. ≤2 7. ≤10 8. ≤1

6.5.1 Monitoring Equipment, Stations, and Frequency

Monitoring should be carried out by a laboratory or entity approved by the relevant regulatory authority for environmental water sampling and analysis. Water quality monitoring will be undertaken at representative locations where project activities have the greatest potential to influence water quality. These locations will include, as applicable:

(i) The raw water intake to monitor source water quality;
(ii) The treated water outlet to confirm compliance with potable water quality standards during rehabilitation; and
(iii) Any stormwater discharge points or receiving water bodies immediately downstream of the facility where there is potential for construction-related runoff to enter the environment.

Monitoring locations may be refined following a site inspection and in consultation with the Environmental Management Authority (EMA) and WASA.

Routine water quality monitoring will be conducted throughout the first year of construction and early operation to establish baseline conditions, identify any project-related changes, and evaluate the effectiveness of mitigation measures. Monthly monitoring provides sufficient temporal coverage to capture seasonal and operational variations while allowing early detection of adverse trends requiring corrective action. Following the first year, monitoring data will be reviewed to evaluate long-term trends and determine whether the monitoring frequency can be reduced to quarterly where results consistently demonstrate compliance with applicable standards and no project-related deterioration in water quality is observed.

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- If parameters are in line with the range of standards, testing can be reduced to being done at quarterly intervals to ensure that parameters stay in check,
- For constantly outlying parameters, testing must be continued monthly along with the mitigative measures.
    - Intermediary physical tests should also be done to fully grasp the state of the water quality in the project area.
- Once parameters are determined to be non-compliant with the regulatory stipulations or process requirements, corrective actions should be taken to bring the parameters back into compliance. Investigations into the cause(s) of the non-compliance should be done as soon as possible once results are obtained to ensure swift and adequate corrective measures are implemented.
- Where monitoring identifies deterioration in water quality attributable to construction activities, the Contractor shall immediately investigate the source of the impact and implement appropriate corrective measures. These may include suspending the activity causing the impact, strengthening erosion and sediment control measures, containing and

cleaning up any fuel, oil, chemical, or concrete wash water spills, improving drainage and runoff controls, and ensuring the proper storage and disposal of construction materials and wastes. Additional water quality monitoring shall be undertaken to verify the effectiveness of the corrective actions before normal construction activities resume.

6.5.2 Climate Adaptation and Water Resource Sustainability

In recognition of projected climate change impacts, including increasing temperatures, prolonged dry periods, changing rainfall patterns, and the potential reduction in available surface water and groundwater resources, the Water Quality Management Plan shall also incorporate measures to support long-term water resource sustainability and adaptive management of the water supply system.

The plan shall establish procedures for the routine monitoring of both water quality and water availability to ensure that changing hydrological conditions are identified early and incorporated into operational decision-making. Monitoring shall include source water levels, streamflow where applicable, groundwater levels and borehole yields (where groundwater supplies are utilised), abstraction volumes, treatment plant inflows, rainfall trends, and operational production records. Water quality monitoring shall continue to include the key physicochemical and microbiological parameters identified within this Plan.

Monitoring data shall be reviewed periodically to identify long-term trends associated with climate variability and projected drying conditions. The results shall be used to:

- evaluate the sustainability of existing abstraction rates;
- identify reductions in source yield or aquifer productivity;
- optimise treatment plant production in accordance with available water resources;
- support decisions regarding seasonal abstraction management, water conservation measures, and operational adjustments during drought conditions;
- inform future investigations, including hydrogeological assessments and yield testing where groundwater development is proposed; and
- support long-term planning for additional water supply infrastructure or alternative water sources where monitoring indicates declining resource availability.

Adaptive management shall be applied throughout the operational life of the facilities. Where monitoring identifies declining water availability or deteriorating source conditions beyond established operational thresholds, WASA shall review abstraction practices, update operational procedures, implement appropriate water conservation measures, and revise water resource management strategies to maintain reliable potable water supply while protecting the long-term sustainability of the source.

6.5.3 Key Performance Indicators

The following KPIs, in Table 6-3, have been selected to evaluate the effectiveness of the water quality management program.

Table 6-3 Water Quality - Key Performance Indicators

NO.	KEY PERFORMANCE INDICATOR	HOW WILL IT BE MONITORED AND MEASURED	RESPONSIBILITY
1	Work halted during heavy rainfall	Site Inspections and photographs	Contractor. Results to be presented to the Implementing Agency
2	Logs indicating any incidents and when work was halted	Review and inspection of documentation	Contractor. Results to be presented to the Implementing Agency
3	Water Quality Results from an approved lab.	Review and inspection of documentation- certificate results to be presented to the EMA at a prescribed frequency.	Contractor. Results to be presented to the Implementing Agency
4	Spot Checks/ Self Audits	Review and inspection of documentation/ processes	Contractor. Results should be used as preventative measures.
5.	Turbidity and TSS levels within limits	Certified laboratory test results	Contractor / WASA
6.	Source water quantity and availability remain within sustainable operational thresholds	Review of streamflow records, groundwater levels, borehole yields (where applicable), abstraction records, rainfall data and treatment plant production trends	WASA

- Sample collection date and time
- Sample submitting information (temperature and condition of sample, time, and date of submission)
- Analysis date
- Test results with units of measurement
- Test methods
- Notes regarding anomalous test results
- Applicable standard
- QA/QC documentation
- Signature of authorized persons
- Sample identification/information and description

The data obtained from the certificate of analysis will be analysed, taking into consideration statutory requirements and operational standards as well as public health and safety. These reports will be prepared by the environmental specialists (internal/ external) and submitted to the EHS Manager

who will then review and take necessary actions and report to the relevant regulatory (agencies according to the reporting frequency in their License).

6.5.4 Roles and Responsibilities

It is the responsibility of the Contractor to ensure that the management and mitigation measures for water quality are clearly understood by all workers and that they are carried out and relevant monitoring reports are prepared.

WASA is responsible for monitoring the contractor to ensure that monitoring is being undertaken and mitigation measures are being enforced.

6.5.5 Data Analysis and Reporting

If there are any violations, these will be reported immediately to the EHS Manager to allow for management strategies to be changed according to the results.

6.6 Air Quality and Dust Control Plan

The Air Quality and Dust Control Management Plan (AQDCMP) provide a structured framework to prevent, monitor, and mitigate adverse impacts on ambient air quality resulting from construction and operational activities associated with the Siparia and Acono Water Treatment Plant Rehabilitation. The plan emphasizes proactive measures to minimize fugitive dust emissions, equipment exhaust, and particulate matter dispersion that could affect nearby communities and sensitive ecological receptors.

The plan seeks to:

1. Protect ambient air quality within and surrounding the Siparia and Acono areas, ensuring that emissions from construction and operation remain within acceptable limits established under the Environmental Management (Air Pollution Control) Rules, 2014 and the World Health Organization (WHO) Air Quality Guidelines (2021).
2. Prevent nuisance dust and particulate pollution from construction activities such as excavation, hauling, stockpiling, and material handling through effective site management and dust suppression techniques. These may include:
    - ✓ Routine wetting, mainly during active construction
    - ✓ Chemical Suppressants for long term or high traffic areas
    - ✓ Physical barriers including dust screens, fences or vegetative buffers
    - ✓ Coverage of loose materials
    - ✓ All construction vehicles and heavy equipment shall observe a maximum speed limit of 10 km/h within the project site. Where vehicles are operating in close proximity to workers, pedestrians, plant operations, or confined work areas, speeds shall be reduced to a maximum of 5 km/h.
    - ✓ Appropriate speed limit signage shall be installed throughout the site, and compliance shall be monitored by the Contractor's Health, Safety and Environment (HSE) Officer.
3. Control exhaust emissions from generators, vehicles, and heavy machinery through routine maintenance, use of compliant equipment, and restriction of unnecessary idling.
4. Safeguard worker health and community well-being by implementing appropriate personal protective equipment (PPE) requirements and maintaining safe air quality levels at work zones and receptor sites.
5. Establish a monitoring and reporting framework to measure particulate matter (PM_{10}, $PM_{2.5}$, and TSP) levels and evaluate the effectiveness of mitigation measures, allowing for adaptive management and continuous improvement in environmental performance.

6.6.1 Monitoring Equipment, Stations, and Frequency

Monitoring shall be undertaken by a laboratory or entity approved for regulatory air quality sampling and testing. Prior to the commencement of refurbishment works, a project-specific baseline ambient air quality survey shall be conducted to establish existing air quality conditions against which construction-related impacts can be assessed.

Baseline monitoring shall be undertaken at representative locations including:

(i) The active construction work area, particularly during demolition, excavation, and material handling activities;
(ii) The site boundary at the predominant downwind location based on prevailing wind direction; and
(iii) The nearest sensitive receptors, where applicable, such as occupied plant buildings, adjacent residential properties, schools, healthcare facilities, or other publicly accessible areas located in close proximity to the works.

Monitoring locations may be refined following a site inspection and in consultation with the Environmental Management Authority (EMA).

The baseline programme shall include monitoring of Particulate Matter (PM_{10}), Particulate Matter ($PM_{2.5}$), and Total Suspended Particulates (TSP), which represent the principal pollutants likely to be generated during refurbishment activities. Baseline monitoring shall be conducted for a minimum continuous period of 24 hours at each monitoring location prior to the commencement of construction works. The results shall be compared against the applicable Environmental Management Authority (EMA) standards and the World Health Organization (WHO) Air Quality Guidelines to establish baseline ambient conditions and inform the implementation of appropriate dust suppression and air quality management measures.

Following the establishment of baseline conditions, routine air quality monitoring shall be undertaken on a monthly basis throughout the construction period. During peak dust-generating activities, including demolition, concrete breaking, excavation, material handling, stockpiling, and increased construction traffic, daily visual dust inspections shall be carried out by the Contractor's Environmental, Health and Safety (EHS) Officer to verify the effectiveness of dust control measures and identify any off-site impacts. Where visible dust emissions, substantiated complaints, or adverse weather conditions indicate an increased risk of air quality impacts, additional particulate monitoring shall be undertaken and corrective measures implemented. Where monitoring results consistently demonstrate compliance with applicable standards and effective dust control throughout the construction period, the monitoring frequency may be reduced to quarterly, subject to approval by WASA and the Environmental Management Authority (EMA).

6.6.2 Management Measures

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

General measures

- Effective implementation, monitoring and enforcement of any guidelines or action provided by the Environmental Management Authority (EMA)
- Record complaints and relevant responses

Fugitive dust control measures

- Cover haulage vehicles transporting aggregate, soil and cement.
- Cover and/or wet onsite stockpiles of aggregate, soil etc., especially during windy and dry conditions
- Locate sources of dust away from sensitive receptors
- Ensure proper stock piling/storage and disposal of solid waste.
- Wet cleared land areas regularly
- Wet dust suppression methods on unsealed roads must be implemented to prevent generation of nuisance dust.
- Provide workers with the necessary PPE e.g. dust masks, and ensure that they are worn correctly
- There must be strict speed limits on dust roads to prevent dust entrainment into the atmosphere.
- Restrict the dropping of material from height during loading and unloading.
- Revegetate cleared areas immediately following construction to prevent loose soil from being blown away.
- Installation of a windsock to identify the wind direction for stockpiling or operating with dust downwind. This will reduce the exposure of dust in the air.

Emissions control measures

- Use low-emission machinery and maintain all equipment regularly.
- Prohibit unnecessary idling of vehicles and generators.
- Ensure all generators, compressors, and construction vehicles meet manufacturer emissions standards.
- Implement strict maintenance logs for heavy equipment.

6.6.3 Monitoring and Compliance

Ambient air quality monitoring will be conducted in accordance with the World Health Organization (WHO) Guidelines for Air Quality (2021) and the Environmental Management (Air Pollution Control) Rules, 2014 under the Environmental Management Act of Trinidad and Tobago.

Baseline data will be obtained from the nearest EMA monitoring stations and verified by project-specific baseline sampling as outlined in section 6.6.1 prior to construction. This will be conducted in accordance with the ambient Air Quality Guidelines displayed in the table below.

Table 6-4 Comparison WHO Ambient Air Quality Guidelines (2021) for PM2.5 and PM10

Parameter	Averaging Time	WHO 2021 (µg/m³)	EMA Standards (µg/m³)
$PM_{2.5}$	24-hour mean	15	65
$PM_{2.5}$	Annual mean	5	15
PM_{10}	24-hour mean	45	75
PM_{10}	Annual mean	15	50

6.6.4 Indicators

A The following KPIs have been selected to evaluate the effectiveness of the air quality monitoring system.

Table 6-5 Key Performance Indicators (KPI) for Air Quality and Dust Management

Key Performance Indicators	How Will It Be Monitored and Measured	Responsibility
Equipment maintenance logs updated	Review of maintenance documentation	Contractor / EHS Officer
Stakeholder notifications and complaints addressed	Review of stakeholder communications	Contractor / WASA
Air quality parameters within WHO/EMA limits	Review of lab certificates	EMA
Frequency of dust suppression (wetting)	Site logs	Contractor
Worker PPE usage compliance	Site inspection reports	EHS Officer

6.6.5 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) Manager is employed to oversee the specific requirements of this plan.

WASA is responsible for monitoring the contractor to ensure that monitoring is being undertaken and mitigation measures are being enforced.

6.7 Noise and Vibration Management Plan

The Noise and Vibration Management Plan (NVMP) establish a systematic approach to identify, monitor, and mitigate noise and vibration impacts associated with the construction and operational phases of the Water Treatment Plant plants. The plan aims to ensure that project activities are conducted in a manner that protects community health, worker safety, and the integrity of nearby structures and ecosystems.

The plan seeks to:

1. Ensure compliance with the Environmental Management (Noise Pollution Control) Rules, 2001 and relevant World Health Organization (WHO) Environmental Noise Guidelines, maintaining noise and vibration levels within acceptable limits for residential and environmentally sensitive areas.
2. Minimize noise and vibration emissions from construction equipment, vehicle movement, and material handling using low-noise machinery, proper equipment maintenance, and scheduling of high-noise activities during daytime hours.
3. Prevent nuisance and health effects on nearby communities, workers, and wildlife in the project regions by maintaining effective buffer zones and implementing temporary barriers or enclosures where appropriate.
4. Monitor and evaluate noise and vibration levels at key receptor sites to ensure adherence to regulatory thresholds and facilitate adaptive management when exceedances are detected.
5. Promote awareness and accountability among construction personnel and contractors through training on noise mitigation procedures and community engagement to address complaints promptly and effectively.

6.7.1 Management Measures

In addition to the monitoring procedures, WASA 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.

6.7.2 Monitoring and Compliance

The ambient noise standards in Trinidad and Tobago are regulated by the Noise Pollution Control Rules, 2001 (as amended) and enforced by the Environmental Management Authority (EMA). The standards vary zonally and are displayed in the table below:

Table 6-6 Noise Standards as outlined by the Noise Pollution Control Rules, 2001 (As amended)

Zone Category	Time Period	Equivalent Continuous Sound Pressure Level (dBA)	Instantaneous Unweighted Peak Sound Pressure Level (dB peak)
Industrial Zone (Zone I)	Any time	75 dBA	130 dB
Environmentally Sensitive Areas (Zone II)	Daytime	Max 60 dBA, or 3 dBA above background level	120 dB
Environmentally Sensitive Areas (Zone II)	Nighttime	Max 60 dBA, or 3 dBA above background level	115 dB
General Area (Zone III)	Daytime (8AM-8PM)	Max 80 dBA, or 5 dBA above background level	120 dB
General Area (Zone III)	Nighttime (8PM-8AM)	Max 65 dBA, or 3 dBA above background level	115 dB

6.7.3 Indicators

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

Table 6-7 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 EMA	WASA; Results to be presented by the EHS Officer to the WASA Technical Leads for the Project and the EMA
Noise parameters within EMA standards	Results Certificate provided by EMA 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		

6.7.4 Roles and Responsibilities

It is the responsibility of WASA 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.

WASA 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 standards outlined in (Table 6-6) as well as the baseline data, and the analysis will be included in the environmental monitoring report prepared and submitted to the EMA. 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.

6.8 Waste Management Plan (incl. Hazardous Materials)

The Waste Management Plan (WMP) provides a systematic framework for the proper handling, segregation, storage, transportation, treatment, and disposal of all waste streams generated during the construction and operation phases of the project.

The main purpose of the plan is to prevent environmental contamination and safeguard human health by ensuring that all waste is managed responsibly, in full compliance with EMA regulations and IDB environmental safeguards.

Objectives

1. Identify and categorize all waste streams likely to be generated during construction and operation (solid, liquid, hazardous, and non-hazardous).
2. Prevent and minimize waste generation through design optimization, reuse, and recycling where feasible.
3. Ensure safe handling and storage of all waste materials, preventing leaching, spills, or unauthorized dumping.
4. Establish waste segregation protocols for recyclable, reusable, and disposable materials.
5. Ensure compliance with the EMA Waste Management Rules and all applicable CEC conditions.
6. Ensure hazardous waste is disposed of in accordance with the EMA Waste Management Rules.
7. Promote resource efficiency and environmental awareness among workers and contractors.
8. Provide monitoring and reporting mechanisms to track waste generation, movement, and disposal.

Waste streams expected during project implementation include:

Decommissioned materials generated during rehabilitation and upgrade activities at the Siparia and Acono Water Treatment Plants shall, where practicable, be temporarily stored within designated waste storage areas located inside the project sites prior to reuse, recycling, or off-site disposal. The anticipated waste streams include:

- Concrete and masonry debris;
- Excavated soil, rock, and surplus concrete from civil works;
- Asphalt and road reinstatement materials generated during pipeline works;
- Scrap steel from corroded staircases, platforms, handrails, structural members, and process equipment;
- Decommissioned transmission and process pipelines, valves, pumps, booster equipment, and associated mechanical fittings;
- Electrical panels, switchgear, SCADA components, instrumentation, lighting fixtures, cables, and conduits;

- Damaged building materials, timber, formwork, roofing materials, doors, windows, and louvres;
- Spent filter media, laboratory fixtures, obsolete treatment equipment, and process components;
- PVC and HDPE pipe offcuts, ductile iron fittings, packaging materials, and other construction consumables;
- Vegetation and organic waste generated during site preparation and maintenance activities;
- General domestic waste generated by construction personnel; and
- Hazardous wastes, including used oils, lubricants, hydraulic fluids, spent filters, batteries, paint residues, solvents, contaminated absorbent materials, chemical containers, and contaminated soils or materials resulting from equipment maintenance or accidental spill response.

Temporary waste storage areas shall be clearly demarcated, secured against unauthorised access, and located away from drainage channels, watercourses, and operational treatment facilities. Waste materials shall be segregated according to their physical characteristics and hazard classification to maximise opportunities for reuse and recycling while preventing cross-contamination. Hazardous wastes shall be stored in designated weatherproof areas equipped with secondary containment, appropriate labelling, and spill response materials. All wastes shall be inspected regularly and removed from the site by licensed contractors for reuse, recycling, treatment, or disposal at approved facilities in accordance with applicable regulatory requirements, ensuring that on-site storage remains temporary and does not create environmental, health, or safety risks.

Additionally, liquid waste is anticipated during both the rehabilitation and operational phases of the project. During construction, these may include concrete wash water, wastewater generated from temporary site sanitation facilities, dewatering water from excavations where required, and minor quantities of wash water generated during equipment cleaning. During operation, liquid wastes will primarily comprise filter backwash water, sedimentation basin sludge supernatant, and other process-related wastewater generated as part of routine water treatment operations.

Concrete wash water shall be collected within designated, impermeable washout areas or containers and shall not be discharged directly onto the ground, into drainage systems, or adjacent watercourses. Following settlement and pH neutralisation, where necessary, the supernatant may be reused on-site for dust suppression or disposed of in accordance with the requirements of the Environmental Management Authority (EMA), while hardened concrete residues shall be managed as construction waste. Wastewater generated from temporary sanitary facilities shall be contained within portable chemical toilets or sealed holding tanks and removed periodically by a licensed contractor for treatment and disposal at an approved wastewater treatment facility. Dewatering water, where generated, shall be discharged only after adequate sediment removal and where water quality meets applicable regulatory requirements. Process backwash water and other operational wastewater shall continue to be managed through the Water Treatment Plant's existing treatment

and sludge handling systems, or upgraded systems incorporated as part of the rehabilitation works, prior to reuse within the treatment process or discharge in accordance with applicable regulatory requirements and WASA operational procedures.

Waste Hierarchy Approach

The project shall apply the internationally accepted waste management hierarchy in order of priority:

1. Avoid / Minimize: Reduce waste generation at the source through efficient material use.
2. Reuse: Recover and reuse materials such as timber or metal parts.
3. Recycle: Segregate recyclable materials (metal, paper, plastic) for collection by approved recycling entities.
4. Recover: Utilize organic waste for composting where feasible.
5. Dispose: Safely dispose of non-recyclable, non-recoverable waste at EMA-approved facilities.

6.8.1 Management Measures

Segregation and Storage

- Provide clearly labelled bins for each waste category.
- Locate waste collection areas away from drains, watercourses, and sensitive habitats.
- Store hazardous waste in impermeable, bundled, and ventilated containment areas with spill containment.
- Maintain an up-to-date Waste Register detailing quantities, categories, and disposal destinations.
- Inspect storage areas weekly for integrity and cleanliness.

Transportation and Disposal

- Only EMA-licensed waste haulers shall be used for transporting waste offsite.
- All hazardous waste must be accompanied by a Waste Tracking Manifest, signed at each transfer stage.
- Non-hazardous solid waste shall be sent to the Forres Park Landfill or other EMA-approved disposal facility.
- Hazardous waste (e.g., used oil, chemicals) shall be disposed of through certified waste treatment or recovery companies (e.g., SWMCOL or other licensed operators).

- Maintain receipts and manifests for verification during audits.
- Ensure waste disposal certificates are kept on file for non-domestic waste.

6.8.2 Indicators

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

Table 6-8: Key Performance Indicators for Waste Management

Indicator	Target / Performance Standard	Frequency	Means of Verification	Responsible Party
No construction waste deposited in the Environment	0	Daily	Site Inspection	Contractor / WASA
Volume of hazardous waste disposed via licensed hauler	100% compliance	Per event	EMA permits and disposal receipts	WASA Environmental Unit
Number of waste-related incidents (spills, illegal dumping, leaks)	0	Ongoing	Incident logs	Contractor / WASA

6.8.3 Roles and Responsibilities

It is the responsibility of the WASA 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.

WASA 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 WASA and contractors for negative impacts caused by the construction works.

Table 6-9: Roles and Responsibilities for Waste Management

Entity / Role	Key Responsibilities
WASA Environmental Unit	Oversee implementation of the WMP; ensure compliance with EMA and IDB requirements; review monthly waste reports; liaise with EMA.
Contractor / HSE Officer	Implement waste management measures onsite; maintain segregation and storage; prepare monthly waste tracking reports; ensure worker training.
WASA On-Site Operators (Operational Phase)	Manage sludge, residuals, and backwash waste during WTP operation; maintain effluent and sludge disposal records.
EMA (Regulatory Authority)	Review waste management documentation; issue permits and conduct site inspections; enforce compliance under Waste Management Rules.
Waste Hauling Contractors (Licensed)	Transport waste safely to approved facilities; maintain manifest records; ensure vehicles are labelled and spill-proof.

WORKERS AND SUBCONTRACTORS	Comply with waste segregation, labelling, and disposal procedures; immediately report any spills or improper disposal.

6.9 Hazardous Materials Handling Management Plan

The WASA personnel responsible for the water treatment plant is primarily responsible for the handling, storage and disposal of hazardous materials.

The IDB Guidelines for Community Health, Safety and Security (ESPS 4) outlines that hazardous materials and substances may include: explosives; compressed gases, including toxic or flammable gases; flammable liquids; flammable solids; oxidizing substances; toxic materials; radioactive material; corrosive substances; chemical fertilizers; soil amendments; chemicals, oils, and other hydrocarbons; paints; pesticides; herbicides; fungicides; asbestos; hospital and pharmaceutical waste; used batteries; radioactive medical waste; some types of fluorescent light bulbs and ballasts; and polychlorinated biphenyls (PCBs) in electrical equipment, among others. These all present a risk to human health, community, and the environment due to their physical, chemical, or biological characteristics. The best way to mitigate against the effects of hazardous waste is to refrain from the use of hazardous materials.

6.9.1 Monitoring Frequency

In the anticipation that the monitoring of hazardous materials handling, storage and disposal should be done weekly to ensure that all measures are being implemented and followed.

6.9.2 Management and Mitigation Measures

The Contractor will ensure that every effort is made to abide by the following mitigation measures during construction or operations in order to lessen the potential negative effects of inappropriate handling of hazardous materials:

Spill Prevention and Hazardous Waste Management

- Environmental conditions must be included in any construction contracts, thereby making contractors accountable for preventing accidental spillages
- Effective implementation, monitoring and enforcement of National Environmental Policy, and the National Pollution Rules and action by the Environmental Authority
- Conduct preventive maintenance for vehicles and machinery to ensure integrity and reliability and reduce/avoid leaks
- Conduct any on site repairs on impervious surfaces.
- Ensure proper handling, use and storage of all chemical and hazardous waste according to best practices:
    - Safety Data Sheets) ought to be kept on site. In case of an accident on site, there should be first aid supplies on hand and clear signage with the emergency numbers of nearby medical centres
    - 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 substance including chlorine and heavy fuel oils 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.
- All hazardous substances must be stored on an impervious surface in a designated bunded area, able to contain 110 % of the total volume of materials stored at any given time.
- Fuel and lubrication of equipment and motor vehicles shall be conducted in a manner that affords the maximum protection against spill and evaporation. There shall be no storage fuel on the project site. Fuel must be brought to the project site each day that Work is 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 Trinidad and Tobago Solid Waste Management Company (SWMCOL) or stored in designated, lined and bunded areas as approved by the Environmental Management Authority
- Handling and disposal of hazardous waste is only conducted by trained personnel wearing the correct PPE
- Any spilling incidents must be reported as soon as possible.
    - Any spill or leak involving fuels, oils, lubricants, chemicals, concrete wash water, or other hazardous substances shall be reported immediately to the Contractor's Environmental, Health and Safety (EHS) Officer and the Site Supervisor.
    - The source of the spill shall be isolated and contained using appropriate spill response materials to prevent migration into drainage systems, soils, or nearby watercourses.
    - . Contaminated materials shall be collected and managed as hazardous waste by a licensed contractor, and any damaged storage containers or equipment shall be repaired or replaced before work resumes.
    - All spill incidents shall be documented in an incident register, investigated to determine the root cause, and appropriate corrective and preventive measures implemented, including additional staff training, review of handling procedures, and enhanced inspection of storage and transfer areas where necessary.
- Chlorine is a corrosive that is irritating to the eyes and to the respiratory system. Storage of chlorine away from heat and in a well ventilated area. Personnel handling chlorine should wear the appropriate PPE including hazardous resistant gloves, sleeved clothing to protect from skin irritation. Respirators would be needed if handling for long periods and in an area that is not well ventilated.

Asbestos-containing materials (ACMs) are expected to be encountered during decommissioning activities associated with the proposed distribution network upgrades for the Siparia Water Treatment Plant. Specifically, the project includes the removal and replacement of an existing 100 mm asbestos cement (AC) water main along Gonzales Street, extending from the intersection with SS Erin Road to the end of Gonzales Street, over an approximate length of 0.2 km, where it will be replaced with a 100 mm PVC main. In addition, engineering assessments have identified the presence of several ageing cast iron and asbestos cement mains within the existing distribution system that are recommended for replacement as part of the wider network improvement programme. Accordingly, all works involving asbestos-containing materials shall be undertaken in accordance with applicable occupational health and safety requirements, recognised international best practice, and the procedures outlined below.

- Asbestos-containing materials shall only be handled, removed, transported, and disposed of by licensed asbestos abatement professionals.
- Prior to commencing removal works, the work area shall be isolated and sealed using plastic sheeting or other suitable containment measures to prevent the release and migration of asbestos fibres. Surfaces not requiring abatement shall also be protected.
- Appropriate warning signage and restricted access barriers shall be erected around the work area to prevent unauthorised entry while asbestos removal activities are underway.
- All personnel involved in asbestos removal shall wear appropriate personal protective equipment (PPE), including at a minimum N-100 or P-100 respirators, disposable protective clothing, gloves, and suitable footwear.
- Asbestos-containing materials shall be thoroughly wetted prior to and during removal to minimise the generation of airborne fibres. Materials shall be removed intact wherever practicable and shall not be cut, broken, or otherwise disturbed unnecessarily.
- Removed asbestos materials shall be double-bagged in 6-mil plastic bags or otherwise packaged in sealed, leak-tight, appropriately labelled containers and transported by authorised personnel for disposal at a facility approved by the relevant regulatory authorities.
    - Dedicated decontamination facilities shall be established to allow workers to safely remove contaminated clothing, footwear, equipment, and tools prior to leaving the work area.

Key Performance Indicators

The following Key Performance Indicators (KPIs) have been selected in order to evaluate the effectiveness of the hazardous materials handling.

Table 6-10 Key Performance Indicators for Hazardous Materials Handling

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	Twice per month
Incident Logs	Reporting of all incidents associated with hazardous materials	WASA personnel	

6.9.3 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) Manager is employed to oversee the specific requirements of this plan.

The Implementing Agency is responsible for assigning the Engineer as the responsible parties for undertaking the monitoring required and for implementing the mitigation measures necessary.

6.9.4 Data Analysis and Reporting

If there are any exceedances, this will be reported immediately to the EHS Manager to allow for management strategies to be changed according to the results.

6.10 Disaster Risk Management Plan

The Disaster Risk Management (DRM) Plan provides a comprehensive framework for identifying, assessing, and mitigating natural and human-induced hazards that may affect the Water Treatment Plant Projects during Rehabilitation and operation. The plan ensures that the facility, its personnel, and surrounding communities are adequately prepared to respond to and recover from extreme events, thereby supporting climate resilience, public safety, and service continuity.

The plan seeks to:

1. Safeguard critical water infrastructure by integrating disaster-resilient design features that reduce vulnerability to natural hazards such as flooding, landslides, earthquakes, and tropical storms.
2. Enhance preparedness and response capacity of WASA personnel, contractors, and local stakeholders through clear emergency protocols, communication channels, and coordination with national disaster agencies, including the Office of Disaster Preparedness and Management (ODPM).
3. Ensure compliance with the Inter-American Development Bank (IDB) Environmental and Social Performance Standard 4 (Community Health, Safety, and Security), as well as the National Disaster Risk Management Policy of Trinidad and Tobago.
4. Reduce downtime and service disruption by establishing proactive risk reduction, rapid response, and recovery mechanisms to maintain the continuous delivery of potable water during and after disaster events.
5. Promote adaptive and climate-resilient operations by incorporating lessons learned from monitoring, simulations, and periodic reviews into the ongoing management of the WTP and its supporting infrastructure.

6.10.1 Management Measures

WASA will ensure that the following measures are implemented for effective emergency response and disaster risk reduction, with clearly identified first responders and visible emergency contact information on-site:

- Elevate key plant structures above the 1-in-100-year flood level plus additional freeboard for projected sea-level rise.
- In the absence of a unified National Building Code for Construction, design structures to withstand Category 4 hurricane wind loads, consistent with the Caribbean Uniform Building Code (CUBiC).
- Flood-proof critical infrastructure through elevated electrical panels, sealed clearwells, watertight doors, and reinforced retaining walls.
- Employ corrosion-resistant materials due to the proximity to the fluvial environment.

- Incorporate engineered foundations and controlled compaction to reduce risks of soil settlement or liquefaction during seismic activity.
- Implement graded site drainage channels, retention basins, and vegetated swales to divert and control stormwater runoff.
- Pre-wire for future renewable energy integration (e.g., solar backup for telemetry and SCADA systems).
- Maintain active liaison with regional emergency services (Fire Service, ODPM, and TTPS) to coordinate emergency response and establish a clear chain of command and communication protocols.
- Conduct regular training programs on disaster preparedness, including:
    - Basic first aid and emergency communications;
    - Fire prevention and response;
    - Evacuation and shelter procedures;
    - Handling of hazardous materials (chlorine, coagulants, etc.); and
    - Flood, earthquake, and marine environment risks.
- Maintain Standard Operating Procedures (SOPs) for:
    - Pre-storm shutdown and protective measures;
    - Backup generator operation and fuel management;
    - Post-event inspection, cleanup, and reactivation procedures.
- Conduct community engagement sessions to raise public awareness of emergency measures and ensure coordination in the event of a disaster.
- Implement quarterly emergency simulation exercises with WASA personnel, local communities, and regional authorities to test and improve the DRM Plan.
- Adhere to hazard-specific plans, the management measures of which are outlined below:

HURRICANES AND TROPICAL STORMS

- Infrastructure to be used in rehabilitation must be able 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/Tropical Storm 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.

Heavy Rainfall and Flood Prevention

- Suspend construction or outdoor maintenance during severe rainfall alerts.
- Secure all chemicals, equipment, and materials away from drains and riverbanks.
- Use bioengineering techniques (e.g., vetiver grass and native vegetation) to stabilize disturbed slopes.
- Install silt fences, sediment basins, and check dams during construction to reduce sediment runoff.
- Conduct drainage performance reviews annually or after each major storm.

Earthquakes

- Apply seismic-resistant design in line with CUBiC Building Code for moderate seismic zones.
- Use deep pile foundations and anchored tanks to minimize risk of differential settlement or movement.
- Conduct structural integrity assessments following any felt seismic event.
- Provide earthquake awareness sessions for staff and communities, including safe evacuation and assembly areas.

6.10.2 Monitoring and Compliance

Monitoring of the plants and associated works will be conducted daily by the Water and Sewerage Authority (WASA) to ensure full compliance with the national building codes, environmental and disaster preparedness regulations of Trinidad and Tobago, and IDB Environmental and Social Performance Standard (ESPS) 4 – Community Health, Safety, and Security.

6.10.3 Indicators

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

Key Performance Indicator (KPI)	Monitoring and Measurement	Frequency	Responsibility
Log of Safety and Emergency Equipment (serviced)	Review and inspection of maintenance records	Monthly	Contractor (maintenance of equipment); Contractor's EHS Officer (verification and reporting); WASA Technical Lead (oversight)
Hazard-Specific Plans (Hurricanes, Floods, Fire, Earthquake)	Documentation review and updates	Annual	Contractor's EHS Officer (review and update); WASA Technical Lead (review and approval)
Worker Training on Emergency and Hazard Plans	Verification of training records and attendance logs	Semi-Annual	Contractor's EHS Officer (training delivery and record keeping); WASA Technical Lead (oversight)
Emergency Drills Conducted	Participation records and drill performance evaluation	Quarterly	Contractor's EHS Officer (planning, coordination and evaluation); All Site Personnel (participation); WASA Technical Lead (observation and oversight)
Post-Event Damage Assessments Completed	Review of inspection reports	Following each major event	Contractor (initial site assessment); Contractor's EHS Officer (documentation and reporting); WASA Technical Lead (review and verification)

6.10.4 Roles and Responsibilities

It is the responsibility of the WASA 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.

6.11 Local Employment and Gender Inclusion Management Plan (LEGIMP)

6.11.1 Introduction and Objectives

This Local Employment and Gender Inclusion Management Plan outlines the commitments and measures to ensure equitable access to employment opportunities for residents in the project communities, and to promote fair, inclusive labour practices in the implementation of the water treatment plant projects.

The objectives of the Plan are to:

- Promote local employment, prioritising suitably qualified residents living along the project corridor.
- Ensure gender-inclusive hiring practices, with specific attention to reducing barriers faced by women in the construction sector.
- Establish transparent, fair, and accessible recruitment procedures.
- Strengthen community trust and reduce grievances related to "locals being bypassed."
- Support decent work conditions in accordance with national labour laws and international standards.
- Ensure safe, respectful working environments for women and vulnerable groups, aligned with the Worker Code of Conduct (CoC).
- Build local capacity where feasible through training and skills transfer.

The Plan supports the OHS and Labour Management Plan, GBVH Prevention and Response Plan, Worker CoC, Stakeholder Engagement Plan (SEP), and the Grievance Redress Mechanism (GRM).

6.11.2 Management Measures

The Plan establishes local hiring commitments and takes into consideration gender inclusion measures, the reduction of barriers for women,

6.11.3 A. Local Hiring Commitments

- Prioritise the hiring of residents in the project related communities.
- Maintain a Local Employment Registry managed jointly by the Contractor and Community Liaison Officer (CLO).
- Advertise vacancies early within affected communities through community boards, WhatsApp groups, leaders, and local organisations.
- Ensure transparency in job criteria, required skills, and application processes.
- Provide feedback to unsuccessful candidates when feasible.

6.11.4 B. Gender Inclusion Measures

- Actively encourage women to apply for positions in:
    - traffic control,
    - administrative roles,
    - site support roles,

  - environmental and social roles, and
  - skilled and unskilled labour where feasible.
- Include a gender-friendly recruitment statement in all job notices.
- Avoid biased job descriptions or discriminatory selection practices.
- Schedule work activities in ways that accommodate women's safety needs.
- Provide safe sanitation facilities for women and men separately.

6.11.5 C. Reducing Barriers for Women

- Provide awareness sessions on gender equality for male workers and supervisors as part of worker induction and training.
- Integrate women's needs into the OHS plan (PPE sizing, safety considerations, toilet facilities).

6.11.6 D. Recruitment and Employment Processes

- Transparent, merit-based hiring with documented decision-making.
- Maintain a record of:
  - applicants,
  - hired workers, and
  - reasons for non-selection.
- Prohibit fees, coercion, or nepotism in hiring.
- Encourage the Contractor to include local subcontractors and workers where possible.

6.11.7 E. Equal Opportunity and Non-Discrimination

- No discrimination based on gender, pregnancy, disability, ethnicity, age, or religion.
- Ensure women are not concentrated only in low-paying roles.
- Prohibit dismissing or penalising women for pregnancy or caregiving responsibilities.
- Consider the recruitment of workers with disabilities where possible.
- Job Matching: Assign workers to roles that are compatible with their skills, experience, and abilities. Persons with disabilities may be considered for positions such as administration, document control, logistics coordination, quality assurance, stores management, environmental monitoring, traffic coordination, security, or other suitable roles that do not compromise safety.
- Training and Awareness: Provide disability inclusion and anti-discrimination training for managers, supervisors, and workers to promote an inclusive workplace, reduce stigma, and encourage respectful behaviour.
- Accessible Communication: Ensure that important workplace information, safety procedures, and training materials are communicated in formats that are accessible to workers with different disabilities, where required.

6.11.8 F. Worker Conduct and Community Interaction

In line with the Worker CoC, workers must:

- Treat fellow workforce and community members respectfully.
- Avoid sexual harassment, intimidation, or inappropriate behaviour.
- Interact professionally, especially when working near homes, schools, clinics, and shops.
- Report any inappropriate conduct immediately to supervisors or the CLO.

6.11.9 H. Worker Grievance Mechanism (Labour GRM)

- Maintain a dedicated grievance system for labour concerns such as:
    - Discrimination,
    - Unfair treatment,
    - Harassment,
    - Unsafe conditions, and
    - Wage issues
- Ensure anonymous reporting options for women.
- Integrate gender-sensitive handling procedures.

6.11.10 Monitoring and Compliance

Monitoring ensures that local hiring and gender-inclusion commitments are consistently implemented and verifiable.

Monitoring Activities

- Weekly tracking of workforce composition by:
    - gender,
    - community of origin,
    - job category.
- Monthly audits of recruitment processes.
- Review of worker GRM entries to identify patterns of exclusion or discrimination.
- Regular supervision of work areas to ensure safe conditions for women.
- Verification of job advertisements and engagement records.

Compliance Mechanisms

- Non-compliance triggers Corrective Action Plans issued by WASA or the Supervisory Consultant.
- Persistent failure to prioritise local hiring may result in contractual penalties.
- GBVH violations result in immediate disciplinary action or removal from project.
- Progress reported monthly as part of the ESMP compliance dashboard.

6.11.11 Indicators (KPIs)

The project's progress will be tracked through the following indicators.

KPI	Monitoring Method	Frequency	Responsibility
Percentage of workforce from local communities	Worker registry; HR records	Weekly	Contractor
Number and percentage of female workers hired	HR records; gender disaggregation	Weekly/ Monthly	Contractor; WASA
% of job advertisements circulated within communities	Communication logs	Weekly	Contractor (CLO)
Number of women applying versus hired	Application records	Monthly	Contractor
Number of labour-related grievances	Worker GRM	Weekly/ Monthly	Contractor; WASA
Induction and training sessions conducted for employed workers (including women)	Training logs	Monthly	Contractor
Incidents of discrimination/ harassment reported & resolved	HR & GBVH log	Monthly	Contractor; WASA

6.11.12 Roles and Responsibilities

Although these principles are well established, it remains important to clearly define roles and responsibilities to support fair employment practices, advance gender inclusion, and maintain transparent labour processes throughout the project. This clarity helps the Contractor and WASA to work collaboratively with community representatives and remain aligned in meeting the project's commitments.

ENTITY / ROLE	KEY RESPONSIBILITIES
WASA	Oversight of local hiring and gender inclusion; monitor compliance; review HR records; ensure equal opportunity standards; lead corrective measures where needed.
CONTRACTOR	Implement transparent hiring; advertise jobs locally; track workforce data; enforce non-discrimination; create safe environments for women; provide training; manage labour GRM.
CONTRACTOR'S COMMUNITY LIAISON OFFICER	Maintain Local Employment Registry; ensure community access to job information; support women applicants; facilitate communication; document outreach.
SUPERVISORY CONSULTANT	Verify hiring processes; review workforce composition; ensure gender inclusion measures are applied; report non-compliance to WASA.
CONTRACTOR HSQ MANAGER/OFFICER	Ensure worksites are safe for male and female workers; monitor behaviour; enforce Worker CoC.
PROJECT WORKERS	Comply with workplace rules; uphold respectful behaviour; report unfair treatment or safety concerns.

6.12 Worker Health and Safety Management Plan (Occupational Health and Safety and Labour Management)

6.12.1 Introduction and Objectives

The Worker Health and Safety Management Plan (OHS & Labour Management Plan) outlines the measures required to protect the wellbeing, rights, and working conditions of all personnel involved in the Water Treatment Plant Projects, including subcontractors, temporary workers, and site-based staff.

The objectives of this Plan are to:

- Ensure safe and healthy working conditions at the work sites throughout construction activities.
- Establish clear labour management practices that comply with Trinidad and Tobago labour laws and international safeguard requirements.
- Prevent workplace injuries, accidents, and occupational diseases.
- Promote responsible worker conduct in communities, including compliance with the Worker CoC.
- Ensure fair, transparent, and non-discriminatory procedures working hours, grievance management, and worker rights.
- Strengthen coordination between the Contractor, WASA, HSQ team, the Supervisory Consultant, and emergency responders.

The Plan complements the LEGIMP, the Community Health and Safety Management Plan (CHSMP), Worker Code of Conduct, Traffic and Road Safety Management Plan, SEP, and GRMs.

6.12.2 Management Measures

- Compliance with National Legislation and Standards

All construction and labour practices will comply with:

- Occupational Safety and Health Act of Trinidad and Tobago
- Minimum Wages and Employment Rights legislation
- International Labour Organization (ILO) Core Standards
- WASA and CDB/IDB/IFC Environmental and Social Safeguards
- Contractor's CESMP and HSQ systems

- Worker Recruitment and Labour Conditions

- Transparent recruitment processes, favouring local employment where possible.
- Equal opportunity for male and female workers; no discrimination on the basis of gender, age, ethnicity, disability, or political affiliation.

- Written contracts for all workers outlining terms, benefits, and rights.
- Clear working hours, overtime rules, and rest periods communicated upon hiring.
- Prohibition of child labour and forced labour.
- Site access controlled by sign-in logs and worker identification.

➢ Worker Induction and Training

Mandatory induction for all workers covering:

- OHS requirements and site-specific hazards;
- Safe trenching practices;
- Heavy equipment operation rules;
- Traffic safety and roadside works;
- Emergency response procedures;
- Use of Personal Protective Equipment (PPE);
- Environmental protection;
- Worker Code of Conduct and expected respectful behaviour toward other project-related personnel and affected communities; and
- Grievance reporting by workers.

Refresher training will be held monthly and toolbox talks about site hazards and precautions will be conducted daily.

➢ Personal Protective Equipment

All workers are expected comply with PPE protocols established for the project including the use of:

- Hard hats;
- Safety boots;
- High-visibility vests;
- Safety gloves;
- Eye and ear protection;
- Respiratory protection measures (dusty environments); and
- Fall protection measures where necessary.

Workers will not be able to enter the worksite without the required PPE. Supervisors will enforce compliance.

➢ Safe Work Procedures

1. Trenching and Excavation

- Daily inspections of trenches for stability.
- Shoring, benching, or sloping where depth exceeds regulatory thresholds.
- Barriers and warning tape surrounding open trenches.
- No worker allowed in trench during heavy rainfall.

- Safe entry/exit using ladders or ramps.

2. Heavy Vehicle and Equipment Operations

- Only certified operators allowed to drive heavy machinery.
- Spotters used for reversing or navigating in narrow areas.
- Equipment parked safely and locked after work hours.
- Strict speed limits enforced within worksite and along the Toco Main Road.

3. Roadside and Traffic-Adjacent Works

- Implementation of Traffic Management and Road Safety Plan
- Use of flag personnel and signage.
- Safe pedestrian pathways maintained for both workers and community members.

4. Working in Sensitive Areas

- Additional caution near schools, homes, shops and other sensitive areas.
- Avoid work near these sites during peak community hours.

5. Environmental Health (dust, noise, vibration)

- Implementation of the dust suppression measures outlined in the Air Quality and Dust Control Plan (see Section 6.6).
- Implementation of noise control and limited working hours as outlined in the NVMP.
- Provide at least two weeks' advance notification to nearby residents, businesses, schools, and other sensitive receptors prior to high-impact construction activities.
- Close monitoring air quality, noise and vibration complaints around social sensitive receptors.

➢ Worker Grievance Mechanism (Internal GRM)

The Contractor must maintain a dedicated worker grievance channel separate from community grievances. The GRM should feature measures to protect workers' rights and to promote safe environment and respectful interactions. These should include:

- Confidential reporting;
- Anonymous submissions allowed;
- Clear timelines for response (acknowledge within 24 hours; resolve in 7-14 days);
- No retaliation for reporting; and
- Integration with broader GRM oversight by WASA.

➢ Worker Accommodation and Welfare

Worker welfare provisions will be maintained to ensure safe, comfortable, and secure working conditions throughout the project. To ensure this, the following will be implemented:

- Adequate sanitation for men and women, drinking water, and shelter from sun/rain.

- Safe storage for tools and personal belongings.
- Worker transportation safety (project roadworthy vehicles, mandated seatbelts, trained drivers).

➢ Emergency Preparedness and Response

Emergency preparedness measures will be maintained to ensure rapid, coordinated, and effective response to any incident that may occur during project activities. These measures will be implemented:

- First aid kits at all work fronts;
- Supervisors with first aid skills;
- Emergency contact numbers posted visibly;
- Spill kits for chemical/fuel handling;
- Trained fire wardens and fire extinguishers to be readily available as well as persons trained to respond to chlorine emergency.
- In the event of a fire or other major emergency, the Contractor shall immediately notify the appropriate emergency response agencies. For the Siparia Water Treatment Plant, emergency response shall be coordinated with the Siparia Fire Station, Siparia Police Station, the South-West Regional Health Authority (SWRHA), the Siparia Borough Corporation Disaster Management Unit, and the Office of Disaster Preparedness and Management (ODPM), as required. For the Acono Water Treatment Plant, emergency response shall be coordinated with the Tunapuna Fire Station, St. Joseph Police Station, the North Central Regional Health Authority (NCRHA), the Tunapuna-Piarco Regional Corporation Disaster Management Unit, and the ODPM, as appropriate.An incident drill early in the project with additional drills if the following occur:
    - The workforce changes substantially,
    - There is an incident or near-miss, or
    - High-risk activities escalate (e.g., night works).

➢ Enforcement and Disciplinary Actions

Guidelines for workers regarding violations of OHS rules, risky behaviour, or CoC breaches may result in:

- Verbal or written warnings;
- Mandatory retraining;
- Suspension;
- Removal from site; and
- Legal consequences (for severe violations).

6.12.3 Monitoring and Compliance

Monitoring ensures consistent implementation of OHS procedures and labour management standards.

Monitoring Activities

- Daily site inspections by the HSQ Officer.
- Weekly audits of PPE use and compliance.
- Monthly review of workplace incidents, near misses, and corrective actions.
- Verification of worker contracts and training attendance.
- Inspection of trenches, equipment, and traffic control setups.
- Monitoring worker fatigue, overtime, and working hour records.
    - Comply with legal working hour requirements and project labour management procedures.
    - Develop work schedules that include adequate rest breaks, meal periods, and at least one rest day per week where required.
    - Limit overtime to exceptional circumstances, ensure prior management approval, and keep it within legal limits.
    - Maintain accurate records of working hours, shifts, attendance, and overtime for all workers.
    - Monitor cumulative working hours regularly to identify workers at risk of fatigue.
    - Train supervisors to recognize signs of fatigue and take appropriate action when workers are not fit for duty.
    - Provide suitable welfare facilities, including drinking water, shaded rest areas, and sanitary facilities, to support worker recovery.
    - Schedule additional rest breaks during physically demanding work or periods of high temperatures.
    - Encourage workers to report fatigue or concerns about excessive working hours without fear of retaliation.
    - Investigate fatigue-related incidents and near misses to determine root causes and implement corrective actions.
    - Carry out periodic audits of working hour records and compliance with fatigue management procedures.
    - Implement corrective actions such as adjusting work schedules, redistributing workloads, increasing staffing, or providing additional recovery time where fatigue risks are identified.

Compliance Mechanisms

- Non-compliance notices issued by WASA or Supervisory Consultant.
- Corrective Action Plans implemented within specified timeframes.

- Repeated violations may lead to contractual penalties.
- Findings included in monthly ESMP compliance reporting.

6.12.4 Indicators (KPIs)

The project's progress will be tracked through the following indicators.

KPI	Monitoring Method	Frequency	Responsibility
Number of OHS inductions completed	Training logs	Monthly	Contractor
% of workers equipped with full PPE	Site inspections	Daily	HSQ Officers
Number of near misses and incidents	Incident log	Daily/ Weekly	Contractor; Supervisory Consultant
Time taken to close corrective actions	HSQ weekly report	Weekly	Contractor
Number of toolbox talks conducted	Toolbox logs	Daily	Supervisors
% of workers with written contracts	HR records	Monthly	Contractor
Worker grievances received and resolved	Worker GRM log	Weekly	Contractor; WASA
Roadside safety compliance	Traffic control inspection	Daily	HSQ Officers

6.12.5 Roles and Responsibilities

The roles and responsibilities of the parties involved in implementing the project's labour and safety requirements are outlined below.

ENTITY / ROLE	KEY RESPONSIBILITIES
WASA	Oversight of OHS and labour practices; review incident reports; enforce compliance; escalate safety violations; ensure workers' welfare standards are maintained.
CONTRACTOR	Implement daily OHS practices; provide PPE; train workers; enforce CoC; maintain worker GRM; document incidents; ensure safe trenching and heavy equipment operations.
HSQ MANAGER/OFFICERS	Daily inspections; hazard identification; maintain OHS documentation; conduct toolbox talks; verify PPE compliance; lead accident investigations. Provide medical and safety support to public emergency responders; respond to accidents; participate in emergency drills.
SUPERVISORY CONSULTANT	Independent OHS oversight; verify compliance; audit training records; issue corrective action requests.

CONTRACTOR'S SUPERVISORS/ FOREMEN	Direct enforcement of safe work procedures; manage crew behaviour; ensure workers understand daily tasks and hazards.
PROJECT SITE WORKERS	Comply with OHS rules; use PPE; report unsafe conditions; follow supervisor instructions; wear project identification.

6.13 Stakeholder Engagement Plan

This SEP outlines the approach for systematically identifying, informing, and engaging stakeholders affected by the Water Treatment Plant Projects.

The objectives of the SEP are to:

- Ensure transparent, timely, and culturally appropriate communication with all directly and indirectly affected communities.
- Support safe implementation of construction activities by informing stakeholders of works, disruptions, risks, and mitigation measures.
- Provide an accessible and responsive Grievance Redress Mechanism (GRM) for all communities and other stakeholder groups, including vulnerable populations.
- Strengthen coordination between WASA, the Contractor, MOWT, Municipal Corporations and other relevant entities to ensure consistent messaging and effective engagement.
- Manage expectations concerning project timelines, service improvements, temporary disturbances, and long-term benefits.
- Promote long-term trust and operational sustainability through ongoing engagement during the operational phase.

The SEP is aligned with the project's CHSMP, Traffic Management and Road Safety Plan, Project GRM, Project Emergency Response Plan, and ESMS.

6.13.1 Management Measures

- Stakeholder Identification and Mapping

Identify all relevant groups, including:

- Project affected communities and residents – Acono.
- Vulnerable groups (children, older adults, low-income households, persons with disabilities, women-headed households, unemployed persons).
- Schools (early learning primary and secondary), outreach (health) centres, elderly care facilities, nurseries, local churches, and community groups.
- Farmers, fisherfolk, small vendors, business owners, and guest house, Air BnB, tour, and other tourism operators.
- Government agencies (WASA, MOWT, Municipal Corporations, Trinidad and Tobago Fire Service (TTFS), Trinidad and Tobago Police Service (TTPS), Public and Private Utilities [such as T&TEC, Telecommunications – Telecommunications Services of Trinidad and Tobago Limited - TSTT]).
- Transport service providers and road users.
- The media.
- The public.

The Contractor's CLO will maintain an updated stakeholder database throughout the project.

- Communication and Information Disclosure

The CLO will:

- Issue advance notifications about construction schedules, road disruptions, traffic diversions, service interruptions, and reinstatement works.
- Use multiple channels:
    - community WhatsApp groups;
    - printed notices and flyers;
    - loudspeaker announcements where appropriate;
    - local radio updates;
    - community notice boards;
    - door-to-door outreach for vulnerable households; and
- Provide regular updates on progress and upcoming works, including any expected changes.

- Engagement Activities

- Conduct regular community meetings and targeted small-group discussions.
- Hold briefings with schools, clinics, businesses, and transport operators.
- Provide safety awareness sessions for schoolchildren, elders, and vulnerable groups.
- Use the CLO and community focal points to maintain continuous feedback loops.
- Document all engagement activities using standardised attendance sheets and contact logs.

The proposed Stakeholder Communication Schedule is provided as Appendix.

- Project Grievance Redress Mechanism

- Maintain a confidential, accessible Project GRM that allows reporting through:
    - phone, WhatsApp, SMS.
    - in-person to CLO or Contractor.
    - community representatives.
    - suggestion boxes at community facilities.
- Acknowledge all grievances within 24 hours and resolve within agreed timelines.
- Track all cases in a GRM database and share summaries at monthly site meetings.
- Include gender-sensitive and anonymous reporting pathways.

Further details on the GRM will be provided in the Grievance Redress Plan.

- Engagement with Government and Institutional Stakeholders

- Conduct regular coordination meetings among the following with scheduling set by the parties:
    - WASA;
    - Contractor;
    - Community leader or representatives;
    - Supervisory Consultant
- Share work schedules, road reinstatement plans, and safety updates.
- Coordinate public notices to avoid conflicting information.

- Community Inclusion and Expectation Management

- Clearly communicate project benefits and limitations (including service boundaries, commissioning timelines, etc.).
- Engage communities early on any issues related to temporary service disruptions (at least 2 weeks in advance), reinstatement, or service variability.
- Provide channels for community ideas and feedback on reinstatement, disturbance mitigation or project-related emergencies.

6.13.2 Monitoring and Compliance

Monitoring ensures that stakeholder engagement activities are implemented as planned and that communities remain well-informed throughout construction and operations.

Monitoring will include:

- Daily updates from the CLO on community interactions.
- Weekly verification of issued notices, communication channels, and GRM cases.
- Review of meeting minutes, attendance sheets, and community feedback logs.
- Monthly audits by WASA or the Supervisory Consultant on engagement quality and responsiveness.
- Tri-party reviews (WASA–Contractor–MOWT) for coherence of public information related to traffic and reinstatement.

Compliance will be reinforced through:

- Corrective Action Plans for inadequate engagement or communication gaps.
- Reporting performance in monthly progress reports.
- Contractual requirements tied to communication obligations.

6.13.3 Indicators

The KPIs for stakeholder engagement are the following:

KPI	Monitoring & Measurement Method	Frequency	Responsibility
Number of community notifications issued prior to construction disruptions	Communication logs; CLO records	Weekly	Contractor; WASA
Percentage of affected households receiving advance notice	Field verification; door-to-door confirmation	Weekly	Contractor CLO
Number of community meetings held and attendance rates	Meeting minutes; attendance sheets	Monthly	WASA; Contractor CLO
Time taken to acknowledge and resolve grievances	GRM database	Weekly/Monthly	Contractor CLO
Number of grievances received vs. resolved	GRM analytics	Monthly	Contractor; WASA
Level of satisfaction with engagement (from community feedback)	Community checks; follow-up calls	Mid-project and end of project	Contractor CLO; WASA
Accuracy and consistency of public information issued	Tri-agency verification	Monthly	WASA; MOWT; Contractor
Participation of vulnerable groups in engagement activities	Attendance disaggregated by gender, age, and vulnerability	Monthly	Contractor CLO

6.13.4 Roles and Responsibilities

Strong engagement requires that all parties coordinate actively, share information on time, ensure inclusive participation, and communicate clearly throughout the project. The following assigns specific roles and responsibilities to each agency, the Contractor, and the CLO to make this happen.

ENTITY / ROLE	KEY RESPONSIBILITIES
WASA/ SUPERVISORY CONSULTANT	SEP Oversight, compliance checks, and verification; advising on engagement strategy; reviewing communication materials; ensuring alignment with ESMS.
CONTRACTOR	Daily engagement activities; issuing notifications; maintaining CLO presence; responding to grievances; coordinating with WASA before releasing public information; documenting engagement; supporting safety awareness sessions. Overall responsibility for SEP implementation; oversight of communication; approval of notices; GRM management; liaison with MOWT, Fire Station, Police Station, ERHA, and Municipal Corporations; ensure consistent messaging; integrate engagement findings into decision-making.

ENTITY / ROLE	KEY RESPONSIBILITIES
CONTRACTOR COMMUNITY LIAISON OFFICER	Main point of contact for communities; daily engagement and issue tracking; maintaining contact lists; door-to-door outreach; assisting vulnerable households; logging grievances; providing updates to WASA and Contractor. Work with local leaders to disseminate notices through community channels including community meetings, to obtain local context and emergency coordination. Coordinate with MOWT regarding the reinstatement of the Toco Main Road; roadworks communication, traffic diversions, notices to the public, and reinstatement updates. Work with emergency responders (Police, Fire, Health Facilities) in emergency coordination; receive information on works that may affect access or response times.

6.14 Grievance Redress Plan

6.14.1 Introduction and Objectives

The following GRM provides a structured, transparent, and accessible process for the affected communities and other stakeholders to raise concerns, lodge complaints, receive redress and feedback related to the proposed Water Treatment Plant Projects.

The objectives of the GRM are to:

- Ensure that all grievances, particularly those related to road access, construction safety, road reinstatement, environmental nuisance, and service interruptions, are systematically recorded, assessed, and resolved in a timely and fair manner.
- Strengthen trust, transparency, and accountability between WASA, the Contractor, government agencies, and affected communities.
- Provide special support to vulnerable groups (older adults, persons with disabilities, women-headed households, low-literacy groups) to ensure equitable access to the mechanism.
- Reduce the risk of conflicts by addressing issues promptly before they escalate.
- Support continuous improvement of project performance by capturing trends and lessons learned.

The GRM aligns with the Stakeholder Engagement Plan (SEP), Community Health and Safety Management Plan (CHSMP), Traffic Management and Road Safety Plan, and relevant CESMP components. A Worker GRM will be implemented but this mechanism, though relatable, is separate and apart from this project SEP.

6.14.2 Management Measures

The following steps will be taken as part of the GRM:

6.14.2.1 Grievance Uptake and Submission

To ensure that persons with disabilities and other vulnerable groups effectively access a Grievance Redress Mechanism (GRM), the concept of universal design is applied, meaning that systems are designed from the outset to be usable by as many people as possible without requiring special adaptation. The mechanism outlined below therefore uses multiple channels for submitting complaints as listed above using different means, including both verbal/voice-based systems and written means as well as in-person and remote means.

Grievances may be submitted through multiple channels to maximise accessibility:

- CLO – in person, by phone, WhatsApp, SMS;
- Verbal via the Contractor site office with clear signage and wayfinding systems;
- WASA project representatives;

- Public meetings or consultations (including wheelchair-accessible offices and meeting rooms and consultation venues);
- Written letters or complaint forms;
- GRM boxes at community facilities;
- Project email; and
- Anonymous submissions.

Physical barriers can prevent persons with mobility impairments from accessing grievance services as well as intellectual barriers and as such, the system allows for representation as follows:

- Permission for family members, caregivers, advocates, or disability organizations to assist complainants.
- Provision for support persons during interviews and hearings.
- Allowance of complaints to be submitted through authorized representatives.
- Partner with Disabled Persons' Organizations (DPOs).
- Disseminate information through disability networks.
- Use community meetings, radio, social media, and accessible materials using simple language and avoiding all jargons.
- Train community workers to assist persons with disabilities in filing complaints.

All grievances are treated confidentially, especially those involving safety, worker behaviour, or sensitive issues including GBVH complaints. This is facilitated through the training of staff or workers that will be collection and handling complaints/grievances that are stored in secured cabinets and properly marked confiential so that when documents are shared during the escalation process they are handled confientially. All staff and workers in the grievance process shoudl also sign a confidentiality policy or Non-Disclosure Agreement (NDA).

6.14.2.2 Registration and Acknowledgement

- Every grievance receives a unique GRM Case ID.
- The CLO enters the grievance into the GRM Log within 24 hours.
- Acknowledgement is issued to the complainant within 24 hours, or immediately for safety-related cases.
- Anonymous cases will also be registered and investigated.

6.14.2.3 Screening and Classification

Grievances are screened and categorised according to type within 48 hours of receiving the complaint:

- Access restrictions/road disruptions;
- Noise, dust, vibration;
- Safety risks (open trenches, traffic hazards);

- Service interruptions (water supply, other project related utility disruptions – electricity, TSTT);
- Environmental issues – air quality, water quality, biodiversity, etc.;
- Worker behaviour;
- Land, property, drainage, reinstatement issues (road and access);
- Gender-based or vulnerable group-related concerns; and
- Requests for information.

Screening determines:

1. Urgency;
2. required investigation; and
3. responsible entity.

➢ Investigation and Resolution

- HSQ team, CLO, and relevant technical staff will conduct site investigations.
- Root cause analysis is carried out for each complaint.
- Contractor/WASA implement corrective action measures, which may include:
    - reinstatement of access;
    - repairing damages;
    - reinforcing safety measures;
    - additional communication;
    - traffic adjustments; and
    - water supply alternatives.

6.14.2.4 *IDB's Grievance Redress Mechanism - Independent Consultation and Investigation Mechanism (MICI)*

Outside of the investigation and resolutions outlined above, should there remain outstanding issues for redress, project-affected people and communities can access the IDB's grievance mechanism, The Independent Consultation and Investigation Mechanism (MICI). MICI has been set up independently of IDB operations and management and which reports directly to the IDB's Executive Board, to consider grievances from individuals and communities affected by projects financed by the IDB Group.

MICI manages two mechanisms through which it assesses claims made by claimants:

(ii) The Consultation Phase, which is a voluntary and flexible space for dispute resolution, under the impartial mediation of the MICI. Through this mechanism, the claimant(s), the Borrower and/ or the executing agency and the IDB have an opportunity to resolve their differences and reach an agreement that resolves the complaint;

(ii) The Compliance Verification Phase, which consists of an investigation of facts by MICI to determine whether the IDB met its obligations with regards to the requirements of its ESPF.

6.14.2.5 Resolution timeframe

Resolution timelines will be applied based on the complexity of each grievance, as outlined below:

- Minor issues: within 7 days
- Moderate issues: within 14 days
- Complex issues requiring agency coordination: within 30 days

Complainants are informed of proposed and completed actions. Feedback on the completed actions will be sought from complainants.

- Close-Out and Documentation

A grievance is closed only when:

1. Corrective action is completed;
2. The complainant confirms satisfaction, where applicable; and
3. The CLO records the closure in the GRM Log.

Cases may be closed without agreement only after escalation and final decision by WASA.

6.14.2.6 Escalation Procedure

If the complainant is dissatisfied:

Level 1: Contractor
Level 2: WASA Project Management Staff
Level 3: WASA Senior Management or an appointed Independent Reviewer
Level 4: National regulatory authorities (e.g., Regulated Industries Commission)

Escalation timelines are communicated clearly to complainants.

6.14.2.7 Disclosure and Awareness

- GRM Summary Posters displayed in communities.
- GRM process explained at all community meetings.
- CLO conducts local outreach, especially with vulnerable households.
- Hotline/WhatsApp numbers publicly posted.

- Confidentiality, Data Protection and Non-Retaliation

- Complainants are protected from retaliation.
- Sensitive cases (e.g., violence, gender issues) handled discreetly.
- Records kept securely by WASA.

6.14.3 Monitoring and Compliance

Monitoring ensures that all grievances are managed efficiently and transparently.

Monitoring Activities

These activities include the following:

- Daily updates from the CLO on new grievances.
- Weekly review of the GRM Log by the Contractor HSQ Manager/Officer.
- Monthly verification by WASA and the Supervisory Consultant.
- Quarterly review of trends, systemic issues, and response time performance.
- Cross-checking actions implemented on the ground.
- Reporting on open, in-progress, and closed cases.

Compliance Measures

- Non-compliance triggers Corrective Action Plans issued by WASA or Supervisory Consultant.
- Repeated failure to respond effectively to grievances may lead to contractual penalties, especially Level 3 and Level 4 grievances or those that have progressively escalated over time without satisfactorily conclusion.
- Performance included in monthly ESMP compliance reports.

6.14.4 Indicators

The performance of the GRM will be tracked through the following indicators.

KPI	Monitoring and Measurement Method	Frequency	Responsibility
Number of grievances received	GRM Log	Weekly	Contractor; CLO
Percentage acknowledged within 24 hours	Log audit	Weekly	Contractor
Percentage resolved within defined timelines	Log review; follow-up checks	Monthly	WASA; Contractor
Number of grievances escalated	Log analysis	Monthly	WASA
Grievance themes and trends	GRM report	Monthly	WASA
Satisfaction rate of resolved cases	Follow-up calls	Monthly	CLO
Participation of vulnerable groups	GRM disaggregation tracking	Monthly	CLO; WASA
Corrective actions implemented on time	Verification inspections	Weekly	Contractor; Supervisory Consultant/WASA

6.14.5 Roles and Responsibilities

Effective grievance resolution requires strong coordination between the Contractor, WASA, supervisory personnel, and community representatives. Roles must be clearly defined to ensure timely response and transparent accountability.

ENTITY / ROLE	KEY RESPONSIBILITIES
WASA	Oversight of GRM; approval of escalation decisions; quarterly analysis; coordination with government agencies; ensuring corrective actions are implemented; public disclosure of GRM summary.
CONTRACTOR	Primary recipient of grievances; implement corrective actions; maintain daily GRM Log; coordinate with CLO; ensure safety and reinstatement issues are addressed promptly.
COMMUNITY LIAISON OFFICER	First point of contact; receive and register grievances; acknowledge complaints; maintain communication with complainants; support vulnerable households; assist with investigations; keep records updated. Work with community leaders/focal points to inform residents, local businesses, guesthouses and organisations about the GRM; to support their communication about the project; and to report concerns early. Coordinate with community leaders, including the Local Government Councillor to inform residents about the GRM; to facilitate communication with residents about the project, local businesses, organisations, and guest houses; and to support their reporting concerns early. Work with partner agencies like MOWT, Municipal Corporations and utilities to address grievances relating to road reinstatement, traffic management and access disruptions; utility damage; and participate in joint inspections.
HSQ TEAM (CONTRACTOR)	Conduct site investigations; verify hazards; inspect access, signage, barriers; support resolution of safety and environmental grievances.
SUPERVISORY CONSULTANT	Independent oversight; verification of grievance handling quality; ensure compliance with ESMP; escalate serious unresolved issues to WASA.

6.15 Worker Behaviour and Anti-Harassment Plan

6.15.1 Introduction and Objectives

The Worker Behaviour and Anti-Harassment Plan outlines the measures to prevent, identify, and respond to any form of gender-based violence and harassment (GBVH), or inappropriate conduct involving project workers and community members.

The objectives of this Plan are to:

- Establish a zero-tolerance policy toward all forms of GBV, SEA, SH, and harassment.
- Ensure all workers, including subcontractors, sign, understand, and comply with a Worker Code of Conduct (CoC).
- Protect women, girls, older adults, persons with disabilities, and other vulnerable groups living in the project communities.
- Reduce risks associated with worker-worker interactions and worker-community interactions, especially during trenching, access restrictions, and community engagements.
- Provide accessible, confidential channels for reporting GBVH-related grievances.
- Strengthen coordination with WASA, the Contractor, the Supervisory Consultant, and community stakeholders to manage incidents effectively.
- Ensure that survivors receive timely, confidential, and survivor-centred support.

This Plan supports the SEP, GRM, OHS, Labour Management Plan, and the CHSMP.

6.15.2 Management Measures

- **Code of Conduct Requirements**

All workers (including subcontractors) must:

- Sign a GBVH-specific Code of Conduct prior to starting work.
- Receive orientation on expected behaviours and consequences of violations.
- Re-sign the Code of Conduct if project conditions change or during annual refresher training.
- Wear identifiable uniforms/ID badges at all times.
- Avoid entering private properties without explicit permission.
- Respect community norms, privacy, and cultural expectations.

The CoC prohibits:

- Sexual harassment, exploitation, or abuse of community members or co-workers.
- Sexual comments, gestures, unwanted attention, or propositions.
- Relationships with minors (under 18), regardless of consent.
- Any sexual relations that are exploitative, unbalanced, or linked to power dynamics.
- Transactional sex or solicitation.

- Use of threats, force, or coercion.
- Retaliation against survivors or complainants.

➢ **Worker Training and Behavioural Oversight**

- Mandatory induction training for all workers on GBVH, respectful behaviour, and reporting obligations.
- Monthly toolbox talks on respectful interaction, safe community engagement, and gender sensitivity.
- Supervisor-level training on identifying risks, enforcing the CoC, and responding to incidents.
- Signage posted at site offices summarising CoC rules and reporting channels.
- Clear disciplinary procedures (warnings → suspension → removal → legal reporting if applicable).

➢ **Community Awareness**

- Communicate CoC commitments to local communities.
- Share reporting channels with community groups, women's networks, health centres, and vulnerable groups.
- Conduct brief awareness sessions at community meetings and schools, emphasising:
    - prohibited behaviours
    - how to report concerns
    - survivor rights and confidentiality

➢ **Reporting and Survivor-Centred Response**

GBVH-related grievances follow the GRM, with enhanced safeguards:

- Complaints can be anonymous and confidential.
- Female community members may report via female staff (CLO, WASA rep).
- Sensitive complaints bypass Contractor and go directly to WASA's designated GBVH focal point.
- Information is restricted to authorised personnel only.
- Immediate referral to medical, psychosocial, or legal support services where necessary.
- No survivor is required to provide written statements or engage beyond what they choose.

➢ **Incident Management**

- Immediate safety assessment and survivor-centred response.
- Contractor removes alleged offender from community interactions pending investigation.
- WASA GBVH focal point oversees investigation and ensures due process.
- Coordinated response with Police or gender-based violence service providers where required.
- All actions documented while preserving confidentiality.

➢ **Risk Mitigation in Worker–Community Interaction**

- Limit worker access to schools, community centres, and sensitive areas unless authorised.
- Enforce working-hour limits to avoid late-evening presence in communities.
- Avoid hiring practices that favour one gender unfairly; encourage women's participation.
- Monitor worker accommodation arrangements (if applicable) for GBVH risks.

6.15.3 Monitoring and Compliance

Monitoring ensures all mitigation measures and Code of Conduct provisions are implemented consistently.

Monitoring Activities

- Daily supervision of worker behaviour by site supervisors.
- Weekly review of any GBVH reports or early warning signs.
- Verification of worker signatures on CoC forms.
- Random interviews with workers and community members to assess behavioural compliance.
- Monthly reporting to WASA on GBVH implementation status.
- Oversight audits by the Supervisory Consultant.

Compliance Mechanisms

- Corrective Action Plans issued for weak enforcement.
- Mandatory removal of workers for serious CoC violations.
- Documentation of disciplinary actions in Contractor records.
- Annual review of the GBVH plan and CoC provisions.

6.15.4 Indicators

KPI	Monitoring Method	Frequency	Responsibility
% of workers who signed CoC	Contractor HR records	Monthly	Contractor
Number of GBVH induction and refresher sessions held	Training logs	Monthly	Contractor; WASA
Number of GBVH-related grievances reported	GRM log	Weekly/Monthly	WASA; CLO
Time taken to respond to GBVH complaints	GRM tracking	Weekly	WASA
% of workers disciplined or removed for violations	HR disciplinary records	Quarterly	Contractor
Community awareness events conducted	SEP records	Monthly/Quarterly	WASA; CLO
Availability of survivor referral support	Service provider confirmations	Quarterly	WASA

6.15.5 Roles and Responsibilities

Effective prevention and response require coordinated responsibilities among the Contractor, WASA, community representatives, and the Supervisory Consultant. Clear accountability ensures zero tolerance for GBVH and protects affected community members.

ENTITY / ROLE	KEY RESPONSIBILITIES
WASA	Oversight of GBVH plan; designate GBVH focal point; ensure CoC enforcement; manage sensitive GBVH grievances; coordinate with service providers; ensure sanctions are applied.
CONTRACTOR	Ensure all workers sign CoC; conduct training; supervise worker behaviour; enforce sanctions; immediately remove workers involved in GBVH incidents; maintain confidential records.
SUPERVISORY CONSULTANT	Monitor compliance; verify implementation; review training materials; audit GBVH reporting and response; escalate issues to WASA.
COMMUNITY LIAISON OFFICER	Maintain safe and respectful engagement; receive confidential complaints; support survivors; maintain referral pathways. Work with community leaders to share information on the project's zero tolerance policy regarding all forms of violence and harassment, the Worker Code of Conduct and expected worker behaviour.

	Where required identify and liaise with the TTPA and relevant GBV service providers in providing the necessary support for survivors (including medical, counselling, psychosocial, legal support to survivors), where required. Also to inform residents about GRM reporting channels.
HSQ MANAGER / OFFICERS	Observe worker interactions; report violations; ensure the CoC displayed; support investigations.

6.16 Emergency Management Plan

The Emergency Management Plan establishes protocols to prepare for, respond to, and recover from emergencies affecting the five water treatment plants. It aligns with international and national standards – for example, it fulfills IDB ESPS4 requirements for community safety– and follows the all-hazards approach advocated by CDEMA and the Trinidad & Tobago Disaster Management Policy. The plan outlines clear responsibilities, communication channels, preparedness measures, and procedures to ensure continuity of safe water service and protection of personnel and infrastructure during disasters.

This plan seeks to:

- Protect Infrastructure and Operations: Reinforce and prepare plant facilities to withstand hazards (flooding, storms, earthquakes, fire) so critical treatment capacity is maintained.
- Ensure Personnel and Community Safety: Establish evacuation plans, safety training, and liaison with emergency services to safeguard workers and nearby residents.
- Maintain Continuity of Water Service: Minimize downtime by having backup power, alternate water sources, and rapid repair protocols to quickly restore operations.
- Enhance Preparedness and Coordination: Conduct regular drills and training on emergency response, and coordinate with ODPM, Fire Service, Police, and local governments.
- Comply with Standards and Policies: Implement measures required by IDB's Environmental and Social Performance Standard 4 on health and safety and by national disaster management policies.
- Promote Adaptive Learning: Incorporate lessons from exercises and actual events into updated procedures to improve resilience over time.
- Preparedness and Mitigation Measures

6.16.1 Management Measures

The following measures will be implemented before and during operations to reduce risks and improve response readiness. This includes both engineered resilience features and operational procedures:

- Corrosion and Material Durability: Given proximity to water and humidity, materials and coatings resistant to corrosion will be used for tanks, piping, and infrastructure. Equipment sensitive to moisture will be sealed or located inside protected shelters.
- Seismic Safety: Foundations will be engineered (e.g. compacted fill, deep piles) to minimize differential settlement or tipping during an earthquake. Tanks and heavy equipment (e.g. generators) will be anchored. Structural design follows the Caribbean earthquake-resistant guidelines. Post-earthquake, the plant supervisor will conduct immediate visual inspections of structures, piping, and tanks for damage.

- Backup Power and Energy: To address power outages, an on-site backup generator (or multiple generators) will be installed with enough fuel for at least 72 hours of continuous operation. Generator and critical electrical equipment will be located above potential flood levels. The electrical system will be pre-wired to allow integration of future renewable backup (e.g. solar panels for SCADA/telemetry).
- Alternate Water Supply: The plan will identify alternate water sources for emergency use (for example interconnection with neighboring systems, tanker-truck supply, bottled water programs) and establish mutual aid agreements with nearby utilities. These agreements ensure sharing of water, equipment, or personnel if any plant is offline.
- Communications and Command: A clear chain of command is established for emergency response. Primary and backup emergency contact information (ODPM, Fire Service, Police, hospital, WASA leadership) will be posted prominently at each site. An emergency operations center (EOC) or incident command post protocol will be set up for major events, with designated roles (incident commander, safety officer, communications officer, etc.).
- Training and Exercises: All staff and contractors will receive regular training on emergency procedures. This includes first aid and CPR; firefighting and extinguisher use; evacuation routes; handling of hazardous materials (e.g. chlorine leaks); and hazards specific to the plants (flood, storm, earthquake safety). Bi-annual drills (tabletop and field exercises) involving on-site personnel, community representatives, and regional responders (ODPM, TTPS, Fire Service) will be conducted to test and refine the Emergency Plan.
- Standard Operating Procedures (SOPs): Written SOPs will guide actions before, during, and after emergencies, including:
    - *Pre-Event Shutdown:* Steps to secure the site and equipment when a storm or hazard is imminent (e.g. safely halt pumping, isolate chemical processes, remove or tie down loose objects).
    - *Generator and Fuel Management:* Procedures for starting and switching to backup power and managing fuel inventory and refueling during prolonged outages.
    - *Post-Event Inspection:* Inspection checklists for structural integrity, equipment function, water quality, and environmental hazards (e.g. chemical spills, debris) following a disaster.
    - *Recovery and Restart:* Steps to de-water flooded areas, clear debris, flush and disinfect pipelines, and gradually bring the plant back online, prioritizing safety checks.
- Fire Safety: The site will have fire risk controls including proper storage of flammables (e.g. fuels, solvents) in approved cabinets, regular maintenance of electrical panels (thermography or inspections), and no-smoking areas. Fire extinguishers and hoses will be

provided at multiple locations, and personnel will be trained in their use. In a fire emergency, staff will immediately begin on-site firefighting (if safe) and evacuate according to the plan, while alerting the island's Fire Service. Contact details for the local fire station will be displayed.

- Community Engagement: WASA will hold outreach sessions to inform nearby communities about the emergency plan: how to receive alerts about water supply issues, where to find emergency potable water if needed, and what to do (e.g. boil-water advisories). This includes coordinating with local authorities on evacuation sheltering or water distribution points.

6.16.2 Monitoring and Compliance

WASA's Environmental Health & Safety (EHS) Officer will conduct ongoing monitoring to ensure all emergency measures are current and effective. This includes:

- Reviewing and updating the Emergency Plan and hazard protocols at least annually or after any significant event.
- Tracking key indicators, such as maintenance logs for emergency equipment (generators, pumps, fire gear), checked monthly; training records (first aid, evacuation) every six months; and drill reports (quarterly) to evaluate performance.
- Performing audits of structural safeguards and compliance with building and safety codes.
- After any incident, a formal after-action review will identify lessons learned, and corrective actions will be implemented.

Results of these monitoring activities will be reported to WASA project leadership and shared with stakeholders as appropriate. The goal is continual improvement: the plan will be revised based on new guidance, technological advances, and lessons from exercises and real emergencies.

Indicators

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

Key Performance Indicators (KPIs)	Monitoring and Measurement	Frequency	Responsibility
Emergency Response Readiness Score (availability and condition of emergency equipment, PPE, first-aid kits, communication devices)	Inspection of equipment readiness checklist; verification that minimum readiness thresholds are met	Monthly	WASA Site Supervisor / EHS Officer
Emergency Comms & Alert System Functionality	Testing and validation of communication systems and posted emergency contacts	Monthly	EHS Officer / Plant Operations Lead
Evacuation Route & Assembly Point Compliance	Inspection of signage, access routes, lighting, and obstruction-free pathways	Quarterly	EHS Officer
Emergency Response Team (ERT) Activation Capability	Review of roster updates, availability confirmation, and contact accuracy	Quarterly	WASA Emergency Manager
First-Aid & Emergency Skills Certification (number and percentage of staff currently certified)	Review of valid certifications and training records	Semi-Annual	EHS Officer
Emergency Response Time (time from incident detection to action taken during drills)	Measurement during simulation exercises and drills	Quarterly	EHS Officer / Drill Coordinator
Backup Power System Reliability (generators, UPS, fuel supply)	Functional testing and review of generator logs; verification of fuel inventory	Monthly	Mechanical/Operations Supervisor
Post-Event Review and After-Action Reports Completed	Review of documented incidents, corrective actions, and lessons learned	After each major incident	EHS Officer / Incident Commander
Corrective Actions Closed Out on Time	Track number of corrective actions implemented vs. pending	Quarterly	WASA Project Manager
Emergency Water Supply & Distribution Readiness	Inspection of emergency supply systems and verification of contingency logistics	Semi-Annual	WASA Operations Division

6.16.3 Roles and Responsibilities

- WASA Management (Project Lead & EHS Officer): Ultimate responsibility for the Emergency Plan. They ensure resources are available (equipment, training, drills) and that all staff and contractors know and follow the procedures. The EHS Officer documents compliance and coordinates reporting to IDB and authorities.

- WASA Personnel and Contractors: All on-site staff must understand and execute emergency procedures (evacuation, shutdown, firefighting). Designated emergency team members (e.g. Incident Commander, Safety Officer) have specific duties during a crisis. They must maintain communications with off-site emergency agencies as needed.

- Emergency Services (ODPM, Fire Service, Police): WASA will maintain active liaison with these agencies. In an emergency, they support the response (e.g. firefighting, security, medical aid). Roles of these first responders and communication protocols are pre-arranged.

6.17 Biodiversity /Habitat Management Plan

The Biodiversity and Habitat Management Plan provides a structured framework to avoid, minimise, and mitigate impacts on terrestrial and aquatic biodiversity arising from the rehabilitation and operational activities at both water treatment plants. The plan focuses on surrounding sensitive riparian zones, and wildlife corridors surrounding the Acono and Siparia WTPs.

6.17.1 Management Measures

Vegetation and Riparian Management

- Avoid clearing mature trees unless absolutely necessary; obtain approvals for tree removal.
- Clearly demarcate "no-go" zones at heavily vegetated sites.
- For work done in green spaces and destruction to vegetation during construction, replant disturbed areas with native species at 1:3 replacement ratio, where applicable.

Wildlife Protection

- Implement wildlife encounter protocols; no worker handling of animals unless trained.
- Avoid working during peak bird-nesting periods (March–July) in sites like Acono which is near forested areas, where feasible.
- Maintain vegetation corridors where wildlife movement is observed.
- Prohibit hunting, trapping, or harassment of fauna.

6.17.2 Monitoring and Compliance

Monitoring and compliance activities are essential to ensuring that all biodiversity and habitat protection measures are effectively implemented throughout the construction and operational phases of each project. Continuous ecological monitoring will be undertaken to track changes in water quality, sediment levels, vegetation condition, wildlife presence, and the effectiveness of erosion and pollution control measures across all sites, with more intensive monitoring at ecologically sensitive locations such as Acono.

This Plan aims to ensure compliance with the Environmental Management Act, ESS Rules, Wildlife Conservation Act, and IDB ESPS 6, and to support long-term ecological stability within these critical watershed areas. Compliance inspections (conducted weekly during construction and quarterly during operation) will verify adherence to riparian buffer zones, waste management protocols, chemical handling requirements, and invasive species controls. All monitoring will be guided by the measurable indicators provided below. Contractors will be required to maintain detailed environmental logbooks and submit weekly compliance reports to the selected implementing agency, which will in turn conduct independent site audits, issue corrective action requests where necessary, and ensure that any non-compliance is promptly rectified.

Serious breaches, such as damage to protected species or uncontrolled pollution events, will trigger immediate stop-work orders and escalation to the EMA and relevant regulatory agencies. All monitoring results will be incorporated into quarterly performance summaries submitted to the IDB

to demonstrate adherence to ESPS 1 and ESPS 6 requirements. Through this rigorous monitoring and compliance framework, the project ensures the protection of ecological integrity, continuous improvement of mitigation measures, and long-term environmental stewardship across all project sites.

6.17.3 Indicators

The following KPIs have been selected to evaluate the effectiveness of the biodiversity and Habitat monitoring system.

Table 6-11: Key Performance Indicators for Biodiversity and Habitat Management

Indicator	Target / Performance Standard	Frequency	Means of Verification	Responsible Party
Vegetation clearance is kept within the approved footprint	100% compliance with site layout	Weekly	Boundary marker checks; supervisor reports	Contractor
Wildlife observations/fauna encounters	Zero wildlife harm; proper documentation of encounters	Weekly	Wildlife logbook; incident reports	Contractor; WASA Environmental Unit
Integrity of riparian buffers (15–30 m)	No disturbance beyond approved limits	Weekly	Site walk-throughs; GPS mapping	Contractor; WASA

6.17.4 Roles and Responsibilities

Effective biodiversity and habitat management requires a clear allocation of responsibilities among all parties involved in each of the proposed projects. Each entity (i.e., WASA, contractors, supervising consultants, and regulatory agencies) plays a distinct and complementary role in ensuring that mitigation measures are implemented, monitored, and continuously improved. During the pre-construction phase, responsibilities focus on ecological screening, baseline assessments, and ensuring all permits, approvals, and management plans are finalized. Throughout the construction phase, roles shift toward daily implementation of biodiversity safeguards, enforcement of buffer zones, wildlife protection protocols, erosion control, and compliance monitoring. During the operational phase, responsibilities include regular ecological inspections. Strong oversight mechanisms, frequent reporting, and coordinated communication among parties ensure that environmentally sensitive areas are protected, impacts are minimised, and regulatory compliance is maintained. The table below summarises the core responsibilities of each stakeholder involved in the project.

Table 6-12: Roles and Responsibilities for Ecosystem/Biodiversity Management

ENTITY / ROLE	KEY RESPONSIBILITIES
WASA Environmental Unit	Provide overall environmental oversight for all project sites; Ensure the plan, including all its site-specific mitigation measures, is implemented and updated; Conduct regular site audits and compliance inspections; Lead ecological monitoring during operation; Review environmental incident reports and enforce corrective actions.
Contractor/HSE Officer	Implement all biodiversity protection measures outlined in the plan; maintain a wildlife encounter log and follow fauna-protection protocols; Restrict activities to approved footprints; Avoid ecological contamination; Provide environmental training for workers; Prepare weekly environmental compliance reports.
EMA (Environmental Management Authority)	Provide regulatory oversight and enforce compliance with national environmental laws; Review reports of ecological incidents or ESS encounters; Conduct site inspections where necessary to verify compliance with CEC.
Forestry Division (for forested/watershed sites)	Provide technical guidance on forest management, wildlife encounters, and habitat protection; Support vegetation assessment and protected species presence; Approve tree removal where applicable; Assist in ecological incident response.

6.18 Decommissioning Plan

6.18.1 Managment Measures

6.18.1.1 Background and Decommissioning Objectives

Aspects of the existing Siparia Water Treatment Plant will be decommissioned following successful commissioning of the replacement equipment at the facility. The Siparia Water Treatment Plant draws water from the existing wellfield. The works are intended to restore and expand the plant's effective treatment capacity from its current design output of 1.32 IMGD to an upgraded design capacity of 2.0 IMGD, while stabilising production.

The Siparia Refurbishment will include the civil and structural scope includes all works necessary to support the upgraded treatment processes and associated infrastructure, including but not limited to:

- Demolition and removal of deteriorated or obsolete treatment units, structures, and foundations.
- Design and construction of new reinforced concrete structures for clarifiers, filters, sludge tanks, equipment foundations, and support facilities.
- Rehabilitation and modification of existing concrete structures to accommodate new process equipment, including surface repairs, protective linings, and structural strengthening where required.
- Construction and installation of a new factory-coated bolted steel clearwell for treated water storage and chlorine contact.
- Provision of access stairways, platforms, catwalks, handrails, and safety barriers to facilitate safe operation and maintenance.

Decommissioning shall be undertaken in a manner that protects, public health and the environment, while eliminating environmental liabilities associated with the existing facility.

All activities shall be undertaken in accordance with the Environmental Management Act of Trinidad and Tobago, Water Pollution Rules, applicable waste management requirements, WASA operational requirements, WHO Guidelines for Drinking-water Quality, IDB Environmental and Social Performance Standards (ESPS), IFC General EHS Guidelines and Good International Industry Practice (GIIP).

6.18.1.2 Structural Isolation & Hydraulic Safeguarding

Intake Switch-Over Lockout: Implement strict mechanical Lock-Out/Tag-Out (LOTO) isolation on all raw water intake valves and connections from the wellfield to the existing plant at Siparia.

Electrical Grid Severing: Coordinate with T&TEC to permanently disconnect high-voltage grid lines feeding the 'old' high-lift pumps, chemical mixers, and air blowers

6.18.1.3 Source Water and Receiving Water Protection

Protection of on-site workers and the surrounding community and environment shall be a primary environmental objective during decommissioning activities.

Treatment units, drainage channels and pipelines shall be isolated prior to cleaning and dismantling. Residual process water, wash water, sediments and demolition debris shall be contained and managed to prevent discharge to the reservoir or adjacent watercourses. Temporary erosion, sediment and spill control measures shall be maintained throughout decommissioning activities.

Any accidental release with the potential to affect water quality shall be immediately contained, investigated and corrected.

6.18.1.4 Chemical and Hazardous Materials Management

All treatment chemicals shall be inventoried and removed from the facility prior to demolition activities.

Residual alum, lime, and activated carbon shall be removed from storage facilities, dosing systems, and associated pipework. All chlorine cylinders shall be isolated, and 150lb chlorine cylinders recovered from the chemical dosing bay and transferred for reuse or returned to the supplier. Chlorine lines, regulators and dosing equipment shall be depressurized, purged and verified safe prior to cutting or dismantling local pipelines to prevent localized toxic chlorine gas vapor releases into the adjacent environment.

The chemical storage room shall be cleaned and inspected following removal of all chemicals to verify that no residual contamination remains.

6.18.1.5 Sludge and Treatment Residuals Management

Treatment units, sludge channels, wash water drains, and associated infrastructure shall be inspected for accumulated sludge and treatment residuals.

Sludge and sediments shall be removed, dewatered where practicable and transported to an approved disposal facility. Waste tracking records shall be maintained for all removed materials.

No sludge, sediment, filter backwash solids or treatment of residuals shall be discharged to the receiving environment during decommissioning activities.

6.18.1.6 Generator and Fuel System Removal

Diesel fuel, lubricants, batteries, and associated materials shall be removed from the standby generator prior to dismantling.

The generator area shall be inspected for evidence of hydrocarbon contamination. Any contaminated material identified shall be removed and appropriately managed. Spill prevention and response measures shall remain in place throughout removal activities.

6.18.1.7 Decommissioning of Process Infrastructure

The coagulation, flocculation, sedimentation, filtration and disinfection systems shall be drained, cleaned and inspected prior to dismantling.

The underground clear well and backwash water storage tank shall be cleaned and assessed to determine the most appropriate closure option. Structures retained on site shall be secured against unauthorized access, standing water, vector breeding and public safety risks.

6.18.1.8 Site Rehabilitation and Environmental Closure

Upon completion of decommissioning activities, all wastes, redundant infrastructure and temporary facilities shall be removed from the site.

Disturbed areas shall be stabilized and rehabilitated as necessary to prevent erosion, sediment transport and drainage instability. Open basin cavities shall be backfilled with certified clean fill dirt. The final topsoil slope shall be graded to eliminate low spots, preventing standing rainwater from creating breeding grounds for *Aedes aegypti* mosquitoes. Also, native Savannah grass shall be planted immediately to stabilize the earth against erosion during heavy tropical downpours.

The site shall be left in a safe, stable and environmentally acceptable condition.

6.18.2 Monioring and Compliance

Monitoring shall be undertaken throughout decommissioning activities to verify implementation of mitigation measures and compliance with applicable environmental requirements.

Monitoring activities shall include:

- inspection of reservoir and watercourse protection measures;
- verification of chemical removal and decontamination activities;
- verification of chlorine cylinder transfer and disposal records;
- inspection of sludge removal and disposal activities;
- inspection of generator removal and fuel management activities;
- verification of waste management records;
- inspection of erosion and sediment control measures;
- verification of site rehabilitation activities; and
- investigation and documentation of environmental incidents and non-compliances.

Inspections shall be undertaken prior to commencement of decommissioning activities, during high-risk activities, following significant rainfall events, following environmental incidents and as part of the final environmental closure inspection.

Any non-compliance identified shall be documented and corrective actions implemented promptly.

Monitored Operational Activity	Statutory Standard	Compliance	Minimum Sampling Frequency

Tank Draining & Basin Fluid Evacuation	**Water Pollution Rules (WPR) Schedule I:** pH must be strictly between 6.0 – 9.0; TSS must remain < 30 mg/L before leaving property.	Continuous grab testing per active batch discharge event.
Demolition & Concrete Crushing	**EMA Ambient Air Quality Standards:** PM10 boundary limit < 150 µg/m^3 over a 24-hour averaging period.	Continuous daily tracking during active crushing or heavy excavation.
Material Haulage & Sludge Logistics	**Waste Management Rules (WMR):** 100% containment; zero visible tracking of mud/sludge on public asphalt; valid EMA-permitted waste handler signatures.	Every departing truck load.
Stockpiling chemical pipes & scrapped Pumps	**WPR Section 4 (General Prohibition):** Zero visible oily sheen or chemically colored runoff permitted in public stormwater channels.	Daily, plus immediate inspection following any heavy rainfall event.

6.18.3 Key Performance Indicators

Indicator	Target
Water Quality Compliance	**100%**
Release of sludge, sediment or process water to watercourses/ into the environment	Zero
Chlorine release incidents	Zero
Fuel or oil spills	Zero
Significant environmental incidents	Zero
Treatment chemicals removed and accounted for	100%
Chlorine cylinders removed and accounted for	100%
Sludge disposal records completed	100%
Waste transfer records completed	100%
Significant erosion associated with decommissioning activities	Zero
Environmental closure verification completed	100%

6.18.4 Roles and Responsibilities

WASA

- Ultimate Oversight: Acts as the primary asset owner and applicant for the decommissioning Certificate of Environmental Clearance (CEC)
- Approves and oversees decommissioning activities.
- Verifies operational shutdown of the facility.
- Review environmental compliance documentation.
- Confirm satisfactory environmental closure of the site.

- Regulatory Liaison: Submits the Final Closure and Rehabilitation Report to the EMA to request formal site de-registration and release from CEC obligations.
- Inter-Agency Coordination: Manages formal communication channels and updates with the EMA

Contractor Project Manager

- Operational Execution: Directs all field personnel, heavy equipment scheduling, and demolition sequencing in strict alignment with the ESMP.
- Implement all decommissioning and mitigation measures.
- Subcontractor Management: retains and monitors the performance of certified specialty subcontractors for gas chlorine extraction, and hazardous waste transport.
- Maintain environmental compliance throughout decommissioning activities.
- Maintain records of waste, sludge and chemical management.
- Undertake site rehabilitation and restoration activities.

Environmental Officer

- Compliance Testing: Conduct monitoring and compliance inspections including daily on-site field testing for pH and total suspended solids (TSS) of all residual basin fluids before discharge
- Chain of Custody Control: Manages the legal waste tracking system for all departing chemical, sludge and structural wastes.
- Verify implementation of mitigation measures.
- Investigate environmental incidents and non-compliances.
- Prepare environmental monitoring and closure documentation.
- Post-Closure Audits: Coordinates the 12-month post-closure groundwater sampling and soil core grid analysis with an accredited laboratory.

Health and Safety Officer

- Safety Enforcement: Implements and verifies Lock-Out/ Tag-Out (LOTO) procedures, confined space air-purging protocols, and mandatory worker PPE compliance
- Oversee chlorine handling and chemical removal activities.
- Nuisance Control: Monitors daily boundary dust levels (PM10) and ensures all stockpiles and departing trucks are securely covered.

- Vector Management: Conducts weekly site walkthroughs to locate and eliminate areas of standing water that could breed mosquitoes.
- Monitor worker safety compliance.
- Implement emergency response procedures.
- Verify safe closure of confined spaces and underground structures.

6.18.5 Post-Closure Activities and Decommissioning Closure Verification

Following complete infrastructure removal, the project must enter a 12-month post-closure validation phase which includes

1. **Groundwater Quality Audit:** Sample quarterly, monitoring wells (one upgradient, two downgradient) around the historical footprints of the old chemical storage bays to track potential historical chemical migration.
2. **Soil Validation Core Sampling:** Take systematic grid-based soil core samples across the old treatment plant footprint. Ensure heavy metal contents and pH levels conform to safe residential/industrial baseline numbers.
3. **Formal Permit Close-Out:** Compile clean water reports, certified soil samples, and disposal manifests into a comprehensive **Decommissioning Closure Verification Report**. This report is then submitted directly to the EMA to officially de-register the old facility, close out the decommissioning CEC requirements, and transfer full site management to the team operating the new 2.0 IMGD plant.

This Decommissioning Closure Verification Report shall be prepared by the Contractor Project Manager and reviewed by WASA and the Environmental Officer.

This Report shall confirm that all chemicals, fuels, wastes and residual materials have been removed and appropriately managed; sludge and treatment residuals have been disposed of at approved facilities; infrastructure has been safely decommissioned; disturbed areas have been rehabilitated; and the site has been left in a safe, stable and environmentally acceptable condition.

6.19 Cultural Heritage Management Plan

6.19.1 Chance Find Program/ Watching Brief

During construction activities, cultural heritage assemblages may be discovered or identified. The Chance Find Program is intended to manage impacts to known, probable and unknown cultural sites. Consultations and communication with the legal and regulatory institutions, such as the National Trust of Trinidad and Tobago should be held and procedures and protocols for assessing any unanticipated cultural heritage sites or materials encountered during the project construction phase should be developed and implemented as outlined below.

6.19.1.1 Chance/Find Protocols & Procedures

Essentially there are several main protocols involved in the implementation of a Chance Find Procedure. These include:

- The Chance Find Program includes the following procedures:
    a. A local specialist or archaeologist should remain on call and shall provide oversight of the entire Chance Find Program.
    b. The on-call specialist should be used on an as-needed-basis and will monitor the Chance Find Program.
    c. The on-call specialists are only required to conduct field monitoring in the case of unusual or highly sensitive and important chance finds.
- A stop work authority/procedure should be affected in the immediate area for the protection of cultural heritage materials encountered during construction activities.
- Document and assess Chance Finds to determine if additional investigations are required.
- Adhere to any established protocols established in consultation with project management of Implementing Agency, Contractors, cultural heritage specialists, local regulatory bodies (for the design and implementation of additional investigations, if needed).
- Identify the roles and responsibilities of the various stakeholders involved.
- The archaeologist must be present during all ground disturbing works conducted within culturally sensitive areas.
- Ground works in other areas should be monitored by at least one member of the project staff who has previously received cultural heritage training.
- Considering that a chance find can be reported by any member of the project staff, it is important that cultural training be provided to all project staff and subcontractors.
- If a Chance Find is encountered, the following steps should be undertaken:
    1. Issue a stop work order in the vicinity of the find.
    2. Inform the site supervisor or project manager.
    3. Install temporary site protection measures such as warning tape or avoidance signs.
    4. Inform all personnel of the Chance Find if access to any part of the work area is restricted.

5. Establish a localized no-go area needed to protect the Chance Find.
6. Arrange for the specialists to perform a preliminary evaluation to determine whether the Chance Find is cultural heritage and if so, whether it is an isolate or part of a larger site or feature.
7. Leave artefacts in place if possible; if materials are collected, they will be placed in bags and labelled by an archaeologist and transported to the relevant agency. Artefacts should not be allowed to be taken by any project personnel as personal possessions.
8. Document the finding via the use of photography, notes, GPS coordinates and maps as appropriate.
9. If the Chance Find proves to be an isolated find or not of cultural heritage, the specialist will authorize the removal of the site protection measures and activity in the area.

If, however, the specialist confirms the Chance Find as a cultural heritage of artefact or site of significance, inform the National Trust of Trinidad and Tobago, and initiate discussions about treatment as follows:

1. Prepare and retain archaeological monitoring records including initial reports whether they are later confirmed or not. The record shall include coordinates of all observations to be retained;
2. Develop and implement treatment plans for confirmed finds using the services of qualified cultural heritage experts;
3. If a Chance Find is a verified cultural heritage site, prepare a final Chance Find report once treatment has been completed;
4. While investigation is ongoing, co-ordination with onsite personnel is needed so as to keep them informed of the status and schedule of the investigations and inform them of when construction will resume.

In the event that mitigation is required, then expedient rescue excavations should be undertaken by the relevant archaeological specialists unless the chance find is of international importance. If this is the case, then special care should be taken and archaeologists with the appropriate expertise in addressing the find should be appointed.

6.20 Consultation Event outline

In accordance with ESPS 10 meaningful consultations are a requirement throughout the project period for all project interventions. As such a public consultation event is essential for the proposed project to facilitate the disclose of project information to allow stakeholders to understand the project's risks, impacts, and potential opportunities and development benefits from the project.

Following the publishing of the ESA and ESMP for the project intervention for public viewing, a public consultation event will be held with no less than 1 week's notice prior to the execution of a public consultation. At least 1 week prior to an event, public advertisement inviting the community should be communicated using multiple modes of communication. The following are some options for advertising that can be utilised for this project:

- Online websites
- Radio or television announcements
- Community Flyers – hard copy in mailboxes and posted community centres
- Community Flyers circulated in the what's App groups of community groups and other community based organisation
- Invitation Letters to government agencies, nongovernmental organisation, private sector and other local entities

To ensure that the consultation meets the requirements of ESPS 10, all communication will be published and presented in the English language, accessible and culturally appropriate, taking into account the needs of groups that may be differentially or disproportionately affected by the project or groups with specific information needs (e.g. disability, literacy, gender, mobility, or accessibility).

In order to make the public consultation accessible for the TT-L1071 program, multiple public consultation events are being recommended based on the groupings outlines below:

1. Project Locations North Central: Acono,
2. Project Locations North East: Matura, Salybia
3. Project Locations South West: Siparia, St. Margaret's, Petrotrin
4. Project Locations South East: Mayaro, Naparimo
5. Project Locations Tobago: Hillsborough, Charlotteville

The consultations will take place within a 1-to-2-week period in the evenings beginning at 5:30pm to facilitate the attendance of the working population.

The public consultations will be conducted with an independent chairperson and will be conducted in a manner that provides opportunities to project-affected people and other relevant stakeholders, without fear of reprisal, to express their views on project risks, impacts, and mitigation measures, and on access to potential opportunities and development benefits, and allows the Borrower to consider and respond to any concerns or questions they have regarding the project interventions.

To facilitate accessibility a Hybrid approach is recommended at all the event to facilitate persons participating remotely in these consultations.

Additionally, each consultation will have a target number of attendees from stakeholders and groups that may be affected by the project activities. The Consultant will also strive to ensure an adequate gender ratio among the participants. A 50/50 balance of males to females is the recommended target.

WASA will serve as the host for the public consultations and will fund and make the logistical planning, venue and refreshments. The project consultants will support this process by assisting with the development of the agenda for the event and will facilitate at all events.

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8 APPENDICES

Appendix 1: National Air Quality Standards (Max. Permissible Levels for Ambient Air Quality)

No.	Substance	Short-Term Maximum Permissible Levels		Long-Term Maximum Permissible Levels	
		Maximum Permissible Levels	Averaging Time	Maximum Permissible Levels	Averaging Time
	Particulates				
1	Total Suspended Particulate (TSP)	150 $\mu g/m^3$	24 hours		
2	PM_{10}	75 $\mu g/m^3$	24 hours	50 $\mu g/m^3$	1 year
3	$PM_{2.5}$	65 $\mu g/m^3$	24 hours	15 $\mu g/m^3$	1 year
	Non-Metallic Inorganic Substances				
4	Carbon monoxide (CO)	100 000 $\mu g/m^3$	15 minutes		
		60 000 $\mu g/m^3$	30 minutes		
		30 000 $\mu g/m^3$	1 hour		
		10 000 $\mu g/m^3$	8 hours		
5	Nitrogen dioxide (NO_2)	200 $\mu g/m^3$	1 hour	40 $\mu g/m^3$	1 year
6	Sulfur dioxide (SO_2)	500 $\mu g/m^3$	10 minutes	50 $\mu g/m^3$	1 year
		125 $\mu g/m^3$	24 hours		
7	Ozone (O_3)	120 $\mu g/m^3$	8 hours		
8	Sulfuric acid (H_2SO_4)	100 $\mu g/m^3$	30 minutes		
9	Hydrogen sulphide (H_2S)	30 $\mu g/m^3$	30 minutes		
10	Ammonia (NH_3)	3600 $\mu g/m^3$	30 minutes		
11	Total fluoride	1.0 $\mu g/m^3$	24 hours	0.4 $\mu g/m^3$	90 days
12	Hydrogen chloride (HCl)	100 $\mu g/m^3$	30 minutes		
13	Chlorine (Cl) and its compounds	300 $\mu g/m^3$	30 minutes		
14	Asbestos (fibres > 5 µm in length)	0.04 fibres/cm^3	24 hours		
15	Asbestos (total)	5 $\mu g/m^3$	30 minutes		
	Metallic Substances				
16	Cadmium (Cd) and its compounds	5.0 $\mu g/m^3$ of total Cd in free and combined form	30 minutes		
17	Mercury (Hg) and its compounds	1.5 $\mu g/m^3$ of total alkyl Hg compounds 5.0 $\mu g/m^3$ of total Hg in free and combined form	30 minutes 30 minutes		

No.	Substance	Short-Term Maximum Permissible Levels		Long-Term Maximum Permissible Levels	
		Maximum Permissible Levels	Averaging Time	Maximum Permissible Levels	Averaging Time
18	Antimony (Sb) and its compounds	75 $\mu g/m^3$ of total Sb in free and combined form	30 minutes	Sb and its compounds	75 $\mu g/m^3$ of total Sb in free and combined form
19	Beryllium (Be) Compounds	0.01 $\mu g/m^3$	24 hours		
20	Lead (Pb)	10 $\mu g/m^3$ of total Pb in free and combined form	30 minutes	1.5 $\mu g/m^3$ 0.5 $\mu g/m^3$	3 months 1 year
	Organic Substances				
21	Biphenyl ($C_6H_5)_2$)	60 $\mu g/m^3$	1 hour		
22	Carbon disulfide (CS_2)	330 $\mu g/m^3$	24 hours		
23	Ethylbenzene ($C_6H_5C_2H_5$)	1000 $\mu g/m^3$	24 hours		
24	Formaldehyde (CH_2O)	65 $\mu g/m^3$	24 hours		
25	Mercaptan (as Methyl Mercaptan- CH_3SH)	20 $\mu g/m^3$	1 hour		
26	Polychlorinated Biphenyls (PCBs)	0.15 $\mu g/m^3$	24 hours	0.035 $\mu g/m^3$	1 yr
27	Xylenes ($C_6H_4(CH_3)_2$) (isomers and mixture)	2300 $\mu g/m^3$	24 hours		
28	Total Dioxin and Furans	0.5 pg TEQ/m^3	24 hours		

"PM_{10}" means Particulate Matter with an aerodynamic diameter of less than **10** µm;
"$PM_{2.5}$" means Particulate Matter with an aerodynamic diameter of less than **2.5** µm;

"ng" means nanogram or one-billionth of a gram which is expressed as 1 x 10^{-9} grams in scientific notation; and

"pg" means picogram or one-trillionth of a gram which is expressed as 1 x 10^{-12} in scientific notation.

Appendix 2: National Air Quality Standards (Stack Release Limits)

NO.	SUBSTANCE/PARAMETER	MAXIMUM PERMISSIBLE LIMITS mg/Nm^3
	Particulate Substance	
1	Particulate matter	100 mg of particulate matter in each normal cubic metre of residual gases, (adjusted to a basis of 12 % CO_2 for air emissions from fuel-burning equipment, if required by the specified test method)
	Physical Parameter	
2	Opacity	20 % [1]
	Non-Metallic Inorganic Substances	
3	Sulfur dioxide (SO_2)	1000
4	Oxides of nitrogen (NO_x)	500 as NO_2
5	Carbon monoxide (CO)	1000
6	Sulfuric acid (H_2SO) mist or sulfur trioxide (SO_3)	100 as SO_3
7	Hydrogen sulfide (H_2SO_4)	15
8	Ammonia (NH_3)	50
9	Fluorine (F) and its compounds	5 as hydrogen fluoride (HF); or 5 as total fluoride
10	Acids and acid gases, as hydrogen chloride (HCl)	10 as HCl
11	Chlorine (Cl) and its compounds	5 as Cl
	Metallic Inorganic Substances	
12	Lead (Pb) and its compounds	0.5 as Pb
13	Antimony (Sb) and its compounds	5 as Sb
14	Arsenic (As) and its compounds	0.8 as As
15	Cadmium (Cd) and its compounds	0.05 as Cd
16	Mercury (Hg) and its compounds	0.05 as Hg
17	Heavy metals (other)	5 as heavy metals (other)
	Organic Substances	
18	Volatile Organic Compounds (VOCs)	20 as VOCs
19	Dioxins	0.2 ng TEQ/Nm^3 [2]
20	Furans	0.2 ng TEQ/Nm^3

In order to calculate a TEQ, a toxic equivalent factor (TEF) is assigned to each member of the dioxin and dioxin-like compounds category. The TEF is the ratio of the toxicity of one of the

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For the purposes of Schedule 2 -

[1] Opacity is to be measured by averaging opacity over any six-minute period.

[2] Toxic Equivalent (TEQ) is a calculated value that allows comparisons of the toxicity of different combinations of dioxins and dioxin-like compounds. The two most toxic compounds in the dioxin and dioxin-like compounds category are the comparison points. For example, a mixture weighing 10 g with a TEQ of 5 g would be as toxic as 5 g of either of those compounds.

Compounds in this category to the toxicity of the two most toxic compounds in the category, that is, 2, 3, 7, 8-tetracholorodibenzo-p-dioxin (commonly referred to as dioxin) and 1, 2, 3, 7, 8 - pentacholorodibenzo-p-dioxin, which are assigned a TEF of 1. TEFs that have been established through international agreements currently range from 1 to 0.0001.

A TEQ is calculated by multiplying the actual grams weight of each dioxin and dioxin-like compound by its corresponding TEF (e.g., 10 grams × 0.1 TEF = 1 gram TEQ) and then summing the results. The number that results from this calculation is referred to as grams TEQ.

For example, consider the following 60g mixture:

10 g of compound A, with a TEF of 1
20 g of compound B, with a TEF of 0.5
30 g of compound C, with a TEF of 0.2

The TEQ of this mixture would be –

(10 g × 1) + (20 g × 0.5) + (30 g × 0.2) = 26 g TEQ

This mixture of 60 g of various compounds would be as toxic as 26 g of either of the two most toxic compounds.

Sampling and analysis to determine compliance with the standards listed in Schedules 1 and 2 shall be in accordance with such methods as are approved by Authority.

Appendix 3: National Water Quality Standards (Water Pollutants)

No.	Parameters or Substances	Quantity, Condition or Concentration at which substance or parameter is defined as a pollutant [a]
1.	Temperature	Maximum variation of 3^0C from ambient
2.	Hydrogen ion (pH)	Less than 6 or greater than 9
3.	Dissolved Oxygen Content (DO)	<4
4.	Five day Biological Oxygen Demand (BOD_5 at 20^0C)	>10
5.	Chemical Oxygen Demand (COD)	>60
6.	Total Suspended Solids (TSS)	>15
7.	Total Oil and Grease (TO&G) or n-Hexane Extractable Material (HEM)	>10
8.	Ammoniacal Nitrogen (as NH_3-N)	>0.01
9.	Total Phosphorus (as P)	>0.1
10.	Sulphide (as H_2S)	>0.2
11.	Chloride (as Cl^-)	>250
12.	Total Residual Chlorine (as Cl_2)	0.2
13.	Dissolved Hexavalent Chromium (Cr^{6+})	>0.01
14.	Total Chromium (Cr)	>0.1
15.	Dissolved Iron (Fe)	>1.0
16.	Total Petroleum Hydrocarbons (TPH)	NIAA
17.	Total Nickel (Ni)	>0.5
18.	Total Copper (Cu)	>0.01
19.	Total Zinc (Zn)	>0.1
20.	Total Arsenic (As)	>0.01
21.	Total Cadmium (Cd)	>0.01
22.	Total Mercury (Hg)	>0.005
23.	Total Lead (Pb)	>0.05
24.	Total Cyanide (as CN^-)	>0.01
25.	Phenolic Compounds (as phenol)	>0.1
26.	Radioactivity	NIAA
27.	Toxicity	NATE
28.	Faecal Coliforms	>100

Appendix 4: National Water Quality Standards (Water Pollutants)

	Water Pollutants	Receiving Environment			
No.	Parameters or Substances	Inland Surface Water	Coastal Nearshore	Marine Offshore	Environmentally Sensitive Areas and/or Groundwater
		Levels or Conditions			
1.	Temperature	35	40	45	NIAA
2.	Dissolved Oxygen	>4	>4	>4	>4
3.	Hydrogen ion (pH)	6-9	6-9	6-9	6-9
4.	Five day Biological Oxygen Demand (BOD_5 at 20^0C)	30	50	100	10
5.	Chemical Oxygen Demand (COD)	250	250	250	60
6.	Total Suspended Solids (TSS)	50	150	200	15
7.	Total Oil and Grease (TO&G) or n-Hexane Extractable\ Material (HEM)	10	15	100	No release
8.	Ammoniacal Nitrogen (as NH_3-N)	10	10	10	0.1
9.	Total Phosphorous (as P)	5	5	5	0.1
10.	Sulphide (as H_2S)	1	1	1	0.2
11.	Chloride (as Cl^-)	250	NIAA	NIAA	NIAA
12.	Total Residual Chloride (as Cl_2)	1	1	2	0.2
13.	Dissolved Hexavalent Chromium (Cr^{6+})	0.1	0.1	0.1	0.01
14.	Total Chromium (Cr)	0.5	0.5	0.5	0.1
15.	Dissolved Iron (Fe)	3.5	3.5	3.5	1.0
16.	Total Petroleum Hydrocarbons (TPH)	25	40	80	No release
17.	Total Nickel (Ni)	0.5	0.5	0.5	0.5
18.	Total Copper (Cu)	0.5	0.5	0.5	0.01
19.	Total Zinc (Zn)	2	2	2	0.1
20.	Total Arsenic (As)	0.1	0.1	0.1	0.01
21.	Total Cadmium (Cd)	0.1	0.1	0.1	0.01
22.	Total Mercury (Hg)	0.01	0.01	0.01	0.005
23.	Total Lead (Pb)	0.1	0.1	0.1	0.05
24.	Total Cyanide (as CN^-)	0.1	0.1	0.1	0.01
25.	Phenolic Compounds (as phenol)	0.5	0.5	0.5	0.1
26.	Radioactivity	NIAA	NIAA	NIAA	NIAA
		Levels or Conditions			
27.	Toxicity	NATE	NATE	NATE	NATE
28.	Faecal Coliforms	400	400	400	100

* all units are in milligrams per litre (mg/L) except for temperature (^0C), pH (pH units), faecal coliforms (counts per 100ml), radioactivity (Bq/L) and toxicity (toxic units)

NIAA-no increase above ambient

NATE-no acute toxic effects

NSD-No solid debris

<-less than

Appendix 5: Ambient Water Quality Standards for Freshwater

	PHYSICO-CHEMICAL PARAMETERS	PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	WATER SUPPLY	RECREATIONAL USE
1	Temperature (°C)	≤ 30	≤ 30	≤ 30
2	Dissolved Oxygen (mg/L)	≥ 3.0	≥ 85% saturation	≥ 80% saturation
3	pH (pH Units)	6.5 to 8.5	6.5 to 8.5	6.5 to 8.5
4	Total Alkalinity (mg/L)	≤ 20	≤ 20	≤ 20
5	Nitrate (mg/L)	≤ 10	≤ 10	≤ 10
6	Total Phosphate (mg/L)	≤ 0.5	≤ 0.5	≤ 0.5
7	Sulphate (mg/L)	≤ 250	≤ 400	≤ 400
8	Conductivity (µS)	Not Applicable	≤ 2,500	Not Applicable
9	Total Hardness (mg/L)	Not Applicable	As Ca: 100 to 300; As $CaCO_3$: 200 to 300	Not Applicable
10	Chlorides (mg/L)	120 to 230 (long term); 640 to 860 (short term)	≤ 250	Not Applicable
11	Colour (TCU)	Not Applicable	≤ 15	Not intense to impede visibility for swimming
12	Hydrogen sulphide (mg/L)	Not Applicable	≤ 0.05	Not detectable
13	Odour	Not Applicable	Inoffensive	Inoffensive
14	Total Suspended Solids (mg/L)	During the dry season: ≤ 25 mg/L During periods of heavy rainfall: a maximum increase of 25 mg/L above background levels, where these levels range from 25 to 250 mg/L. Where background levels are ≥250 mg/L, increase should not be more than 10% of background levels.	Not Applicable	During the dry season ≤65 mg/L. During periods of heavy rainfall, a maximum increase of 100 mg/L above background levels, where these levels range from 65-500 mg/L. Where background levels are >500 mg/L, the increase should not be more than 10% of background levels

	PHYSICO-CHEMICAL PARAMETERS	PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	WATER SUPPLY	RECREATIONAL USE
15	Total dissolved solids (mg/L)	Not Applicable	≤ 600	Not Applicable
16	Turbidity (NTU)	Not Applicable	≤ 5	≤ 50
17	Taste	Not Applicable	Inoffensive	Not Applicable
18	Total Oil and Grease (mg/L)	≤ 1	≤ 1	Not detected as a film, sheen or discolouration, or by odour on water's surface; not detected by sight or odour on shorelines, river banks and sediments
19	Silica (mg/L)	Not Applicable	≤ 80	Not Applicable
20	Sodium (mg/L)	Not Applicable	≤ 200	Not Applicable
21	Ammonia (µg/L)	≤ 320	≤ 500	Not Applicable
	METALS	**PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS**	**WATER SUPPLY**	**RECREATIONAL USE**
22	Aluminium (mg/L)	Not Applicable	≤ 0.2	Not Applicable
23	Arsenic (µg/L)	≤ 5	≤ 10	Not Applicable
24	Barium (µg/L)	Not Applicable	≤ 700	Not Applicable
25	Cadmium (µg/L)	≤ 2.0 (short term); ≤ 0.25 (long term)	≤ 2	Not Applicable
26	Chromium (total) (µg/L)	Not Applicable	≤ 50	Not Applicable
27	Chromium III (µg/L)	≤ 570 (short term); ≤ 74 (long term)	Not Applicable	Not Applicable
28	Chromium VI (µg/L)	16 (short term); ≤ 0.01 (long term)	Not Applicable	Not Applicable
29	Copper (µg/L)	≤ 1	≤1,000	Not Applicable
30	Iron (µg/L)	≤ 300	≤ 300	Not Applicable
31	Lead (µg/L)	≤ 65 (short term); ≤ 1 (long term)	≤ 10	Not Applicable
32	Manganese (mg/L)	Not Applicable	< 0.5	Not Applicable

	METALS	PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	WATER SUPPLY	RECREATIONAL USE
33	Mercury (µg/L)	≤ 1.4 (short term); ≤ 0.026 (long term)	≤ 1	Not Applicable
34	Nickel (µg/L)	≤ 470 (short term); ≤ 25 (long term)	≤ 20	Not Applicable
35	Selenium (µg/L)	≤ 1	≤ 10	Not Applicable
36	Silver (µg/L)	≤ 3.2 (short term); ≤ 0.02 (long term)	≤ 100	Not Applicable
37	Zinc (µg/L)	≤ 120 (short term); ≤ 2.4 (long term)	≤ 5,000	Not Applicable
	PESTICIDES/ HERBICIDES	**PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS**	**WATER SUPPLY**	**RECREATIONAL USE**
38	Aldrin (µg/L)	Not Applicable	≤ 0.03	Not Applicable
39	Chlordane (µg/L)	≤ 2.4 (short term); ≤ 0.0043 (long term)	≤ 0.2	Not Applicable
40	Dieldrin (µg/L)	≤ 0.24 short term; ≤ 0.056 (long term)	≤ 0.03	Not Applicable
41	DDT (µg/L)	≤ 0.006	≤ 1	Not Applicable
42	Endrin (µg/L)	≤ 0.086 (short term); ≤ 0.01 (long term)	≤ 0.2	Not Applicable
43	Endosulfan (µg/L)	≤ 0.06 (short term); ≤ 0.003 (long term)	≤ 20	Not Applicable
44	α-Endosulfan (µg/L)	≤ 0.22 (short term); ≤ 0.056 (long term)	Not Applicable	Not Applicable
45	β-Endosulfan (µg/L)	≤ 0.22 (short term); ≤ 0.056 (long term)	Not Applicable	Not Applicable
46	Heptachlor (µg/L)	≤ 0.52 (short term); ≤ 0.0038 (long term)	≤ 0.03	Not Applicable
47	Hexachlorobenzene (µg/L)	≤ 0.01 (long term)	≤ 1	Not Applicable
48	Lindane (γ-BHC) (µg/L)	≤ 0.95 (short term); ≤ 0.07 (long term)	≤ 0.2	Not Applicable
49	Mirex (µg/L)	≤ 0.001	Not Applicable	Not Applicable
50	Pentachlorobenzene (µg/L)	≤ 6	Not Applicable	Not Applicable

	PESTICIDES/ HERBICIDES	PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	WATER SUPPLY	RECREATIONAL USE
51	PCBs (µg/L)	≤ 0.014	≤ 0.5	Not Applicable
52	Toxaphene (µg/L)	≤ 0.73 (short term); ≤ 0.0002 (long term)	≤ 3	Not Applicable
53	2,4-Dichlorophenoxy acetic acid/2,4-D (mg/L)	Not Applicable	≤ 0.03	Not Applicable
54	Alachlor (µg/L)	Not Applicable	≤ 2	Not Applicable
55	Atrazine (mg/L)	Not Applicable	≤ 0.003	Not Applicable
56	Bromoxynil (mg/L)	Not Applicable	≤ 0.005	Not Applicable
57	Carbaryl (µg/L)	≤ 2.1	≤ 90	Not Applicable
58	Carbofuran (mg/L)	Not Applicable	≤ 0.007	Not Applicable
59	Dalapon (mg/L)	Not Applicable	≤ 0.2	Not Applicable
60	Diazinon (µg/L)	≤ 0.17	≤ 20	Not Applicable
61	Dicamba (mg/L)	Not Applicable	≤ 0.12	Not Applicable
62	Dimethoate (mg/L)	Not Applicable	≤ 0.006	Not Applicable
63	Glyphosate (µg/L)	≤ 27 (short term); ≤ 0.8 (long term)	≤ 280	Not Applicable
64	Malathion (µg/L)	≤ 0.1	≤ 190	Not Applicable
65	Metolachlor (mg/L)	Not Applicable	≤ 0.01	Not Applicable
66	Metribuzin (mg/L)	Not Applicable	≤ 0.08	Not Applicable
67	Paraquat (mg/L)	Not Applicable	≤ 0.007 (as Paraquat ion)	Not Applicable
68	Picloram (mg/L)	Not Applicable	≤ 0.19	Not Applicable
69	Simazine (mg/L)	Not Applicable	≤ 0.002	Not Applicable
	POLYCYCLIC AROMATIC HYDROCARBONS	**PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS**	**WATER SUPPLY**	**RECREATIONAL USE**
70	Acenaphthene (µg/L)	≤ 5.8	Not Applicable	Not Applicable
71	Anthracene (µg/L)	≤ 0.012	Not Applicable	Not Applicable
72	Benzo[a]anthracene (µg/L)	≤ 0.018	Not Applicable	Not Applicable
73	Benzo[a]pyrene (µg/L)	Not Applicable	≤ 0.01	Not Applicable
74	Fluoranthene (µg/L)	≤ 0.04	Not Applicable	Not Applicable

POLYCYCLIC AROMATIC HYDROCARBONS		PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	WATER SUPPLY	RECREATIONAL USE
75	Fluorene (µg/L)	≤ 3	Not Applicable	Not Applicable
76	Naphthalene (µg/L)	≤ 1.1	Not Applicable	Not Applicable
77	Phenanthrene (µg/L)	≤ 0.4	Not Applicable	Not Applicable
78	Pyrene (µg/L)	≤ 0.025	Not Applicable	Not Applicable
79	Total PAHs (µg/L)	Not Applicable	≤ 0.1	Not Applicable
OTHER ORGANIC CHEMICALS				
80	Benzene (µg/L)	≤ 370	≤ 1	Not Applicable
81	Ethylbenzene (µg/L)	≤ 90	≤ 300	Not Applicable
82	Toluene (µg/L)	≤ 2	≤ 700	Not Applicable
83	Xylene (mg/L)	Not Applicable	≤ 0.5	Not Applicable
84	Cyanide (µg/L)	≤ 22 (short term); ≤ 4 (long term)	≤ 50	Not Applicable
85	Heptachlor epoxide (µg/L)	Not Applicable	≤ 0.2	Not Applicable
86	Methyl tertiary-butyl ether (MTBE) (µg/L)	≤ 10,000	Not Applicable	Not Applicable
87	Tributyltins (TBTs) (µg/L)	≤ 0.46 (short term); ≤ 0.072 (long term)		Not Applicable
88	Di (2-ethylhexyl) phthalate (DEHP) (µg/L)		≤ 6	Not Applicable
MICROBIOLOGICAL PARAMETERS		PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	WATER SUPPLY	RECREATIONAL USE
89	*Cryptosporidium* (counts/100 ml)	Not Applicable	0	Not Applicable
90	*Escherichia coli* (counts/100 ml)	≤ 126	0	≤ 200 (geometric mean of at least 5 samples)
91	Faecal coliforms (counts/100 ml)	Not Applicable	0	≤ 200 (geometric mean of at least 5 samples)
92	*Enterococci* (counts/100 ml)	≤ 33	0	≤ 35 (geometric mean of at least 5 samples)
93	*Giardia* (counts/100 ml)	Not Applicable	0	Not Applicable
94	*Legionella* (counts/100 ml)	Not Applicable	0	Not Applicable

MICROBIOLOGICAL PARAMETERS		PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	WATER SUPPLY	RECREATIONAL USE
95	Heterotrophic plate count (colonies/ml)	Not Applicable	≤ 500	Not Applicable
96	Total coliforms (counts/100 ml)	Not Applicable	0	Not Applicable
97	Cyanobacteria (cells/100 ml)	Not Applicable	Not Applicable	≤ 100,000

Appendix 6: Ambient Water Quality for Marine Environments

PHYSICO-CHEMICAL PARAMETERS		PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	RECREATION
1	Temperature (°C)	≤ 32	≤ 32
2	Dissolved Oxygen (mg/L)	≥ 5 mg/L	> 80% saturation
3	pH (pH Units)	6.5 to 8.5	6.5 to 8.5
4	Nitrate (mg/L)	≤ 10	≤ 10
5	Total Phosphate (mg/L)	≤ 0.1	≤ 0.5
6	Total Suspended Solids (mg/L)	Dry season maximum 25 Maximum of 250 during periods of heavy rainfall	during the dry season ≤ 80 mg/L. During periods of heavy rainfall, a maximum increase of 100 mg/L above background levels, where these levels range from 80-500 mg/L. Where background levels are >500 mg/L, the increase should not be more than 10% of background levels
7	Colour (TCU)	Increased colour (in combination with turbidity) should not reduce the depth of the compensation point for photosynthetic activity by more than 10% from the seasonally established norm for aquatic life	should not be so intense or so dark as to impede users in estimating depth, seeing subsurface hazards easily and, for people concerned with their safety, in detecting users in difficulty
8	Total Oil and Grease (mg/L)	≤ 1.0	Not detected as a film, sheen or discolouration, or by odour on water's surface; not detected by sight or odour on shorelines, river banks and sediments
9	Salinity (ppt)	Human activities should not cause the salinity (expressed as parts per thousand [‰]) of marine and estuarine waters to fluctuate by more than 10% of the natural level expected at that time and depth	Not Applicable
10	Ammonia (mg/L)	≤ 0.5	≤ 0.5
11	Odour	Not Applicable	Not detectable
12	Litter	Not Applicable	≤3 items of litter per m2

METALS		PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	RECREATION
13	Arsenic (mg/L)	0.036 (CCC)	Not Applicable
14	Cadmium (mg/L)	0.0079 (CCC)	Not Applicable
15	Chromium VI (mg/L)	1.1 (CMC); 0.05 (CCC)	Not Applicable
16	Copper (mg/L)	0.0048 (CMC); 0.0031 (CCC)	Not Applicable
17	Lead (mg/L)	0.21 (CMC); 0.0081 (CCC)	Not Applicable
18	Mercury (mg/L)	0.0018 (CMC); 0.00094 (CCC)	Not Applicable
19	Nickel (mg/L)	0.074 (CMC); 0.071 (CCC)	Not Applicable
20	Selenium (mg/L)	0.290 (CMC) to 0.071 (CCC)	Not Applicable
21	Silver (mg/L)	0.0019 (CMC); 0.0008 (CCC)	Not Applicable
22	Zinc (mg/L)	0.09 (CMC); 0.081 (CCC)	Not Applicable

PESTICIDES/ HERBICIDES		PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	RECREATION
23	Aldrin (µg/L)	0.0013 (CMC)	Not Applicable
24	Chlordane (µg/L)	0.09 (CMC); 0.004 (CCC)	Not Applicable
25	Dieldrin (µg/L)	0.71 (CMC); 0.0019 (long term)	Not Applicable
26	Endrin (µg/L)	0.037 (CMC); 0.0023 to 0.004 (CCC)	Not Applicable
27	Endosulfan (µg/L)	0.09 (CMC); 0.002 to 0.005 (CCC)	Not Applicable
28	α-Endosulfan (µg/L)	0.034 (CMC); 0.0087 (CCC)	Not Applicable
29	β-Endosulfan (µg/L)	0.034 (CMC); 0.0087 (CCC)	Not Applicable
30	Heptachlor (µg/L)	0.053 (CMC); 0.0036 (CCC)	Not Applicable
31	Lindane (γ-BHC) (µg/L)	0.16	Not Applicable
32	Mirex (µg/L)	0.001	Not Applicable
33	PCBs (µg/L)	0.03	Not Applicable
34	Toxaphene (µg/L)	0.21 (CMC); 0.0002 (CCC)	Not Applicable
35	Carbaryl (µg/L)	1.6	Not Applicable
36	Diazinon (µg/L)	0.82	Not Applicable

	POLYCYCLIC AROMATIC HYDROCARBONS	PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	RECREATION
37	Naphthalene (µg/L)	1.4 to 50	Not Applicable
	OTHER ORGANIC CHEMICALS	**PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS**	**RECREATION**
38	Benzene (µg/L)	110 to 500	Not Applicable
39	Ethylbenzene (µg/L)	25	Not Applicable
40	Tolnene (µg/L)	215	Not Applicable
41	Cyanide (µg/L)	1 to 2 (CMC); 1 (CCC)	Not Applicable
42	Methyl tertiary-butyl ether (MTBE) (µg/L)	5,000	Not Applicable
43	Tributyltins (TBTs) (µg/L)	0.42 (CMC); 0.0074 (CCC)	Not Applicable
	OTHER ORGANIC CHEMICALS	**PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS**	**RECREATION**
44	Di (2-ethylhexyl) phthalate (DEHP) (µg/L)	16	Not Applicable

	MICROBIOLOGICAL PARAMETERS	PROTECTION OF AQUATIC LIFE & AQUATIC ECOSYSTEMS	RECREATION
45	*Escherichia coli* (counts/100 ml)	Not Applicable	≤ 250 (geometric mean of at least 5 samples)
46	Faecal choliforms (counts/100 ml)	Not Applicable	100 (geometric mean of at least 5 samples)
47	*Enterococci* (counts/100 ml)	Not Applicable	The geometric mean of at least 5 samples, taken during a period not to exceed 30 days, should not exceed 35 enteroccocci/100 mL. Resampling should be performed when any sample exceeds 70 enterococci/100ml. However, if it can be demonstrated that *E. coli* or faecal coliforms can adequately demonstrate the presence of faecal contamination in marine waters, then the *E. coli* or faecal coliform maximum limit for fresh waters may be used. If there is any doubt, samples should be examined for both sets of indicators for extended periods to determine if a positive relationship exists.

Appendix 7: Grievance Submission Form

Case ID Number:	
Applicant's Name:	
Sex:	[Male] [Female] [Not stated]
Age:	

☐	I wish to submit complaint anonymously
☐	I demand that my personal details not be disclosed without my consent

Address:
Telephone:
Email:

Description of Complaint:

(Subject of case, when did it occur, location, who is involved, reach, and effects of situation, etc.)

_____

_____

_____

_____

_____

_____

_____

_____

Date of Incident:	
☐	One-time incident/complaint

☐	Happened more than once (indicate how many times):
☐	Ongoing (an ongoing problem)

In your view, what measures would provide solution to the problem?

_____

_____

_____

_____

_____

_____

_____

Signature:	
Date:	

Note: Please Submit your completed form to:

The Community Liaison Officer
[Official Address]/Email/Whatsapp
Trinidad and Tobago